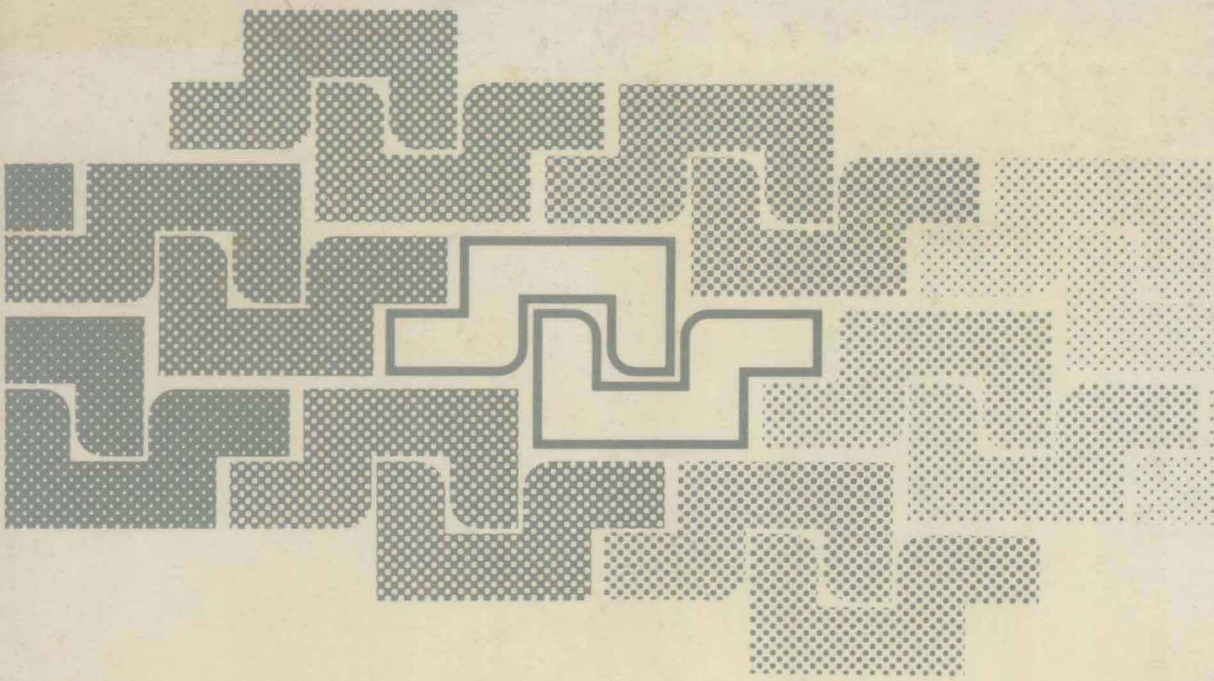

Information Technology and the Computer Network

Edited by K. G. Beauchamp

NATO ASI Series

Series F: Computer and System Sciences, Vol. 6

Information Technology and the Computer Network

Edited by

Kenneth G. Beauchamp

Director of Computer Services, University of Lancaster
United Kingdom

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Series F: Computer and Systems Sciences Vol. 6

FORWARD

This volume contains the papers presented at the NATO Advanced Study Institute on Information Technology and the Computer Network held between August 21st and September 2nd, 1983 at Bonas, France. Previous meetings on a continuing theme of computer networking were held in 1978 and 1981 and published under the auspices of the NATO Scientific Affairs Division as volumes C80 and C42 of this series.

The purpose of this latest meeting was to provide a study of the current achievements in network technology, the emerging needs for services and performance together with the theoretical and technological methods under development for the attack on the consequential problems. A background of tutorial information was given by lecturers concerned with the implementation and research into Information Technology Networks at both national and international level. Attention was directed not only to existing and planned systems but also to the theoretical and mathematical developments in Information Technology Management upon which the future of the present development is based. Lectures and panel discussions included the subjects of wide-band communications, distributed computation, message handling, security, network management, integrated services digital networks, mathematical development and network performance.

