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An example of the use of the WWW as a tool and environment for research and collaboration

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Abstract

This paper, being a practice paper, addresses the conference theme directly by reporting on and demonstrating how one idea, in the biomedical field, has been implemented and works in practice. It presents BioMedNet as an example of a new work environment akin to the definition of IOF, as a means to illustrate: one design option (that is actually implemented); one solution strategy (that is currently used and evaluated) and one environment which researchers and practitioners can interact (that can be used as a model).

BioMedNet is a virtual club or cyberclub built on the Internet to provide professional and focused services of interest to its members anywhere in the world. In essence, it is more than just a club. It is a laboratory or office-based working tool giving users powerful resource on their desktop. If all goes according to plan, BioMedNet hopes to become a model workplace of at least the biomedical research community if not the world research community, not only in changing the way researchers work, but also in the way information and service providers such as publishers and online service providers communicate with their customers.

In conclusion, the authors point out the two-fold mission of this paper - to get researchers onto the Information Superhighway, and to show an example of the use of BioMedNet as the way biomedical scientists will work in the future.

Keywords

BioMedNet, cyberclub, model workplace, research collaboration

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1 INTRODUCTION

This paper, being a practice paper, addresses the conference theme directly by reporting on and demonstrating how one idea, in the biomedical field, has been implemented and works in practice. It has been said that the key problem for technology providers will be with integration, not in the integration of the various technologies, but the integration of technology into the social and organisational dimensions of work. Despite technological advances in information and communication technologies, and their wide-spread proliferation in organisations, there is a danger that as office systems and their tools get more sophisticated, they may end up as solutions looking for problems.

The challenge is therefore in the design and implementation of office systems that really *'work'* (Bots, Uijlenbroek and van den Herik, 1995). Hence, this paper presents a real example of a new work environment akin to the definition of the International Office of the Future (IOF) by Bots et al, as a means to illustrate:

- one design option (that is actually implemented);
- one solution strategy (that is currently used and evaluated);
- one environment which researchers and practitioners can interact (that can be used as a model).

This paper merely attempts to provide a model already implemented, so that there is a basis to start answering the questions and issues raised so far, in the hope that we will have some indication whether IOF is a flawed concept or an inevitable future, what other (new) questions that will be raised, as well as potential research directions for both academia and industry.

2 · WHAT IOF MEANS

In this age of rapid technological advances, the term IOF may be seen as one of the many coinages that pops up regularly in the computing world. To the ordinary office worker, what does it mean? Questions like what an office is, what the characteristics of an office environment are and what office work entails are no longer trivial questions to answer or easy to understand.

2.1 Definitions

From examining the literature on this topic, there are many competing terms that mean about the same thing, or at least overlap considerably with office and its association with 'computer-supported work' (Greif and Cashman, 1984; Englebart and Lehtman, 1988; Kraemer and King, 1988; Ellis et al, 1991): office automation, technological support for work group collaboration, computer-supported cooperative work (CSCW), collaborative systems, workgroup computing, group decision support systems (GDSS), augmented knowledge workshops, computer-assisted communications (CAC), group process support system, teamware, decision conferences, coordination technology, flexible interactive technologies for multi-person tasks, computer conferencing, electronic meeting systems (EMS) and groupware.

Adding to this confusion, there is also the reality of office workers who work from home or other remote locations (terms like telecommuting, teleworking and teleconferencing), the globalisation of businesses and communications, and the resulting interorganisational information exchange both nationally and internationally.

IOF can be seen to encompass a number of concepts: Office Automation in the 1970s (Englebart), the CSCW movement in the 1980s (Greif and Cashman, 1984), Groupware (Johnson-Lentz et al, 1992) and 'Groupware technologies' in the late 1980s. Driven by technological advances in telecommunications, networking, groupware etc., significant changes have taken place in the support of the office, the office work and the office workers, as can be seen from Hollingsworth's (1993) account of four generations of office systems and related technologies that found their way into the office.

In an attempt to explore the IOF concept, Bots, Glasson and Vogel organised a series of activities, the first of which began with four position papers presented at the IFIP WG 8.4 workshop held in conjunction with the IFIP World Congress in Hamburg, Germany, August 1994, and two brainstorming workshops, one at the same conference and the other at the IFIP WG 8.3 working conference in San Sebastian, Spain, September 1994.

In the first workshop, the participants were asked to consider the question *'What are the issues that come to mind when you think of the International Office of the Future?'* (Bots and Uijlenbroek, 1995). From an analysis of 45 unique responses recorded, many issues were raised about the 'I' in IOF, and it is not difficult to understand why this is so. With the advances in technologies, there is now a major challenge for organisations to respond to the new world order of working on a global scale unprecendented in history. Practically organisations of all shapes and sizes will no doubt have to find a way to deal with interorganisational information exchange, and combining with the issues raised (see table 1), will have more questions than answers. Nevertheless, it is important that these issues are out in the open so that they can be taken into consideration in future research.

