Dennis Moore given to Bunbury ACS conference 1978

COMPUTERS, COMMUNICATIONS AND CO-OPERATION

Introduction

The thread that holds this paper together is the development of computing in the University of Western Australia over the past 16 years. This will range from the advent of its first small computer, through the early days of time sharing and the development of the Regional Computing Centre, and to its more recent involvement in computer networks. Some of these developments may have been unique to Australia, but on the whole they have been commonplace overseas. While there may be interest in why they have not happened elsewhere in this country, or why they have not evolved to the same extent, none are of any spectacular originality. We have become, and unfortunately so, a technologically imitative society and computing is no exception.

It is however not a history, unique or otherwise, which is the real theme of this paper. It is hoped to address some of the problems which face us both as computer professionals and members of the community at large as we implement our technology - a technology of remarkable power and wide ranging influence which continues to impact new application areas even as we struggle with second or third round applications in older areas.

Such a broad theme means that I shall inevitably ramble, but it is the very breadth of computing, now coupled with communications, which is one of the dominant characteristics of our technology. Another dominating factor is the rate of change of the technology itself. In the short twenty years I have been in the business I have seen the coming, and in some cases going, of such things as valve machines, magnetic drums, the transistor, large scale integrated circuits, core memories, MOS memories, higher level languages, bubble memories, time sharing, data base management systems, secondary storage capacity increases from zero to 10^{12} and more bits, and data communication networks.

Never in the history of technology has there been such rapid change in so short a period. Yet despite its dazzle, and despite the uneasy computer joke in the daily paper, there is a general unawareness in the community of what is really happening. Indeed many people who should know better prefer to pretend that change will not continue at such a rate, and remain unperturbed when change catches up with them (unless of course they have gone broke in the meantime).

Alvin Toffler in "Future Shock" writes -

> "It is no longer sufficient for Johnny to understand the past. It is not even enough for him to understand the present, for the here-and-now environment will soon vanish. Johnny must learn to anticipate the direction and rate of change. He must, to put it technically, learn to make repeated, probabilistic, increasingly long-range assumptions about the future. And so must Johnny's teachers."

This is not disagreed with but the advice might be better directed at Johnny's father or even his grandfather. The very title and theme of Toffler's book is that the individual is in extreme difficulty, or is going to be in extreme diffficulty, coping with the "shock" of change. Nothing is, I believe, further from the truth. The absolute acceptance of technology by the community once it has been introduced is a remarkable phenomenon. Radio, television and the telephone have been the cause of monumental changes in our life style and all have been taken into the bosom of the family with what could be described as anything but "shock".

It is the eye of the novelist rather than the journalist which is the more discerning when it comes to people. Aldous Huxley in "Eyeless in Gaza" writes -

> "Progress may, perhaps, be perceived by historians; it can never be felt by those actually involved in the supposed advance. The young are born into the advancing circumstances, the old take them for granted within a few months or years. Advances aren't felt as advances. There is no gratitude - only irritation if, for any reason, the newly invented conveniences break down. Men don't spend their time thanking God for cars; they only curse when the carburettor is choked."

Coping with change is a problem that exists in the industry itself. We must of course be aware that what we did five or ten years ago is not necessarily what we should be doing now, but one of the great challenges of information processing management is the making of decisions for change without chasing novelty to the point of gaining no economic return from the

.. 3

previous technological cycle. Another great challenge is how to gain productivity from technical staff with existing hardware and software without neglecting the need for their continuous re-education.

We have not had much experience in handling these problems, and perhaps there is no satisfactory solution in such a violently developing environment. For example if you make a programmer aware of new and exciting developments around the corner, will he become dissatisfied with his current lot to the point where he will race ahead to that corner on another employer's machine?

These are interesting problems but I am wandering too far too fast, and should perhaps return to the past to get my feet on the ground and perhaps better illustrate some of these difficulties.

Early Days

Despite some five or more years of prior pressure from some members of the hard sciences, the first computer in the University of Western Australia was not installed until 1962. Such a late date of entry into the field after such a long gestation period might be considered another example of the vision and decisiveness of the academic world. In fairness it must however be remembered that despite the 60% educational discount then offered by I.B.M., such a purchase would have made a sizeable hole in the research budget of what was, and still is, a relatively small University, and the concept of leasing was, and still seems to be, alien to those who control tertiary educational funding. It must also be considered that funds for equipment in a University are quite small once the salaries component is taken out of the budget, and the mechanism by which these funds are allocated, which resembles a bun fight, are not conducive to the purchase of major pieces of equipment by collective efforts from individuals or research groups. This problem was solved in the years 1962-1972 by the Australian Universities Commission, the then external funding body, by allocating 'earmarked' grants for computing.

