The geeks will say that the rewired World is now one big wire and that distance is dead.\textsuperscript{1,2} We offer a more realistic assessment and a glimpse of the future. Computer networks in orthopaedic and trauma surgery have begun to develop knowledge management systems of better quality.\textsuperscript{3,4} Networks can be used to support clinical assessment and examination either by replicating the clinical interview or assisting in decision-making.\textsuperscript{5} They can be helpful in indicating diagnostic possibilities or in emphasising the relevance of a particular piece of information.\textsuperscript{6–8}

Orthopaedic surgery has not yet fully grasped the remarkable potential of information technology. Instinctive opposition to ‘computer medicine’ is inherent.\textsuperscript{9} Human pattern recognition and memory, if properly trained, are faster and more accurate than any computer system. The problem is that absorbing and retaining the necessary knowledge have become impossible in the wide field of surgery.\textsuperscript{10}

The potential of computers to support information management, administration, research and clinical practice in surgery has hardly been touched. Only simple clinical and administrative information is currently being managed by most hospital information systems. The progress made in surgical information technology is a complicated mix of abysmal failures, near successes and unconditional triumphs. There are many examples of failed promises from vendors of information technology who promote devices designed supposedly to streamline our practice and improve decision-making. One such example is the computerised electronic patient record (EPR). While it is viable in a few hospitals it has yet to become universally available, partly because of a lack of standardised vocabularies and data structures.\textsuperscript{11} The resulting problem, while a boon to vendors, has probably done more to halt the progress of surgical information technology than any other single factor. There have been some outstanding successes in the application of technology to surgery. Laboratory automation is now so standardised that haematological analysis and reporting are taken for granted and computer-driven MRI has revolutionised orthopaedic practice. Simpson and Gordon\textsuperscript{12} stated that “the proper foundation for healthcare computing should be clinical information systems based on the individual patient” and “with such systems, paperless operation is possible”. At present, however, few hospitals can function completely in a paperless environment.

**Acceptance of innovation and change in orthopaedic computing and networks.** The factors which influence the successful adoption of innovation in information technology are poorly understood and often impossible to quantify objectively. Iansiti\textsuperscript{13} found that better outcomes were obtained from the development of ‘system-focused’ technology which gave a high priority to how innovation would ultimately behave within its intended context. Therefore there is a need for close attention to be paid to the problems triggered by the adoption of technology rather than simple acceptance of its performance characteristics. An important factor in the adoption process is the purchasing decision. In industry, Webster\textsuperscript{14} noted that many different parties affect this. Innovations are welcomed by some influencing groups, but are perceived by others as unacceptable system-changing risks, often unrelated to the benefits which they purport to provide. This is clearly demonstrated in the health-care industry in the UK with policymakers, suppliers, hospital managers, primary-care and hospital physicians and sometimes patients all working to different agendas.\textsuperscript{15}

In the UK, within the National Health Service (NHS), as in many countries,\textsuperscript{9} there is a gap between the organisational practice of information technology and government policy. We need workplace access to a computer connected to the Internet to obtain evidence-based assistance with clinical decision-making.\textsuperscript{16} Increasing emphasis on training for health-care professionals, clinical governance and the wider use of evidence in health care may even make it mandatory.\textsuperscript{17} This process is more likely to be manageable, predictable and ultimately successful when users are well aligned and when the Internet offers that assistance in a more user-friendly fashion.\textsuperscript{18}

Major reasons for network failures\textsuperscript{19} are unrealistic

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\textsuperscript{1} J. F. M. Clough, DPhil, FRCS C, Clinical Instructor
\textsuperscript{2} Department of Orthopaedic Surgery, University of British Columbia, 3114-910 W 10th Avenue, Vancouver, Canada V6Z 4E3.
\textsuperscript{3} C. W. Oliver, DM, FRCS (Trauma & Orth), Consultant Orthopaedic Trauma Surgeon
\textsuperscript{4} Edinburgh Orthopaedic Trauma Unit, Royal Infirmary of Edinburgh, Lauriston Place, Edinburgh EH3 9YW, UK.