Table 1 Internationalization issues of IOF

we must think about asynchronous work (time zoning)
impact of national policies
different cultures
awareness of participants' background
different languages/translation
interpersonal communication requires more than just vocabular translation
mechanisms for cross-cultural creativity (remove inhibiting differences)
facilities to deal with ambiguities between cultures (slang, cultural terms, etc)
managerial awareness of cultural differences
is foreign experience prerequisite for functioning in an IOF?

In the second workshop, the participants were asked to consider the question *'What do you visualize (or think of or imagine) when we speak of the International Office of the Future?'* (Glasson and Quek, 1995). From an analysis of the 39 unique responses recorded, most of them (about 54%) were clearly technology-related visualisations, and it is not difficult to see that some aspects of IOF is already happening today. Table 2 represents the authors' attempt at clustering some of the responses under the heading of Office work, Office and its environment, and Office systems:

Table 2 Clustered responses to visualisation of IOF

Office work	Office and its environment	Office systems
eliminate dead (i.e. waste) time in decision making (e.g. travel etc.)	transparent remote portability	simultaneous translation
access to flows of telecommuting information		more enriched communications (i.e. multi-media)
asynchronous work	portable office (e.g. satellite connection)	routine inter-organization document and image transfer

There may not be any consensus about what a definition of IOF is, but it is obvious that we are all aware of the kinds of technologies that will shape the IOF, as well as the questions that will continue to be asked. The work place of tomorrow is pointing to one where place and time do not matter, as the technology can bridge the gap of instant communication and face-to-face interaction. The key is to 'get connected' and 'get online', via modems, ISDN, satellite links, etc., and that the office paradigm of a work place will give way to a work space; portable offices such as home offices, cars, airports, airplanes and the subways.

2.2 New work environment

The availability of computers and computing, once strictly in the domain of government agencies, researchers and scientists, has been a major factor in changing the way we work today and in the future. Their pervasiveness in homes and offices, across all age groups and occupational levels, began with the advent of personal computers and other equally inexpensive products in the mid 1970s. Many of the office applications of computers lie in non specialist uses, and the nature of these applications influences the development of interactive systems (Newman, 1987).

Not surprisingly, organisations are increasingly moving toward more flexible working, flatter structures and project-based teams. Living in an age of widespread global communication, office workers are no longer static (geographically), immobile groups working in a single unit. Telecommuting, the technology of bringing the work to the workers than the other way round (Kelly and Gordon, 1986) is already widespread, especially with doctors, lawyers, sales people and researchers. In America, it has been projected that by the end of 1995, about 9.2 million teleworkers will work from home or from remote sites (Wired, Oct 1995).

Another emerging trend and market which impacts upon the office and office work is Groupware, a class of office applications that provide 'electronic, computer-based support for any group of individuals working towards a common goal' (Data Sciences and Novell 1994). Groupware technologies provide integrated email, calendaring, scheduling, desktop conferencing, document management and task management, examples of which are the likes of GroupWise from Novell and Lotus Notes from IBM.

So what will this new environment of the future be like? One prediction for the year 2000 is that it will be about ubiquitous mobile computing (Byte, 1995), of "portable technology for portable work". We can already see a number of examples today. Schools and colleges are embracing the technologies of tomorrow by training a new generation of students experienced with virtual lectures, virtual libraries and virtual collaboration.

2.3 Challenges ahead

Having defined what IOF means, and what the new work environment will be thus sets the background for the remainder of this paper. The promise of a 'paperless office' offered by office automation never came about. office systems as surveyed by Traünmuller (1995), still need improvements in i) providing basic CSCW mechanisms, ii) introducing additional features, iii) models and theories governing interaction, and iv) interdisciplinary approach to design. And the current fad of groupware technologies and proprietary groupware applications may not face up to the more open Internet, which can possibly replace the need for groupware packages (Computer, 1995).

The challenges facing IOF are therefore similar to the challenges faced by those mentioned above. According to Bots et al (1995), "a decade of office systems literature shows that the real problem lies in determining the office functionality for a specific organisation". Hence, developing more modelling tools for office analysis or creating more generic functionalities is not the solution. As Traünmuller (1995) puts it, "most of the easy things have been done".

Existing office computer systems do not always offer the flexibility required to meet the needs of today's user, and the problem is that people need to have access to organisational information in a relatively unstructured manner, access from any location. The answer may lie in the statement expressed by Columbia University professor Eli Noam (1995) about a reversal in the historic direction of information flow: "In the past, people came to the information, which was stored at the university. In the future, the information will come to the people, wherever they are". And this is where the authors believe that the Information Superhighway can hold the key in revolutionalising the way businesses are conducted, offices communicate and workers interact.

