teleinformatics '79

edited by
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IFIP

north-holland

Teleinformatics '79

Proceedings of the International Conference on Teleinformatics
Paris, France, 11-13 June 1979

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1979

NORTH-HOLLAND PUBLISHING COMPANY – AMSTERDAM • NEW YORK • OXFORD

ISBN 0 444 85349 9

Published by:
NORTH-HOLLAND PUBLISHING COMPANY – AMSTERDAM • NEW YORK • OXFORD

Sole distributors for the U.S.A. and Canada:
ELSEVIER NORTH-HOLLAND, INC.
52 VANDERBILT AVENUE
NEW YORK, N.Y. 10017

PRINTED IN THE NETHERLANDS

International Conference on
Teleinformatics
11-13 June 1979

Sponsored by
IFIP TC 6, UNESCO, CEC, ICCC

Organized by
AFCET

NORTH-HOLLAND PUBLISHING COMPANY – AMSTERDAM • NEW YORK • OXFORD

ACKNOWLEDGEMENTS

The Conference is organized with the financial support of :

la DIRECTION DES INDUSTRIES ELECTRONIQUES ET DE L'INFORMATIQUE (D.I.E.L.I.)
la DIRECTION GENERALE DES TELECOMMUNICATIONS (D.G.T.)

and of :

C.I.I. - HB
la COMPAGNIE INTERNATIONALE DE SERVICES EN INFORMATIQUE (C.I.S.I.)
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WELCOME ADDRESS

I am pleased to have been invited to welcome you to TELEINFORMATICS '79.

Let me first congratulate and thank the organizers of the conference and, in particular, the IFIP Technical Committee 6 who has taken the initiative and AFCET who agreed to organize this very important event.

Let me also thank its sponsors:

- The Commission of the European Communities
- The International Council for Computer Communications
- The French authorities
- and, especially, UNESCO with which IFIP is working more and more closely in several areas.

It is with a particular pleasure that I am addressing these words in the UNESCO house exactly 20 years after the first UNESCO sponsored International Conference on Information Processing which as you know took place in the same house and was the base for the creation of IFIP in 1960.

The developments of the past years in both hardware and software have not only been very spectacular but have made possible a lot of things which only a few years ago we could only dream of. These changes have influenced many areas but especially data communication or teleinformatics. New possibilities are now at our fingertips and we are living a period of extremely rapid change in the whole world. Telecommunication systems are being implemented very rapidly and all the related aspects not only are important for the researchers and scientists but become fundamental also for the industry.

Communication between all parts of the world is quasi instantaneous and the products and services offered through telecommunications are being, or will soon be, distributed in the whole world almost intantantaneously. This will undoubtedly bring fundamental changes in the structures of our society.

IFIP is concerned with all aspects of communications between its members throughout the world. It is therefore with great satisfaction that our Federation sees events being organized by its members such as TELEINFORMATICS '79.

I sincerely hope that the program of the next three days will be valuable to all of you and will contribute to a better understanding of the changes which teleinformatics will bring to us during the next years.

Pierre A. BOBILLIER.
IFIP President

PREFACE

The convergence of computing and communications technologies which has taken place over the past couple of decades has already had a very significant influence on Government, Industry and the Commercial world. But, hithertoo, the effect on people had been indirect, though most of us are aware of the way our environment seems to be changing at an ever increasing pace. What is not yet generally apparent is the recent acceleration of this convergence being brought about by new micro electronics developments that provide cheaper data links, computing power and data storage facilities. These, in turn, make feasible new systems based on an intimate blend of communication and processing techniques at such a low cost that they can impact the individual directly.

Today's novelties, like Teletext, Teletex, Viewdata and Personal Computing are just the beginning of a revolution in our ability to interact with information systems, computing services and indeed with each other, in new and far more effective ways than ever before. As a result, there may soon be dramatic changes in our personal relationships and in the society in which we live.