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implementation timetables, projects of unmanageable size, lack of retrospective review of past systems, and lack of incremental, as opposed to ‘big-bang’, implementation. If there is no feasible alternative to the ‘big-bang’ approach, projects should ensure that the timetable for implementation is realistic. Senior management should be aware of the importance of halting a project which has been overtaken by events rather than merely continuing to spend money.

**Importance of networked information systems for orthopaedic surgeons.** Health Information Management (HIM) is concerned with the management of data and information relating to all aspects of the health-care system. HIM plays a vital role in the management of information resources and technologies which support clinical, administrative and financial information systems in health care. The advantages and disadvantages of networked HIM are shown in Table I.

**Orthopaedic organisations should contribute to the process of focusing attention on the advantages of networked resources.** An easy starting point is a website which is a valuable public-relations exercise. It should provide information about the practice of orthopaedics at several levels such as practical directions for patients, information about orthopaedic conditions, scheduling, teaching commitments, case presentations, information about research, and meetings. Putting it on the Internet is very simple. The organisation of an effective website requires commitment and need. Knowledge organisation requires personnel who have the correct skills of knowledge management and who already have training in organising information, indexing, using computers and negotiating access to library-type materials.

While computer systems are becoming ever more powerful, they are only an aid to problem-solving (Table II) and

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**Table I.** The advantages and disadvantages of orthopaedic networked information systems

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy navigation</td>
<td>Cost of network, hardware and software</td>
</tr>
<tr>
<td>Different forms of information (multimedia)</td>
<td>Cost of maintenance, training, depreciation</td>
</tr>
<tr>
<td>Searchable</td>
<td>Staff salary to support</td>
</tr>
<tr>
<td>Intuitive and easily trained</td>
<td>Licensing of databases</td>
</tr>
<tr>
<td>Up-to-date</td>
<td>Maintaining other ancillary systems, telemedicine,</td>
</tr>
<tr>
<td>Access to huge volumes of information</td>
<td>digital imaging</td>
</tr>
<tr>
<td>Bookmarking</td>
<td>Abuse of copyright</td>
</tr>
<tr>
<td>Allows individual approach</td>
<td>Unlawful use to access forbidden material</td>
</tr>
<tr>
<td>Transferable computer skills</td>
<td>Threats of virus attack, confidentiality breach,</td>
</tr>
<tr>
<td>Intranets have relatively low cost</td>
<td>privacy intrusion, theft, data loss</td>
</tr>
<tr>
<td>Incorporation of legacy systems</td>
<td>Artificial barriers between competing networks</td>
</tr>
<tr>
<td>Easy email communication</td>
<td>(i.e. NHSNet v Internet)</td>
</tr>
<tr>
<td>Access from anywhere</td>
<td>Need for a firewall</td>
</tr>
<tr>
<td>Booking resources with the organisation</td>
<td>Innate resistance to change</td>
</tr>
<tr>
<td>Distribution of web-based teaching and continual medical education</td>
<td>Surgeons rarely know how to type</td>
</tr>
<tr>
<td>Web-based research tools for outcome recording</td>
<td></td>
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<tr>
<td>Electronic orthopaedic images more convenient</td>
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**Table II.** Using computers in orthopaedics

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>More efficient data gathering</td>
<td>Computer processes and ‘decisions’ are inherently different from human ones</td>
</tr>
<tr>
<td>Better data quality</td>
<td>Inhuman</td>
</tr>
<tr>
<td>Overcoming problems of inefficient coding of data</td>
<td>Garbage in; processed garbage out</td>
</tr>
<tr>
<td>May be cost-effective</td>
<td>Initial capital outlay for hardware and software</td>
</tr>
<tr>
<td></td>
<td>Costs in updates and maintenance</td>
</tr>
<tr>
<td></td>
<td>Staff training</td>
</tr>
<tr>
<td></td>
<td>Administrative staff costs</td>
</tr>
<tr>
<td></td>
<td>Storage and rooms</td>
</tr>
<tr>
<td>For patient evaluation computers may be less daunting than long list of written tests</td>
<td>Patients may decline to use computers or may not have the requisite skills</td>
</tr>
<tr>
<td>Tireless – same response irrespective of time of day</td>
<td>Use of computers in patients’ homes may be impractical</td>
</tr>
<tr>
<td>Provide immediate feedback to patients</td>
<td>Crashes</td>
</tr>
<tr>
<td>Informed patients may understand their condition better</td>
<td>Partially informed patients become ‘cyberchondriacs’</td>
</tr>
<tr>
<td></td>
<td>Clinical encounters with better-informed patients may be prolonged</td>
</tr>
<tr>
<td></td>
<td>Information providers use the unique ease of access to computers to manipulate the public and orthopaedic surgeons to suit their own clinical, administrative or commercial needs</td>
</tr>
<tr>
<td>Overcome problems of illegibility</td>
<td>Requires typing or some other interface</td>
</tr>
</tbody>
</table>