3 AGENDA FOR RESEARCH

One of the key topics which this conference is keen to explore, is on the "effective use of the Internet and the Information Superhighway". The Internet is threatening to invade our homes just as the personal computers have done. While the personal computers offer computing power, the Internet offers access to information on a scale unimaginable even a few years before.

There is no doubt that the Internet, and in particular, the World Wide Web, has become an important form of communication. The growth in the Internet's interest and usage has been phenomenal, evidenced from the amount of commercial investment and the number of people who are already connected to it. It will come to be as important a development in communications as the telephone over 50 years ago.

3.1 Information superhighway

The Internet, more popularly known as the Information Highway, is not new. It came into existence in 1969 as ARPANet, a US Defense Department network supporting military research (Krol, 1992). It was developed to satisfy the need for researchers at different geographical locations to be able to communicate with each other on a more rapid basis than they had been communicating (Uhlig, Farber and Bair, 1979). With the development of Ethernet local area networks (LANs) and workstations in the 1980's, it was eventually expanded to include academic research establishments. However, connection only became more easily available in 1982. In the late 1980's, it was superseded by NSFNet which finally allowed everyone access to the network.

Today, the Internet is a technology that is extremely mature and practical. Internet access could not be simpler, as practically anyone, from educational institutions to private individuals can get access by using a personal computer, an Internet Access Provider (IAP), a phone link and some type of access software (PC User, 1995).

With the explosion of popular interest in networked computer systems and the Internet, this conference is expected to play an important role in framing and extending the discussion about the role of the Internet in the future of work and its work place.

3.2 Research collaboration

Ironically, despite the fact that researchers have always been the first to benefit from Internet access, it did not exactly take off until 1992 with the introduction of the World Wide Web (WWW), a collection of servers working together to form a graphically-based hypertext network which can incorporate many different text styles, pictures, sound and video (PCM, 1994). Today, the Internet is often quoted as being made up of 50,000 networks, four million computers and 30 million users (though no one knows exactly what the real size is).

Revisiting the original purpose of ARPANet, and examining the purpose of this conference, it seems coincidental that they both have similar aims, that of satisfying the needs of researchers. In the words of this conference, it is to "provide a forum and prototype environment in which researchers and practitioners can interact". In this light, the authors have deemed appropriate to explore IOF in the context of using the Internet towards future research collaboration.

One of the main facets of research collaboration is the need for access to information relevant to the research topic at hand. Traditionally, libraries and online information and services providers have catered to the researchers' needs. Information search and document delivery are areas that are affected by the way the information is held in the first place, and as more and more information are being made available on the Internet, researchers will need to use the 'virtual library' more effectively by learning to use the cognitive gateway with which to approach an access source and the concept of a search strategy and its formulation (Loomis and Fink, 1993).

Another facet of research collaboration is the need to work and interact with other fellow collaborators which involve discussions and meetings. Undeniably, the most effective way of holding a conference is to *"actually gather the people together in a room, for face to face discussions. In such a discussion, the full richness of non-verbal expressions, facial expressions, inflections of the voice, and what is called 'body language' contribute significantly to the ability of an individual to convey to the audience the meaning underlying his words"* (Uhlig, Farber and Bair, 1979). However, given the demands on the researchers today and the technologies that are available, there are feasible alternatives to meetings and conferences which can be just as effective, e.g. two-way video conference, telephone conference and computer conference.

One other facet of research collaboration is the culminating in the production of a research document, such as a research paper to be submitted for publication in an academic journal. The point here is that the publication of research papers in traditional academic paper-based journals are painfully slow as the publication cycle is still time consuming. Even the fastest of scholarly publications would normally take between 4-8 weeks. However, the Internet has already shown that electronic publishing can cut this cycle time. To quote the chairman of McGraw-Hill Joseph Dionne, *"If you take this (Internet) technology, you have someone submit his research, have it reviewed by knowledgeable people, the process could be done in a week or two weeks"* (Financial Times, 1995).

As can be seen, the Internet is changing all the above facets of research collaboration. It is not a case of the Internet needing the researchers, but the researchers needing the Internet. This paper

aims to provide one design option (that is actually implemented) of an Internet application that focuses on this topic of collaboration for researchers.

3.3 BioMedNet as an example

In line with the thinking of the IOF series of events, an Internet application which the authors are involved with seems to lend itself very well to "present a real working environment in which researchers and practitioners can interact".

BioMedNet is a new club built in cyberspace, offering a new work (virtual) environment for its members. It offers i) meeting rooms for real-time discussions that can incorporate the simultaneous sharing of documents and images, ii) searchable noticeboards that are set up by societies, journals or conference organisers, iii) a full-text electronic library featuring an extensive collection of journals and databases in biomedicine, and iv) a shopping mall which provides information, catalogues and ordering mechanisms for relevant products and services. Using a variety of search strategies, including searches on chemical sub-structures, members can purchase and retrieve individual items/articles from the library or take out on-line subscriptions.