Nearly all the contributions to this meeting are included here and should provide a valuable contribution to the literature of this dynamic field. This should provide an authoritative overview of current developments as well as pointing the way to future directions and should be of use to Communication Specialists as well as those concerned with Computer Operations and Development.

The Editor would like to acknowledge the financial support of NATO Scientific Affairs Division and the European Research Office of the U.S. Army for making this meeting possible and extend his thanks to his Co-director, Dr. J. Howlett, Professor Simon of the University of Paris, and to all those who assisted in the organisation of the meeting.

Finally thanks are due to the authors of the papers who have provided such a valuable compilation.

K.G. Beauchamp
Lancaster,
October, 1983.

NATO ASI Series

Series F: Computer and Systems Sciences

No.1

Issues in Acoustic Signal - Image Processing and Recognition

Editor: **C.H.Chen**

Published in cooperation with NATO Scientific Affairs Division
1983. VIII, 333 pages. ISBN 3-540-12192-7

This volume of the NATO ASI series is primarily concerned with underwater acoustic signal processing and seismic signal analysis, with a major effort made to link these topics with pattern recognition, image processing and artificial intelligence. The approach of artificial intelligence to acoustic signal analysis is completely new, as is the pattern recognition method to target motion analysis.

No. 2

Image Sequence Processing and Dynamic Scene Analysis

Editor: **T.S.Huang**

Published in cooperation with NATO Scientific Affairs Division
1983. IX, 749 pages. ISBN 3-540-11997-3

This volume contains the proceedings of a NATO Advanced Study Institute held 21 June - 2 July 1982 in Braunlage/Harz, Federal Republic of Germany, which was devoted to the rapidly emerging field of analyzing time-varying scenes and imagery. Twelve invited papers and twentysix contributory papers cover a wide spectrum of topics which fall into three overlapping categories: displacement and motion estimation; pattern recognition and artificial intelligence techniques in dynamic scene analysis; and applications to diverse problems, including television bandwidth compression, target tracking, cloud pattern analysis, cell motion analysis and description, and analysis of heart wall motion for medical diagnosis. About half of the invited papers are tutorial overviews, while the rest - along with the contributory papers - describe the most recent progress in research.

Springer-Verlag
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Heidelberg
New York
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No. 3

Electronic Systems Effectiveness and Life Cycle Costing

Editor: **J.K.Skwirzynski**

Published in corporation with NATO Scientific Affairs Division
1983. XVII, 732 pages. ISBN 3-540-12287-7

This volume contains the complete proceedings (including verbatim texts of several panel discussions) of a conference on the whole field of reliability and life cycle costing of modern electronic, computer-based systems. It contains a braod introduction to mathematical techniques supporting the field of technology, i.e.statistics, queuing theory, stochastic calculus, decision and utility theory. It presents reliability disciplines adopted by large organisations such as NASA, COMSAT, defense establishments in the USA and UK, in nuclear engineering and other areas. It concentrates both on hardware (including mechanical systems) and on software.
These proceedings are an up-to-date statement of problems solved and problems encountered in prediction the behavior of electronic systems, their maintainability, spare allocation and operational costs. An especially important feature is the concentration on diagnosis of system malfunctions.
Subjects covered in the panel discussions include: empirical prediction of failure rates; reliability and safety of computer based systems; hardware versus software reliability and maintainability; uncertainties in life cycle costing prediction;design audit programs; and aspects of warranties on system performance.

No. 4

Pictorial Data Analysis

Editor: **R.M.Haralick**

Published in cooperation with NATO Scientific Affairs Division
1983. VIII, 468 pages. ISBN 3-540-12288-5

The purpose of the book is to provide a broad integrated treatment of pictorial data analysis beginning with local neighborhood computation and ending with computer vision and artificial intelligence techniques. The low level techniques include neighborhood operators, thinning, quadtrees, pyramids, and segmentation. The high level techniques include syntactic patterns analysis, relational matching under distortion, computer vision representation and control, a survey of computer vision systems, and an introduction to artificial intelligence.