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there remains a critical role for intangible human skills such as intuition, experience and imagination. Time and human contact are significant factors. The traditional interface of mouse, keyboard and screens of text allows us to work ‘on’ computers, while techniques such as visualisation will truly enable us to work ‘with’ computers. The attributes of a well-designed network resource are shown in Table III.

**Redundancy of effort of orthopaedic networks.** While the introduction of computer networks to orthopaedic practice may be seen as a technological problem to be solved by programs, planning and funding, this is only part of the story. The need to change existing patterns of behaviour is essential. The advantages of using computers in orthopaedics are many and the disadvantages can be overcome (Table II). The pace with which the Internet has penetrated to an individual level is remarkable but it is not yet integrated into the working patterns of most of us. A review of the journals listed on the Medline database reveals that there are 102 in which the main subject is orthopaedic surgery, hand surgery or sports medicine. It is fallacious to think that we can ‘keep up’ with the literature. Our dilemma with the stream of information has been vividly described as “learning to drink from a fire hose.” Current orthopaedic culture dictates that we carry all the knowledge which we will ever need in our memory ready for instant use. A review of personal operative techniques (JFMC) has shown that the only operation done using the exact technique taught during training is compression plating. Everything else is new or modified, even casting! If the old paradigm is failing it is fortunate that information technology offers new ways to search rapidly, comprehensively and ‘just in time’. Reading the journals for fun and serendipity will still be valuable but we must *teach* how to search and find information when we need it. We should ensure that good information, including the full text of journal articles, is available, accessible and reasonably priced. Search engines for finding orthopaedic information on the Internet must be improved. There are so many webpages with orthopaedic content that it is difficult to find those which hold the quality of information required. Making websites appeal to search engines is a craft which many reputable sites do not consider and there are disreputable traps for the unwary. Searching skills are taught by organisations such as the Internet Society of Orthopaedic Surgery and Trauma (ISOST). Websites like OMNI and OWL have a varying review of the quality of the sites and cannot be comprehensive. It is not clear whether a site is not indexed because it failed the quality review or because it was never considered. All index sites and search engines suffer from ‘link rot’ since the evanescent nature of the Internet causes the linkage information to become rapidly out of date.

In teaching hospitals throughout the world, on a daily basis, works of scholarship are presented to critical audiences. The quality must be high enough to satisfy the teaching staff and indeed much of what we have learned during training came from such events. The value, however, is dissipated as the presentation floats off into null space and the audience leaves. Such presentations should be retrieved for cyberspace. With a clearing house for orthopaedic information, the next person to present the topic would have a flying start. Information technology allows us to do these things if we change our attitudes to embrace it.