Against this background TELEINFORMATICS '79 has been planned to explore and highlight the anticipated evolution and impact of Teleinformatics over the next ten years. It is therefore most gratifying that the authors of the papers contained in these proceedings have risen to the challange by offering us such a wealth of ideas and information on the developing new technology, on the possibilities for its application and on some of the consequent changes we may expect to see in the years ahead.

We are all indebted to IFIP Technical Committee 6 for initiating this event, to the sponsors who made it possible, and to the members of the Program Committee for their time and efforts so freely given to assure its success. It certainly has been a privelege and a pleasure for me to have been associated with them and with the staff of AFCET, without whom we could have achieved very little.

But, above all, thanks are due to you - the participants - for helping to make this conference the memorable event that it is certainly going to be.

D.L.A. Barber

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SESSION A

IMPACT ON ORGANIZATIONS

Chairman: H.P. Gassmann

TELEINFORMATICS 79, Boutmy/Danthine (eds.)

DECISION SUPPORT SYSTEMS AND INFORMATION FLOWS IN THE 1980'S

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Decision Support Systems (DSS) are a class of computer-based information systems fundamentally different from traditional and most current EDP applications. A DSS addresses a managerial decision making situation which is complex, uncertain, and judgmental involving trade-offs between valid goals and requiring flexibility for rapid decision making to comply with a dynamic environment where no overall optimal decision can be calculated. DSS have slowly emerged for specialized applications in U.S. business during the last decade; today the concepts and techniques are spreading rapidly throughout industry and into more diverse applications. Tomorrow's technological/cost changes will accentuate and broaden the growth rate of DSS, resulting in a revolution in decision making throughout middle and upper levels of management.

Powerful microprocessors (equivalent to today's IBM 370/168's), each dedicated to an individual manager, will be linked together in a broadband, intelligent telecommunication network including distributed databases and multi-processor mainframe configurations. Information exchange will be at the level of transferring application software and entire databases through the network to an individual DSS for either analysis or communication purposes. Very high level languages will be developed to enable managers to tailor and evolve their DSS.

It seems evident that individuals who lack analytical and DSS skills may become managerially illiterate. The level of managerial performance will rise and interdepartmental coordination will increase, enabling greater specialization, decentralization, and/or increased organizational size. The full managerial and organizational impacts of such DSS networks are not entirely clear but will certainly be momentous--further research in this area is needed to predict, control or modify the probable impacts.

I. INTRODUCTION

Predicting the state of Teleinformatics in the late 1980's is not easy. However, we do know some things. It will not be a simple linear extrapolation of today. Nor can we forecast any one factor, technological or organizational, in isolation from other factors. The dynamic interaction of organizational needs and technological changes will result in a completely different state for the whole as well as each component factor.

Consequently, this paper will briefly explore compatible future developments of seven interrelated factors: the socio-political environment of complex organizations, managerial needs in complex organizations, decision support systems, database management systems, telecommunications, microprocessors, and very high level languages. Next, the integrated effect of these seven factors will be discussed in relation to distributed Decision Support Systems (DSS) and associated data communication. Then the probable impacts of distributed DSS in individual managers, complex organizations, and the socio-political environment will be hypothesized.

It is important to note that this paper focuses only upon middle and senior management in complex organizations (profit-motivated, non-profit, and governmental). Other trends in Teleinformatics will impact other sectors of our societies and will be, in turn, impacted by management of complex organizations. Managers of complex organizations are a tiny minority of our population but have a disproportionately large influence, multiplied, as it were, by their huge organizations: corporations, hospitals, and government agencies. Managers are certainly a group worth considering, because their efficiency, effectiveness, flexibility, competence, and responsiveness affect us all.

II. SEVEN FACTORS

1. Socio-political Environment

Futurists disagree among themselves on nearly every aspect of medium- and long-range future developments. A concensus has emerged in only four areas [1]:

(1) The rate of change in all factors will continue to increase, accelerating perhaps to the point of fundamental instability.

(2) The demands and expectations of consumers/clients/citizens will continue to be more diverse, transitory, and strident.

(3) Science and technology will continue to rapidly advance our potential, constrained only by our ability to select and implement these potentials.