Volume 5

International Calibration Study of Traffic Conflict Techniques

Held at Copenhagen, May 25-27, 1983

Editor: **E.Asmussen**

Published in cooperation with the NATO Scientific Affairs Division
1984. Approx. VIII, 229 pages
ISBN 3-540-12716-X

In many situations a reliable analysis of safety problems is not possible because of insufficient accident data.Traffic Conflict Techniques (TCT) were developed for use as a supplement to accident data. These techniques provide administrations and research organisations with an alternative to accident data for identifying safety and operational problems and selecting appropriate improvements. The Traffic Conflict Technique (TCT) was originally introduced by Perkins and Harris at General Motors Research Division in the USA and was further refined in a number of other countries (UK, France, the Netherlands, Germany, Sweden). The TCT is based on the assumption that near-accidents and accidents occur as a consequence of the same events, with only the outcome being different. The advantage of using the TCT is the higher frequency of near-accidents. In order to verify the usefulness of these techniques, there is an urgent need for validation. This volume contains all papers as well as a summary of discussions and conclusions, presented at an international TCT study group in Copenhagen in 1983. It gave all participating teams and interested observers an opportunity to discuss in detail existing TCTs in preparation for the second International Calibration Study, held in June 1983 in Malmö.

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TABLE OF CONTENTS

INFORMATION TECHNOLOGY

INFORMATION TECHNOLOGY - THE REQUIREMENTS

Keith Bartlett
Department of Trade and Industry
United Kingdom

1. The Nature of Information Technology

Information technology is difficult to define, at least, it is difficult to limit the definition but it certainly includes office automation, messaging, data processing, industrial and process control, database systems, learning systems and computing.

However, these are all industrial or business activities and the technology is now reaching into the home. Presently this is confined to data base access systems such as Teletext - where there are 1 million sets in the UK - and Videotex but, encouraged by the present emphasis on cable TV systems, it will soon extend to include telebanking and teleshopping.

One definition of Information Technology (or IT) is:

"The acquisition, processing, storage, dissemination and use of vocal, pictorial, textual and numerical information by a micro-electronics-based combination of computing and telecommunications".

While not perfect, this definition - and its shortcomings - can be used to discuss the nature of IT.

Firstly, as made clear by the inclusion of telecommunications in the definition, it is essentially a distributed technology - either because the human user and the service are separated or because it involves interactions between geographically remote, intelligent systems. In fact, we are possibly in danger of assuming that IT is necessarily a distributed technology as implied by the AND function in the quoted definition. Certainly, it only became identified as a separate technology when computing and communications converged so rapidly during the last decade. However, standalone computing is still part of IT albeit, this form of computing is in decline.

Another assumption made about IT at least originally, was that it is concerned only with digital data. Here, the definition given is more accurate as it lines up with current acceptance that voice and image representation and manipulation are included within the technology. There is a warning here as the work and thinking on voice and image are less well-developed than that on data-oriented elements of the technology.

Thus, it is a very pervasive technology and this means that it must be multi-supplier activity. No one supplier can supply all the component parts of an IT system covering computers, terminals, transmission, software, transducers, input/output devices and the base data. Even if a single supplier system is installed, it is inevitable that it will grow and that it will eventually interconnect and interwork with others.

NATO ASI Series, Vol. F6
Information Technology and the Computer Network
Edited by K. G. Beauchamp

It is also, of course, a multi-user activity. There will be many users with different terminals and different communications access techniques on any one system but more importantly, each user will wish to access a number of systems from a single terminal at different times. It is already apparent that one IT system will wish to interact with another so that a system will need to interwork with a variety of both human and machine users.