BioMedNet can be seen as falling under the CSCW banner, where *"the need of people to co-operate in groups when doing their work, with the distinctive feature being identified that people liked to move to the workstation style usage"* (i.e. usage of their personal computer to work individually and with others).

BioMedNet, already a researcher's tool on the Internet, thus seems very relevant to the agenda set for this conference. The authors aim to illustrate BioMedNet by way of a live demonstration of researchers collaborating together on a specific task, so that everyone in the audience will be able to experience first hand how it can work and cannot work, thereby to start answering the questions raised so far, and to raise new questions.

4 WHAT BIOMEDNET IS

BioMedNet is the world's first working environment built in Cyberspace for researchers, scientists and clinicians in all areas of biology and medicine (The BookSeller, 1995, Electronic Press 1994). It is based upon the simple concept of a club, which allows people of similar interests to get together to share ideas, resources, and services. Members may be separated by geography and time-zones, but the resources they share, from the library to the real-time discussion groups, are central to their working lives, and being a club will help to provide a professional and focus service to its members.

The club concept is a very powerful metaphor (as is explained in the next section), especially with the way the Internet is today. Despite the Internet's big advantage in providing instantaneous and all-hour accessibility to the huge amount of information on offer, its biggest downfall to date is its lack of 'organisation', where its growth has been almost organic, without a clear set of rules as to how it should be developed. As the Internet's potential continue to excite many quarters as a medium of global communication, there will certainly be a push towards making the Internet more 'organised' and secure. One such example is the OCLC Office of Research project, which started the categorisation of textual information on the Internet, and this could lay the groundwork for classifying traditional reference sources to enable better searching of information on the Internet (OCLC, 1992).

In this light, BioMedNet can thus be seen to be taking a step towards not only belonging to a new generation of Internet-enabled systems, but also to help with some of the 'sign-postings' on the Information Superhighway.

4.1 Concept of a club

"Although scientists can already discuss issues with like-minded scientists, join user groups with specific interests, gain limited access to journals and order books on the Internet, these activities have not yet been brought together in a single space designed for researchers."
The above statement can be seen as the design goal of BioMedNet. BioMedNet is not about merely having an online presence on the Internet. It is about building an environment on the Internet where researchers can work either individually or with others. It addresses the issue of the needs of researchers on the one hand, and the opportunities or problems (depending on your personal point of view) of the Internet on the other.

At this point, it is important to also briefly discuss about the role of online services today like online databases such as Dialog, online services such as Compuserve etc in light of the Internet. There is a number of differences between online services and the Internet, and understanding these differences would reveal why the former will continue to prosper along side the Internet instead of being swallowed by it. For example, unlike the Internet, forums provided by online services are moderated, and any information uploaded are checked to prevent from infringement of copyright. The information and services provided are focused and targeted at specific groups of users of the services. The Internet however, is a 'free-for-all' situation, and there is little or no control over what is said and what is done. Already, despite the relatively young age of the Internet, the Information Highway is filled with masses of information, and in a way, is already the Information Junkyard since all kinds of information are being dumped on it.

Online services such as Compuserve has been described as 'a kind of club of clubs' (PCM, 1994). It is a club which not only can offer its own proprietary services, but also services of others. This concept is also adopted by BioMedNet as a means to achieve a positive and responsible answer towards imposing some form of control over content, use and membership on the Internet. The idea of BioMedNet is therefore to create a virtual club or cyberclub to provide professional and focused services of interest to its members anywhere in the world. It is like an imaginary space around which BioMedNet provides the walls for researchers in the field of biology and medicine. The use of the club metaphor is not unlike the real scientific world, where clubs and societies emerged to cater to the specific interest of their members, and like-minded people form a closed circle to share similar interests and work together for their own professional interests or towards the general well-being of the club as a whole. A club will therefore be the natural place for like-minded professionals to conduct their professional work and further their interest, with the traditions of reward for recognised contribution. It will be the place where they will feel comfortable, and to know that they can expect certain services provided by the club as privileges enjoyed as members.

Recognising the tradition in the scientific community to work in societies with like-minded professionals, there is also further evidence drawn from the Theory of Clubs* (Buchanan, 1965; Ng, 1973; Berglas, 1976; Helpman and Hillman, 1977) to suggest that the club concept is not merely a use of a metaphor for understanding and designing work systems on the Internet, but also recognising a very important aspect of the social, political, economic and professional arrangement in the scientific community, which lends itself very well to provide a natural way of organisation for

* Many characteristics of collaboration are similar to that of a club.

researchers using the Internet. A club will therefore be able to offer both services as well as rules and regulations that all members must obey and observe for the interest of everyone. There is also the implicit and explicit respect for order and professionalism within the scientific community. Unlike the Internet where unmoderated forums and data conferences can degenerate into 'slanging' matches, the club will be able to facilitate the respect for intellectual and professional discussion.