(4) Governmental intervention, reporting requirements, and constraints on complex organizations will continue to grow. These effects are growing inter-governmentally, as well (e.g., in the U.S., Government Accounting Office and Environmental Protection Agency demands on the Department of Energy).

These four trends alone will present an overwhelming challenge to the capability of complex organizations to cope effectively with such a dynamic/heterogenous/demanding environment. Because of the critical role of complex organizations in our society, their conceivable collapse (that is, inability to efficiently and effectively fulfill political and economic needs) is a problem of the first magnitude. To the extent that Teleinformatics can alleviate this problem, it is a goal worthy of concerted effort.

2. Managerial Needs in Complex Organizations

Complex organizations have always faced decisions in allocation and acquisition of resources (funds, facilities, skills), discerning consumer needs, production and distribution of goods and services, and in organizational structure, policies, and procedures. In order to achieve their goals, complex organizations have partitioned their complex tasks and assigned them to specialized units. Each specialized unit becomes differentiated from all other specialized units in terms of skills, objectives, time perspectives, procedures, technologies, techniques, operating style, and so forth. It is the function of middle and senior management to coordinate the activities of these specialized units.[2]

In the past, the environmental rate of change was slow enough that complex organizations could adapt reactively from internally gathered information. This allowed management to deal with comparatively reliable, quantitative, internal historical data sources and structured processes for hierarchically aggregating this data into management information. This is where computer systems got their start--in lowering the costs of high volume and routine aggregation of data from daily operating transactions.

Tomorrow's complex organizations will find, as many of today's have already found, that their viability and stability require pro-active adaption to their dynamic environments. This requires management to deal with comparatively uncontrollable, qualitative, external, future-oriented data sources and unaccustomed processes for analysis, simulation, and consolidation of diverse data types into management information. Today this is a major and painful vacuum in many complex organizations. Teleinformatics has promised management information but, according to all indicators, has delivered only operational and financial data, leaving middle and senior management desperately wanting.[3] To begin addressing this vacuum, some advanced organizations have already developed some Decision Support Systems, albeit only for limited and specific applications.

3. Decision Support Systems (DSS)

Structured decisions are characterized by our knowledge of how to calculate the best answer. They may be very complex because of a lot of relevant variables, high volumes, or implementation difficulties given data capture costs or organizational impacts. Semi-structured decisions, however, are uncertain involving multiple, legitimate, conflicting goals where no overall optimal decision exists. They require searching, analysis, and insight for some or all of the phases of decision making: problem identification, generation of alternatives, and evaluation of alternatives.[4]

The purpose of a DSS is to support semi-structured decision making, not to replace managers (or clerks); to supplement experience-based managerial judgment with rapid analysis of interacting variables; to provide a relevant and accessible database; and to enhance the manager's effectiveness (not efficiency) in decision making. [5]

Applications of Teleinformatics to structured decisions and paper shuffling activities (i.e., data storage and retrieval) comprise 90% of the installed applications in the U.S. today.[6] This is not to say that traditional applications are not important, for most complex organizations would simply cease to function without them. However, traditional applications are incapable of fulfilling the managerial information needs for complex organizations discussed in the previous section; only DSS are capable of dealing with such semi-structured decision characteristics.

Because traditional and DSS applications both use a computer, there is a disastrous tendency to assume everything else about them is the same. To be successful, DSS users and developers must recognize the differences in decision characteristics, data type and sources, project justification, and creation processes. There is insufficient space to go into details here, but there are books on the subject.[7] Perhaps the following classical example of DSS application from U.S. industry will help clarify these differences.