**Computer networks and patients.** Most of us have been exposed to the ‘cyberchondriac’ patient who has searched widely, read much, absorbed little and succeeded only in raising his or her anxiety and regrettably our own hostility. Our own efforts of provision of information have not been satisfactory to the patient who has also not been directed to ‘approved’ information resources on the Internet. A recent review of presentations on information technology at the 68th Annual Meeting of the AAOS revealed justifiable concern about the quality of informa-

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**Table III.** Content of a well-designed network resource

| High-quality clinical and administrative content | Regular updates |
| Ease of browsing and searching | Reinforcement of corporate identity |
| Added value to Internet i.e. local resources | Comprehensive and universal access to staff |
| Reliability and availability 24 hours per day seven days per week | Preservation of patient confidentiality |
| Use of style guides to conform and ease navigation of pages | Logical menu structures, useful help and FAQ file |
| Details of authorship, credentials and referencing | Page creation date and date of updates |

**Table IV.** Required areas of coverage for orthopaedic patient information sites on the Internet

| The condition | Name |
| Non-operative treatment | Description of treatment |
| Operative treatment | Procedure(s) |

| Illustrations | Drawings |
| Radiographs | Video |
tion which patients were accessing. It was clearly stated that patients will continue to use the Internet for orthopaedic information and that it is up to us to provide good information and guide them to it. There is a need for a change in attitude so that we form a partnership with our patients and welcome, guide and profit from their thirst for knowledge. In a presentation to the Canadian Orthopaedic Association, Clough proposed subject areas which should be covered in a patient information site on an orthopaedic subject. These include information about the condition, its natural history, options of non-operative and operative treatment and the complications and outcomes of each (Table IV). A review of websites covering total hip replacement was undertaken to examine this criterion-based approach and showed that none of the sites satisfied all the criteria. Even pages posted by highly reputable organisations did not cover all the ground.

Orthopaedic information overload and email lists. Unsolicited email can become a significant problem because the orthopaedic patient perceives all orthopaedic surgeons as experts who could and should be contacted for help. Patients in search of answers seldom appreciate the difference between obtaining orthopaedic information and an opinion about an individual case. It is manifestly unethical, legally perilous and downright stupid for an orthopaedic surgeon to offer an orthopaedic opinion on a patient whom he or she has never seen, examined or investigated. Many orthopaedic surgeons use a standard response.

Membership of an email list is one of the great pleasures of using the orthopaedic Internet. Email provides a unique and fascinating forum for the discussion of orthopaedic problems, usually on a case-by-case basis. Because of the international membership both the problems and the solutions advanced by members are unusual. Membership of even one mailing list results in a large increase in email traffic and strategies are required for coping with overload.

Advanced usage of networked computers in orthopaedics. The application of interactive computer network systems in areas of artificial intelligence, virtual reality systems, decision support and telemedicine is in rapid evolution. These systems need to be introduced cautiously and the impact on patient outcome has to be very carefully considered. Advanced systems will fail by making decisions centrally, setting up central bureaucracy, deciding on applications and telemedicine sites on a geographical needs basis, installing the technology in a ‘grand manner’, and insisting that clinicians deliver telemedicine services without appropriate training and support. It is important to ensure that research grants which establish advanced computer technology networks and systems should have an exit strategy so that useful projects do not die after the funding expires.

We should think of the Internet as a technology with power to change society radically, and specifically the practice and management of knowledge in orthopaedics. Some changes can be predicted. We alluded earlier to the iterative process of forming consensus on a teaching topic. Resources such as the presentations posted at McGill could be taken as the starting point. Each trainee charged with presenting one of those topics should review what has been posted, update, improve and expand it and then repost the result. Both the conduct and the reporting of orthopaedic research are likely to change. Multicentre trials can be opened to everyone who can satisfy the organisers that they can follow the trial protocol. This should make a difference both to the speed with which powerful trials can be completed and to the applicability of their results to general orthopaedic practice.

Implicit in all these glimpses of the future is the need for a clearing-house of orthopaedic information. This would be a site managed by the profession for the benefit of the subject of orthopaedic surgery and ultimately for our patients. Some institution would be required to manage the treatment of orthopaedic topics and threads of orthopaedic research. Clearing-houses for orthopaedic information, such as ISOST and Orthogate, are in the early stages of development. It can be said that the Internet does not need these organisations to promote it any more than we need a society for the promotion of the telephone. However, the case for the Internet in academia is overwhelming. Without a vision and without a push to achieve those goals, global orthopaedic surgery on the Internet will evolve through chaos and no one can predict which institutions will arise to influence our future. The Internet and computer networks may not need promotion but orthopaedic surgery on the Internet assuredly does.

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