The club concept in the electronic world, is also an active conduit among the members, the societies and the publishers. As a club of clubs, it brings together the three parties much closer than ever before as evidenced by comments made below:

"On the outside people are running around like crazy: there is disorder and confusion. Inside it is beautiful. There are guides to explain where to go and what to do. There are places where you can go to chat with friends, and in this space we go to all the buyers and say come and buy, we go to all the sellers and say come and sell. If we can get them to interact within the space, we will have created another sort of business." - a publisher

"Most people will go to a site if their friends go there. The scientific community is organised into groups (and as such), should be recruited as groups. For example, if you get the members of the editorial board to join all at the same time, then everyone else will follow." - an immunologist

4.2 Club membership

As a professional club, BioMedNet is similar to any scientific and professional clubs in the biomedical field. Researchers can apply for individual memberships. Alternatively, if they are already members of societies that have applied for society memberships, then their members can become members too. Members will pay a fee to use the club services and facilities for a period of time which is renewable.

BioMedNet also brings the societies, the publishers, information and services providers, and the members more closely together. In order for BioMedNet to achieve its fullest potential, it is imperative that the three groups must work together to make this new club workable and sustainable. At the time of writing, BioMedNet already has about 4,000 members, 10 societies and and 20 publishers working together. By the end of 1995, the projected figures are 12,000 members, 25 societies and 40 publishers, growing to over 100,000 members during 1996. We shall look at what the club can offer to each of the group in turn:

For the societies

Any society's role is to serve the interest of its members. Many societies have already recognised the importance of the Internet and the information sources that are relevant to their members. Participating in BioMedNet thus give their members an instantaneous 24-hour club service. Societies' journals and publications are the obvious candidates to provide an electronic version. Not only will their publications be searchable, but other societies' publications will be available too for cross-searches.

University College London, part of University of London, UK, became a member of BioMedNet in 15 November 1995, and in effect, all its 15,000 students become members of BioMedNet too.

For the publishers, information and services providers

It has become necessary for publishers, information and services providers to have a presence on the Internet, and this means making available an electronic version of current services and products. Increasingly, information becomes available on the Internet even before the printed version, and there is also 3-D Molecular models and scientific text that are available only online with no print equivalent.

Being a club of clubs, BioMedNet allows other publishers, information and services providers, whether big or small, to participate in setting up an environment providing relevant services and products to a target group without having to resort to a go-alone approach. For example, publishers do not have to put their titles into the BioMedNet database in order to sell articles through the system. They can hold all their journals on their own server, and if a BioMedNet member wants to access a journal held by a publisher, the BioMedNet software will forward the request to the publisher who can then sell the copy of the article for whatever price it chooses. For others who do not have the capability to go into electronic publishing, BioMedNet, from its range of services, can offer a service to other publishers, or societies to provide the administration, database design, maintenance, software development, customer service, and technical support.

For the members

It is obvious that with the tradition of scientific research, researchers become members of professional societies to collaborate with others in a professional environment. BioMedNet offers a similar arrangement which is an extension of the current practices. It offers tailored services to suit the interest of its members.

Each member will have a profile. Part of the profile will be information other members can see. They will be able to search for members according to the information in this part of their profile. This is particularly useful for searching for members who share similar interests to collaborate together. Another part of the profile will be for controlling access and manage charges which is confidential to the club. Each member will be obliged to have a personal account, usually based on credit card or bank credit arrangement. It will allow the club to charge all purchases approved with the personal password to be charged by the club against the members personal account.

Each member will be able to have a number of additional accounts, such as an institutional account where the member's institution will agree to pay for member purchases. The profile will also contain information on any discounts or access privileges a member may have, e.g. discount given by publisher for members subscribed to paper version of the publication, or member of a society.

4.3 Electronic library

The BioMedNet library provides members with the full content of an extensive collection of journals, monographs, dictionaries and databases, which is one of the largest online collections in biomedicine. Via the Internet, it increases the accessibility and speed up the delivery of information by sending it directly to the member's computer. Members will be able to search the entire body of research literature in the field of biology and medicine for articles and references. They will then buy the material they want at the price of a copyright fee to the publisher. This will enable them to cut and paste the material, keep it in their files, or print it out. It moves away from a single concept of the 'research article' as the sole and exclusive way of disseminating research information. It enables detailed and related literature to be searched in a well-stocked but focused electronic library, together with other products put up by other publishers, information and services providers.

Another feature of the library is the creation of a citation web, which is the creation of bi-directional links between any citation (reference) and

- bibliographic database e.g. Medline entry for the citation;
- a full text document of the citation (if available);
- any other document containing the citation as a reference.

This will allow browsing by following a citation trail and maximise the number of pointers at any item in the library, increasing the opportunity for a hit (for the member) and a sale (for the supplier).