In fact, it is possibly too large to remain classified as one technology, For practical purposes, it remains sub-divided and the well-known elements listed above remain separately identifiable. Thus office automation and industrial process control are presently pursued as different subjects using different techniques, different equipments and different standards. Other classifications are convenient such as IT within a particular industry or sector - banking, education, libraries, medicine, law etc.. However, there are real advantages in defining and treating it as one technology which will be lost if unnecessary separation and development continue. In the UK, the importance of IT and the need for its co-ordinated development have long been recognised by the existence of a Minister for Industry and Information Technology within government.

This shows how we are beginning to accept IT as part of all our activites and part of the basic fabric of modern life which fits naturally into everything we do - as it does in science fiction films where it is taken for granted. The basic curricula at school must consist of reading, writing and programming. This is not to use 'programming' in the strict computer science sense but to describe the basic principles of IT control so that we may instinctively drive, control, interrogate or customise the systems according to our immediate needs.

2. The Basic Requirements for Information Technology

The conference theme is 'IT and Computer Networks'. In practice, the programme is largely devoted to computer networks. The purpose for which the networks are developed is hardly mentioned. This, presumably, is becuase it is taken for granted within this community that there is a strong relationship between the two, with networking underpinning the whole of the technology and the development of one being dependent upon progress in the other.

Indeed, any discussion on the requirements for Information Technology must start with the need for communications and, since that communication facility must include switching, then the requirement is for networks. While accepting this, it may be instructive to look ahead and see which way the underlying micro-electronics technology may develop. It is possible that the advances in storage technology and a continuing reduction in costs will make it possible to have much of the data we need stored locally. This will affect the rapidly-expanding need for remote access to data (and incidentally, change the economic structure and business opportunities within the technology).

Such advances may control the exploding demand for remote access by storing locally data which is permanent or valid for some time but there will always be the demand for up-dates, 'live' data, messages, transactions etc and networking will remain one of the fundamental requirements of IT.

There are two other fundamental needs which, again, we rather take for granted. The first is computing itself. We need to continue the advance in computing techniques, array-processing, languages and the development of micro-electronics. At present, the technology in these areas is running ahead of demand but this will not always be so. As more of the population becomes aware of the value and opportunities presented by IT, so they will increase their demands upon it. There are 1 million homes in the UK which have at least one microcomputer and 14% of these have more than one. This is a large and growing public. Its demands on the fundamental techniques will also grow and we must be prepared for it.

Another obvious requirement is information - the raw data. There is a growing market in data and its manipulation. It is not the subject of this conference but IT is dead without it.

Thus one way of looking at Information Technology would produce the three requirements of networking, computing and data.

However, there is another way of looking at the requirements. This is to identify the needs which arise directly from the nature of the technology which, as discussed earlier is distributed, multi-vendor and multi-user. This leads to a different requirement - that for standards. This must be coupled with those dictated by the human users which demand a 'friendly' user interface and trust.

3. The Nature of the Standards

In the English language at least, there are two meanings to the word standards. In the first interpretation it means levels of quality, the maintenance of a certain degree of excellence. This meaning applies to IT becuase the technology is treated with considerable suspicion in many quarters and it needs to win friends and influence people and it will not do this if the systems are of poor quality or unreliable. To a large extent, this contributes to the 'trust' requirement.

The other meaning of the word concerns the rules and conditions which govern the construction or the behaviour of a device, its ability to perform its stated or implied function and is the definition which perhaps most readily springs to mind in this forum. These technical standards are most important when applied to IT for, as already stated it is concerned with the interconnection and interworking of elements supplied, owned or managed by different organisations. It is necessary to standardise the interface between the different functional elements within a system such as computing and communications. This allows technological developments to proceed in a reasonably self-contained manner without requiring consequent changes in other technologies or

other parts of the system. In addition to common interfaces for equipments and components, there is the requirement for common interfaces to the users.

In all cases the interfacing must be technically complete and the functions either side of the interface must be understood and agreed by both parties - be they human or electronic.