Manufacturing and Marketing face different external environments, each with its source of uncertainty; moreover, they must coordinate their efforts if either is to be successful. Aggregations of daily operational details for each function do not result in the integrative, future-oriented contingency analysis necessary to balance the diverse activities of many departments. Manufacturing operational data enables cost reductions through product standardization,

lower inventories, and steady levels of production. Marketing operational data enables increased sales through product differentiation, improved availability with high inventories, and rapid changes in production to meet changing demand. Both Manufacturing and Marketing have legitimate but conflicting goals which must be resolved for coordinated efforts. Increased advertising, product availability and lower prices will help product X but perhaps at the expense of product Y; specialized machinery will lower production costs but also lower flexibility; steady production helps manufacturing lower costs but inhibits Marketing from meeting changing consumer preferences.[8]

In multi-product, multi-market, multi-plant firms the balance and coordination of Manufacturing and Marketing activities is a complex and uncertain task necessitating semi-structured decisions for the long, medium and short terms. In a dynamic environment, given the lags involved in identifying emergent consumer demand, new product development, building new plants, or replacing obsolete technology, it is quite possible for the firm's responses to external change to be fatally out of synchronization. Analogous situations exist in non-profit and governmental organizations--balance of medical specialties in a hospital or multi-program resource allocation in large government agencies such as the Department of Energy.

4. Database Management Systems (DBMS)

Yesterday's dream of a single database for an entire complex organization has been postponed as technically and economically infeasible. Today's multiple, semi-independent databases designed around logical application groups, however, are more and more numerous. They are growing rapidly in comprehensiveness of operational data and in complexity. Physical distribution and logical separation of databases is necessary for operational needs but limits the flexibility of non-routine access by managers anywhere in the organization.

Today's DBMS are hierarchically designed, requiring considerable effort to determine their best access roots and resulting in severe lack of flexibility and inefficiency in accessing data in non-routine ways. Relational DBMS are being developed which provide several alternative access schemes for a database. They do increase flexibility somewhat, but incur considerable overhead inefficiencies.[9]

DSS databases are specialized by application, require frequent content changes and re-design, and are built from diverse operational databases merged with external data and quantifications of managerial judgment. Current DBMS limitations inhibit the customizing of databases for DSS.

Tomorrow's DBMS will be back-end, multiprocessors built around the new microprocessor technology of Content Addressable Memory (CAM). This will obsolete hierarchical and relational database structures with a predominantly flat structure, allowing all key fields in a record to be roots. Essentially flat database structures, dependent on CAM, provide access to any record in two machine cycles (plus telecommunication line delays for physically distributed databases), drastically reducing access costs, significantly increasing flexibility, and, in effect, creating an integrated database of many logically and physically distributed databases. Even security and privacy will be no problem, as each field query can carry the access code mask of the requestor to be matched or rejected by the field's security mask.

To visualize the difference between hierarchically designed and Content Addressable Memory DBMS, consider a Human Resources system for the federal government where the roots are agency and employee numbers. For high-volume, routine uses like payroll or queries where the agency/employee number is known, this presents no problem. However, for non-routine uses or queries like "Who speaks both Hebrew and Arabic?," the DBMS would have to sequentially search every record in each of the distributed databases and compare languages spoken to Hebrew and Arabic. This is analogous to a Professor going to the dormitory room of every student in his class and asking, "Do you speak Hebrew and Arabic?". With CAM, every distributed database could be searched simultaneously--the Professor asks all the students in the class to raise their hands if they speak both Arabic and Hebrew. Use of such a DBMS is, however, heavily dependent upon telecommunication cost and speed, especially with physically distributed databases.

5. Telecommunications

Widespread use of telecommunication networks for very large scale data transfer (i.e., transmitting databases and software, not records and reports) is currently inhibited by three factors: bandwidth, cost per bit, and distance dependent cost.

Bandwidth determines the amount of time it takes to transmit a given amount of data. At current 50KB rates, nationwide networks for Remote Job Entry, inquiry, and report transmission are viable. However, transmitting multiple copies of databases and software to geographically dispersed sites is impractical managerially because of the delay, and economically because of the cost.