To help with the searches, the library operates a sophisticated search engine, using helpful lists (authors, sources, etc.), user-definable relevancy, intelligent numeric ranges (dates, measurements etc.), and a thesaurus. Also, searching is not limited to text; tables, captions, mathematical symbols, and chemical structures are searchable as well. For example, chemical substructures are stored and retrieved via MD Molfile format, the industry standard for chemical substructure data. This is the beauty of the electronic medium where graphics and images are seen in their full glory; can be displayed in full colour, and can be rotated or sized in a variety of ways.

There is also a choice of output. Abstracts, to full text of an article can be accessed and printed in PDF format (optimised for printing), or as web pages from whichever browser that the members uses.

By far, the main distinction between the BioMedNet library and other electronic libraries that exist on the Internet already (in a sense they are all electronic libraries), is that the web pages retrieved will be highly interlinked. The simple retrieval of a web page will be given value added from the cross-linking achieved as a result of publishers and other information providers working together to service a community. Such interlinking is very useful and important. For example, it enhances the opportunity to come across interrelated things on the off-chance, such as finding a citation with an offer to purchase the full text there and then. For the researcher, it is very useful as it allows the following of a train of thought more easily and more likely to navigate to other relevant links.

Librarian service

Like in a real library or society, the club has a librarian that members can go to for assistance, a free service as part of the membership.

4.4 Discussion groups/conferences/lecture theatres

In the scientific world, the format of conferences and meetings is a guide for structuring the social dynamics on the Internet because it already works that way and people are familiar with. One definition of a conference is *"a special meeting called to bring a group of qualified individuals together for the purpose of discussing (and hopefully solving) problems or sharing information on a specific subject or related group of subjects"* (Uhlig, Farber and Bair, 1979).

Hence in BioMedNet, it offers a number of rooms to provide facilities for discussion rooms, conferences, lectures and seminars, thereby providing a collaborative work environment enabling members to reserve meeting rooms for real-time discussion while at the same time sharing documents and images. This facility can be used for virtual lectures and discussions, and could even be used by journal publishers to carry out their peer review process.

Discussion rooms

A discussion room is a private room where participants must be on the invitation list. A number of meetings can be held in it over time, and a record of dates, times and notes on the meetings should be maintained. The main purpose of these discussion rooms is to provide a way for a group of collaborators to meet, discuss, work on documents of various types together, and keep a record of their meetings.

In this room, all participants have an equal right to speak. However the initiator of the meeting has a control of certain functions, such as changing a document (word processing, graphics or other one) while all can see the changes and can save both the conversation and the changes on their local machines for future reference. The initiator can also pass the control to others in the room. The room can stay open until the initiator closes it.

Public rooms

Members will also be able to open a public discussion room. It will have the same facilities as the private room but every member will be able to enter it freely, and the room will be listed in a list of currently open public rooms, with their title and other information available.

The rooms have the facility of opening and closing at specified times and dates, and rooms open beyond a reasonable time will be closed by the club after suitable checks.

Lecture rooms

The lecture rooms are rooms where the speaker has control over presentation, while other members present in the room can pose question or comments, but the speaker has an option on when to ask for them and when he wants to reply. There is an interrupt option, allowing a 'listener' to interrupt the speaker to pose a question. Because it is a club and the identity of the member is known, it will be less proned to abuse such as interrupting by dissent.

The lecture rooms can be private or public, just as the discussion rooms can

Noticeboards

Notice boards and news groups are also part of the BioMedNet system. Societies, journals, conference organisers and groups of members can also set up their individual noticeboards, and for cross-purposes, are fully searchable.

Conferencing tools

BioMedNet is currently working on customising Netscape Chat, an IRC real-time chat client application for use within its meeting rooms. The current major conferencing tool used within BioMedNet will be for data only so that it provides the lowest common denominator to all its members. As the bandwidth improves and members have higher specification machines, BioMedNet will certainly introduce voice and video conferencing tools when the time comes.

Also, as a business partner with Netscape, BioMedNet will gain from working with others, for example, the acquisition of Collabra by Netscape incorporate Collabra Share groupware capabilities into Netscape Navigator browser and Netscape servers in early 1996 (Information Week, 1995).

4.5 Shopping mall

BioMedNet offers a shopping mall which provides information, catalogues and ordering mechanisms for relevant products and services, and all information is fully indexed and searchable. Through a

sophisticated, state-of-the-art billing mechanism to ensure a secure method of buying online, members can order products and services from the supplier directly conveniently and hassle free.

4.6 Billing system

Pricing and developing billing systems on the Internet are new areas for businesses. BioMedNet is working with Netscape and Oracle to develop a Billing System for its use.

Pricing options is left to the publishers to decide the price of accessing the full text of publications, databases, whether individual articles/records, or by online subscription. Publishers can change the price of access (at reasonable intervals) and set different prices for different types of articles (e.g. review article vs book review). They can also set different prices for the same title, based on member profile criteria (e.g. society affiliations, print subscribers, personal or institutional subscribers etc.).