As far as the user is concerned, it is useful to categorise standards into visible and invisible. Information Technology will not make real progress until user-visible standards are developed and applied. The most obvious requirements here concern data-base query techniques, electronic message insertion and recovery, document creation, editing, filing and recovery and system access procedures. These are necessary to avoid alienating the user, to avoid making him feel that the system is master and its needs are paramount. This factor should more properly be considered under one of the other requirements - user-attraction.

However, to construct, utilise and interwork IT systems, it is the user-invisible standards which are important. These are internal to the system - or may be only partly visible. Standards which fall into the category of partial visibility include those for data structures, document architectures, operating systems and computing languages both programming and job control.

Other standards are completely invisible and most of these are generally grouped under the heading of Open Systems Interconnection (OSI). OSI standards are the essential glue for IT systems and their importance is illustrated by the number of presentations on the subject in this (and other) conferences.

3.1 Accelerating the Development of Standards

They are certainly accepted as important to the UK where, in 1981, a high level committee was formed, under the chairmanship of a government minister, to examine the problems and priorities of IT standards. This committee requested urgent action on standards for Open Systems Interconnection, Local Area Networks, Teletext and Viewdata. While some teletext and viewdata standards were available, OSI standards (including those for LANs) were not. As a result, the Department of Trade and Industry is now committed to a programme of rapid development and introduction of OSI and LAN standards.

This programme is based on the technique of 'intercepting' international standards. This means that the work of the appropriate international committees is picked up and used as soon as it appears to be technically and 'politically' mature and stable - without necessarily waiting for full ratification procedures.

There are obviously some risks in this procedure but the pressure for the standards from both users and suppliers is so strong that the risks are considered to be small compared with the advantages gained. There are very strong indications that other groups and nations are simultaneously convinced of the benefits of OSI yet frustrated

by progress in ISO that they will adopt similar policies. This is particularly true within the EEC. These activities are most encouraging as OSI standards must be international to be effective.

OSI standards are being developed by a number of international bodies. Paramount among these are CCITT and ISO. However, there are others and the IEEE 802 committee in USA has taken a pre-eminent position in the development of local area network standards. There is a need for strong, formal links between these bodies to prevent duplication and unnecessary local invention. Whilst some co-ordination exists, it is informal and insufficient. The need for early, worldwide standards covering all aspects of IT is such that stronger ties between these bodies are needed with consequent better use of the scarce manpower required for this specialised work and the subsequent improved pace of development.

4. User attraction

The term 'user-attraction' is used rather than the more familiar 'user-friendliness' because there is a positive need to sell the technology in the face of some resistance from those who fear re-deployment, unemployment or an inability to cope with the technology.

This is very important as Information Technology must be attractive and responsive. The logic of IT is obvious to most and while its engineering elegance may gain admiration from some it must also appeal to the non-professional. It is necessary to win the hearts and minds of users. Thus the user interface must be responsive to human needs and not as in the past, demand the maximum intelligence and flexibility from the user in order to extract the most from the technology. This is the wrong way round; it is the technology which must bend and it is now becoming cheap enough to do so.

In part, this aspect can be tackled through the application of visible standards as previously mentioned. A database access and interrogation method should be acceptable to both naive and expert users - many database access techniques lean too far in addressing the new user and thus are unnecessarily tedious and condescending when the user is more familiar with the system. Perhaps more important are standard techniques for initial system access and logon procedures. This may be achieved by using plastic cards or portable chips as keys to IT systems so that the tiresome but secure procedures are embedded in plastic or silicon. However, it will be noted that such embedding demands the use of invisible or technical standards to allow reading, transmission and encryption to be effected by any terminal.

The quality control aspect of user-friendliness has been noted already. Users are not sufficiently wedded to the technology that they will tolerate weak or badly-engineered systems. It is in the interests of all to ensure that systems are reliable, efficient and 'smooth'.