The computer which was installed was an IBM 1620. It is claimed by Monte Sala, that remarkable personality of Western Australian electronics, not to have been the first computer in the State but that it was preceded by a Bendix G15 at the Main Roads Department. Being first or otherwise is

.. 4

unimportant, the fact that we were so late on the computing scene is not.

The 1620 was a common machine in the smaller Universities in those days. It was one of the first transistorized computers and was first manufactured in the late 1950's. By modern standards it was very slow and expensive, being easily outperformed by what would be regarded today as a rather small mini. It is quite amusing to occasionally hear a remark such as "Oh, he's a big computer man, he doesn't understand minis", when it is considered that we used to fly from Sydney to Adelaide eighteen years ago to use the 7090 at W.R.E. with its 32K of 36 bit words. All machines were minis then.

Experience with a first machine in the University was probably not much different from similar institutions with their first machines. Stretchers and alarm clocks were soon installed next to the computer as the work load rocketed to saturation although it had been forecast before installation that we might get into a second shift in five years' time. Staffing in the Centre was inadequate in that the academic staff had little experience in computing and sometimes I wondered how many unofficial research students I had. The main problem was this one of education, and it was tackled in a haphazard way through regular crash courses in FORTRAN and occasionally in assembly language, and then letting the research students loose and helping when one had time.

They were busy days indeed and are looked back on as a struggle for survival. My wife once threatened to leave me for going into work one Christmas day to help a user battling to get some results for a paper past its deadline. It would not have been so bad but I had forgotten that I had done the same thing a year before. My wife also broke me of the habit of debugging late at night in bed by more subtle means. Listings in cardboard binders can be quite heavy.

Three issues of general importance come to mind from that period. The first is the complete unawareness by many of the senior University officials at that time of the potential demand for computing. The second was the unwillingness of a surprisingly large number of the senior academic staff to expose themselves to the possible humiliation of not being able to cope with a new field. The opposite attitude was taken by the research students and some of them wandered off into undisciplined computer usage because of

lack of control brought about by this unwillingness of their supervisors to become involved in something new. This is reportedly a common problem when computers are introduced in commerce, but at the time it surprised me because of the nature of the institution. Academics may have a higher average I.Q. than the rest of the community but of human frailities they have their fair share.

The final point of particularly current interest was the noticeable effect that study leave had on so many academic staff as far as computing was concerned over the whole of the 1960's, and it is even occasionally seen today. This has left me a strong defender of study leave, which now seems to be under some attack. Due to such leave the thrust of research in many areas was completely re-orientated, perhaps not so much in content as in methodology. More important in the short term was the earlier transfer of these new technological concepts and skills to the community. Teaching using computers was often first introduced by a staff member on returning from leave after he had seen what was happening in his own field abroad and had had the time to assimilate it.

So important is this type of leave to isolated communities such as ours that I always feel some distress when I hear of its occasional abuse. This is the surest way of bringing about its restriction or demise.

Golden Days

The next period in the Centre's development was possibly the most interesting from a personal viewpoint. So fascinating were the professional challenges of the time that it is only with hindsight that it is realized how close we may have been to a disaster. I refer to the installation of a DEC PDP-6 in 1965 following the allocation of the princely sum of £150,000 ($300,000 for the very youthful here) for computing in the 1964-66 triennium.

The choice of a DEC PDP-6 was in itself interesting. To purchase as a major central machine an unknown product from a small unknown company was as bad as the decision by the company itself to sell at a critical time of its development to a customer located almost exactly at its antipodes. However, blinded as we were by the promise of "time sharing", which was sold to the throng by the golden tongue of a salesman/designer from another company

DEC's advanced and aesthetically pleasing machine was a popular choice after some crude benchmarks had been done on the back of an envelope. The "Gibson mix" was very popular in those days and we pushed ahead in our ignorance. The other company was a Canadian firm, Ferranti-Packard, and the design of machine in question, which was the FP6000, was I believe sold to ICL (or what was to become ICL) to ultimately become the basis of the ICL 1900 series. But then the stories in the computer business float by daily, true or not.

At that time occurred one of the first attempts at getting some global co-operation and co-ordination into Australian computing for Tertiary Education and Science. It was thought that as all the Universities and C.S.I.R.O. were in the market at the same time, that if a number of the parties got together that somehow the manufacturer of the combine's ultimate choice could be "squeezed". A very large group assembled in the senate room of the A.N.U. and achieved exactly nothing. The manufacturers were away out in front and had possibly all of the Universities (or at least the computing professionals in them) committed before the meeting. From memory only two Universities bought the same machine, and one of those purchases was not, it is rumoured, the choice of the selection committee. The collapse of the chair of a well-known Professor of Mathematics from the University in question, which was the highlight of the meeting, was possibly as much a prognostication as it was dramatic.