Two technological trends are converging which will change the nature of telecommunications and the content of transmissions: first, the continual growth in bandwidth and decline in cost per bit; and, second, the use of artificial satellites and microwaves for transmission. Satellites make the costs independent of distance, enabling national and international networks as viable as regional networks. Microwaves remove the costs inherent in

cable transmissions and microprocessors are lowering hardware costs, increasing bit densities, and improving utilization. All in all, we can expect an across-the-boasrd 50% decline in costs and an order-of-magnitude improvement in long distance costs by the end of the 1980's.[10]

6. Microprocessors

Microprocessors have already been mentioned as components in DBMS and telecommuncations; their impact, however, may be even greater as stand-alone desk-top computers. We will certainly see the functional equivalent of a IBM 370/158, and perhaps in the late 80's an IBM 370/168, packed into a desk-top computer. Parallel advances in micro-memories and flat-digital display screens will yeild desk-top computers with 1MB main memory, 10MB of random access storage, wide-band communications, full-color graphic display, and the processing power necessary for any DSS on the desk of most managers, all for the price of your secretary's electronic typewriter.[11]

Given the need for DSS by management of complex organizations and the technological capability to access, transmit and manipulate data, we can logically anticipate a revolution in management decision making akin to what we have already experienced in computer applications for operational activities. There is only one catch--who is going to program the millions of custom-designed DSS necessary?

7. Very High Level Languages

Several decades ago the American telephone industry studied the growth rates of telephone usage and switching requirements. It was concluded that, with the then-current technology, in twenty years every female between the ages of 18 and 35 would be required as switchboard operators. The conclusion was infeasible, obviously sexist, and it spurred the development of new technology.[12]

We are in an analogous position with programmers. Today most organizations have several years' backlog of approved proposals for new systems. Moreover, research shows that the true demand for new systems, especially flexible on-line inquiry and DSS, is suppressed because of the already existing backlog.[13]

With millions of managerial users of DSS, each must be able to program for his or her own needs. With today's computer languages, this is impossible. The only way out of this trap is through the development of user-oriented Very High Level Languages (VHLL). Some work has already been done in this area (e.g., flexible inquiry languages such as Easytrieve and Mark IV and ad-hoc analytical DSS creation utilities such as GMIS [14]); however, much more needs to be accomplished and many projects in this area are already underway.

III. IMPACTS OF DSS IN THE 1980'S

Discussing trends in these seven factors separately leaves no assurance that they will actually occur. However, when the converging nature of these trends is considered, it is easy to see how each will reinforce the others. The socio-political environment and managerial information needs in complex organizations create an unavoidable demand, distributed DSS provide a methodology for fulfilling that demand, and advances in DBMS, telecommunications, microprocessors, and VHLL provide the technical ability to deliver. It is a mutually complementary process. For example, the managerial needs will guarantee a market for the technology assuring its development and use for DSS; successful implementations of DSS will increase the level of aspiration of managers, thereby increasing the development of distributed DSS and the market for the appropriate technology.

The 1980's Teleinformatics configurations will be a mixed network of central-site multiprocessors with CAM DBMS, regional and plant computer sites with CAM DBMS, and field offices and individual managers throughout the organization using VHLL to create DSS on desk-top microprocessors. Within facilities, communication will be by cable; between facilities, by satellite. Data transfer over this network will include the current reports and records as well as entire databases for DSS (and messages from the parallel revolution in Office Automation).

Taken together, the trends in these seven mutually reinforcing factors foreshadow a revolution in managerial decision making in complex organizations. Individual managers will sit at their microprocessors using DBMS to access databases throughout the organization, pulling together selected fields and adding fields for external and judgmental data to create customized databases for particular DSS applications. Using a VHLL, the managers will then formulate the analyses to be performed to support their decision making. As managers' understanding of the decision situation evolves, they will continually modify their databases and analytical routines. Libraries of DSS and authors will be maintained for sharing of databases and analytical routines; each manager, however, will be free to customize the functional content of his or her own copy, downloading from current operational databases whenever fields need to be updated. This availability of truly relevant information and the capability to meaningfully analyze it will create a significant improvement in the effectiveness of decision making and organizational coordination.

In discussing any nascent revolution, the question as to its impacts naturally emerges. In this case, of course, we don't know exactly what those impacts will be--partially because the style with which changes are implemented materially affects the outcomes and peoples' attitudes, and partially because we don't know enough about the future of other trends and how