4.7 Job exchange

Another service offered to members of BioMedNet is a Job Exchange service which provides related and relevant job posting, such as positions wanted and available.

4.8 More than just a club

BioMedNet exploits the potential of the Internet and the advantages of a club concept to open up the opportunities for other related activities, services and resources to be made available to its members. In essence, BioMedNet is not exactly publishing, bookselling or document delivery. It is also not just a club, but a laboratory or office-based working tool giving users powerful resource on their desktop. If all goes according to plan, BioMedNet will eventually become a model workplace of the world research community, not only changing the way researchers work, but also the way information and service providers such as publishers, online providers etc. communicate with their customers (The BookSeller, 1995).

5 BIOMEDNET IN ACTION

"I imagine that the easiest, most natural way for a biomedical scientists to work, should be inside BioMedNet."

The vision statement above, to some, may seem like a bold claim. It is not easy for researchers who have worked individually or collaborated with others to be told that the way they have worked in the past thirty years may not be that natural in the future, and to give way to a new way of working on the Internet. On the surface, it may sound daunting, but in actual fact, researchers have been gradually exposed to whatever technology that come their way, from online services, CD-ROM databases to the more common telephone and fax correspondences. The Internet looks like the next most popular mode of information gathering and communication channel right from the researcher's own desktop computer.

The purpose of this paper is not to prove or disprove the vision statement, but rather, in the context of IOF, to provide a model already implemented, so that there is a basis to start answering the questions and issues raised so far, in the hope that we will have some indication whether IOF is a

flawed concept or an inevitable future, what other (new) questions that will be raised, as well as potential research directions for both academia and industry.

Hence, it is useful to examine how BioMedNet works, and what experiences we can draw from the field of biology and medicine in their effort to herald in the work environment of the future. As this is a practice paper and the medium of presentation is a live demonstration of BioMedNet, it will not be possible to capture its essence on paper. Instead, the authors will present two scenarios in this paper, one on how researchers work individually, and another on how they collaborate with others, and then describe how using BioMedNet will provide a change of tools, interaction and environment in the way that they work in the future.

5.1 Working alone

In Table 3, the authors present a scenario, albeit a simplistic one, to highlight the way a researcher works individually via non-Internet means, the Internet and as a BioMedNet member.

Other possible scenarios are listed below, and due to space constraint, will not be expanded.

Finding research literature:

- usage of search facilities available;
- finding information from a specific resource;
- searching for full-text of cited reference in an article in a journal;
- browsing for information.

Preparing and producing research document:

- typing materials gathered in a word processor;
- copying any information (text, pictures, tables) into the document;
- usage of personal bibliographic manager and electronic documents;
- usage of spelling checkers, thesauri, special characters or symbols;
- usage of measurement tables and conversions, chemistry and mathematical writing aids;
- performing statistical analysis of data.

In the Functional Analysis of Office Requirements (FAOR) Project (Shafer, 1988), the project developed the concept of 'office technology potential', which is "the potential of the office system to change the support of office work". This concept is useful, not only in the case of an office system but also BioMedNet, as an analysis of its potential (categorised as possible quality improvements in the form or the handling of the information objects due to support by office technology) will help to identify possible improvements or deteriorations in the support of office activities. In BioMedNet, the Internet technology plays a very important part in defining and changing the way researchers work in the future. Therefore, we must look at the situation before and the situation after its introduction. To date, BioMedNet is an example of having merely identified the potential, so there will be room for further research.

Table 3 Scenario of a search for the full-text of an article in a journal

Activities	Non-Internet Researcher	Internet surfer	BioMedNet member
Library Search Collection of information in various media. Library provides resources acquired as well as from information services and products by commercial providers	Visits the library, or use online library system from library's or researcher's desktop computer to check whether library subscribes to journal, and that copies are available for browsing or loan. Also uses various online services and databases	From researcher's computer, uses Internet search tools to locate journal or journal publisher. Visits publisher's web site	From researcher's computer, uses web browser bookmark to go straight to BioMedNet Club home page. Log onto BioMedNet using membership name and password. Searches BioMedNet library for journal article
Requires assistance with search Cannot find journal article. Needs further assistance to determine other means of acquiring it	Seeks librarian for help with further search, perhaps available via interlibrary loan	Virtual library, but no librarian support. Perhaps post email	Goes to electronic librarian page and posts message for guidance. Electronic librarian responds immediately with relevant information
Contacts Publisher direct As a last resort, contacts the publisher of journal for assistance	Finds out contact telephone, calls customer service department of publisher for journal article availability	Checks publisher web site for reprint service online. If not, jots down telephone and calls customer service department	Found bibliographic reference with full-text available
Document delivery Publisher has reprint service. For a fee, full-text reprint of article from the journal arranged to be delivered to researcher	Researcher agrees to pay a fee for reprint and to be delivered via post within x time	Publisher has full-text document online. Makes credit card payment and gets authorisation to download document in PDF or HTML format	Makes use of membership payment account to pay for document conveniently. Downloads document in PDF, HTML or SGML format

5.2 Research collaboration

In the scientific community, it is often common for researchers and scientists to collaborate with others with similar interests. They may be from the same or different organisations. In fact, most often a number of individuals representing their organisations will work on something together without getting together physically to collaborate. It is a virtual organisation of people void of geographical distinction, physical space or physical place. When they do meet up face-to-face, it is often at conferences or society meetings, on a social level rather than actual work basis. Collaborations range from writing papers together, sharing data collected to continuing research and investigation of someone else's work.

For the scenario to depict research collaboration, perhaps the best visualisation of BioMedNet is from the following interview with Vitek Tracz, the visionary behind BioMedNet (BookSeller, 1995):

"Say I am writing a paper (in London) and my collaborators are in New York and Tokyo. We can all three of us meet here, and we can start talking to each other across the world. We can go to the library and look up articles and we can send pieces of text to each other. In the end we have a record of everything that we have been working on. We have effectively had a meeting.

At present, if three scientists want to work on a paper together, it can be very hard for them. They can use the fax, they can talk on the telephone. It is however (difficult and cumbersome), when you want to find something from the library. As things are, the speed at which you can search and see the real thing is very slow."

When a number of members are working on a document together, everyone will all see the same document, able to make changes and additions to it using tools, aids, macros etc. available to them from the club, their desktop, or downloadeble plug-ins from external suppliers. Scripts typed by one member can be seen by others in real time. The changes made can be saved and a record made of the discussion and the changes.

The multimedia capabilities of the Internet will also provide the means to work on illustrations together, or on tables, calculations and chemical problems. There are already examples of researchers working on the same chemical structure via VRML modelling.

5.3 Change of tools, interaction, environment

BioMedNet, as a collaborative tool, allows members to exchange ideas and information, to circulate and annotate documents, to communicate in real-time, and even to attend virtual conferences and lectures complete with colour illustrations and real-time question and answer sessions. As a work tool, it is a powerful desktop resource, providing access to an extensive library of journals, monographs and databases. As an environment, it brings together publishers and information services providers, societies and researchers so that relevant resources, products and services can also be researched and ordered directly through the system.

The BioMedNet experience has shown that the changes that are taking place are not exactly new, or for that matter, considered as real changes in some quarters. This is because the above description of BioMedNet is actually an ideal and natural environment that researchers have always dreamt of, and it may actually be a much closer reality that we think.

There will still be a certain amount of resistance to change that has to be overcome. On one hand people may not be Internet-aware or familiar with BioMedNet, and on the other hand, people who are sceptical that this vision of the future is possible.

Nevertheless, BioMedNet, despite its early days, can be seen as the first of a new generation of Internet-enabled systems that will help bring this reality to the fore. However, though the paper has shown how BioMedNet was designed and the choice of its solution strategy, it must be noted that it still has a lot to learn and implement to allow it to achieve its full potential.

It will be officially launched in mid February 1996, and come April 1996, the authors will hope that they will be able to report back more experiences and lessons learnt in their contribution towards this IOF conference.

6 CONCLUSION

This practice paper has a two-fold mission: i). to get researchers onto the Information Superhighway, and ii). to show the example of the use of BioMedNet as the way biomedical scientists work in the future. Having said that, it does not mean that they are mutually exclusive or that one must happen before the other can. In fact, they are so closely intertwined that you cannot have one without the other.

To get researchers onto the Internet, it is no longer a question of why, but how. BioMedNet has taken the initiative to encourage publishers, societies and researchers to help build this new environment. It is a big challenge as anyone can imagine. It would be unheard of today if a researcher would to claim that he does not use the telephone as a means of communication. The same can be said about the Internet in the near future. As one Immunologist commented, the real challenge is not the group that is already on the Information Superhighway, *"but those who would sooner pick up the phone than e-mail are the ones you want to reach"*.

To show the example of the use of BioMedNet, it is providing the investigation of the IOF concept with an example of a design option and a solution strategy that works in practice. This must not be misconstrued to say that BioMedNet is the 'total solution', or that it has implemented all the features available within its design. Office systems of today still have 'big deficiencies' that should be improved by adding specific CSCW functions (Traünmuller 1995), and BioMedNet is no different. With the emergence of CSCW as a body of research concerned with the social organisation of human conduct in technologically mediated cooperative work environments, it will help prevent the problems of earlier attempts at introducing technology to the work place taking a technocratic approach in the design and implementation of office systems.

And in order for BioMedNet to work as a model workplace for at least the biomedical research community, it is vital that support is forthcoming from the publishers, the societies and the researchers. Only time will tell whether BioMedNet's model can really become the model work place for the world research community for other fields and disciplines as well. And the involvement with this conference will allow BioMedNet and the authors to help speed up this learning process.

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