The PDP-6 delivered to the University of Western Australia bore serial No. 4 and was claimed to be the first machine commercially delivered as a multi-access time sharing machine in the world. The earlier serial numbered machines were for in-house development or sold as machines for on-line data acquisition. Being first of course does have its problems. The major immediate problem was that the monitor did not work.

A systems programmer arrived with the machine who never slept and seemed to spend 75% of his time debugging code and the other 25% drinking beer. He fitted in well - we were all a bit nervous but perhaps our percentages were the other way round. However there came a day when the software actually seemed to drive more than one teletype at a time and the machine stood up long enough for acceptance tests.

It was a minimum machine. We could not afford magtapes, discs were then physically enormous and expensive and backing store was by DECtape - a

low cost magtape originally developed for smaller laboratory machines. Memory was minimal. Disc and floppy disc developments have virtually removed DECtapes from the market.

Although it was a long time before the operating system grew into anything like the highly sophisticated operating system of today's DEC-10 the increase in speed over the 1620 made up for a lot of faults in the software and a considerably improved service could be offered.

The PDP-6 was a beautifully conceived machine and the success of the line over 13 years bears witness to this. It was a computer totally dedicated to remote access interactive time sharing and it is interesting to compare it with the Cyber, which grew out of the CDC 6600 and was the epitome of a large scale batch processing machine. Ultimately interactive computing was grafted on to the 6000 series and batch was grafted onto the PDP-6. Neither I think with complete success, as there seems to be a basic incompatibility between the hardware and software requirements for the two methods of computer usage. This problem will probably be solved when true multi-processing machines are readily available.

The first batch processing that took place on the PDP-6 was after two or three months spent by the Centre wrestling with a particularly poor piece of systems software. "Batch" is a very interesting word if you play around with the vowel sound. "Betch" is not much of a word, although it is close to "belch", but "bitch", "botch" and "butch" were fairly expressive of our feelings at the time.

At the time of the arrival of the 6 an assistant director (Ian Nicholls) was appointed to the Centre who made a remarkable contribution to its development, particularly on the systems and real-time data acquisition side. The nature of the 6 did allow multiple access by many devices and a range of peculiar ones were interfaced. At one stage these included a rat-race, a diffractometer, a mass spectrometer, a flying spot scanner, an analogue computer and several mini computers. This development taught us much - particularly how not to do some things. For example ten or more years later you can see people making the same mistake of trying to interface too many devices to a mini or a midi - the added complexity is just not worth the system complexity or the administrative hassle compared with the cost of an additional mini. We also learnt that the argument of interactive versus batch was a non-event, both types of computing will continue to co-exist in the

foreseeable future. We learnt of the merits of standardised operating systems once they became stable. Perhaps most important was the early feeling developed for the potential power of communications networks even though we did not have the technology available to us at the time, and its proper introduction has been a long, hard grind which continues today. We could see the advantages of being able to offer people the independence of their own local specialist computing with the advantages of linking through to large host machines to gain the best of both worlds. Other advantages which I shall mention later have emerged over the years as networks have developed overseas. Of the greatest importance was that in this period co-operation with non-University users of the Centre began and this had considerable bearing on the next period of development.

The Regional Centre

The two pages on Computers in the fourth Report of the Australian Universities Commission published in May 1969 make wonderful reading for what they do not say. Let me quote a few paragraphs.

> "Shortly before he became Prime Minister, the Minister for Education and Science (then Senator the Hon. J.G. Gorton) caused the Policy Committee on Computers, established in 1960, to be reconstituted and instructed it to examine the needs of Universities, CSIRO, and colleges of advanced education so that proposals might be taking fully into account the Commonwealth's requirement for an integrated network".

> "It (the Policy Committee) decided to report the following recommendations .....

In NSW

(d) A scheme prepared by the Vice-Chancellors of the Universities of Sydney and New South Wales for serving the combined needs of the two universities should be examined and developed in more detail by a special committee of impartial persons highly competent in the technical aspects of computing. It was hoped that the committee's work would be completed in time for recommendations to be made concerning immediate needs of the two universities during the triennium 1970-72."

In Victoria

(i) The special committee of impartial experts to be formed to develop in more detail the scheme for the Universities of Sydney and New South Wales should also examine afresh the situation in the Melbourne area, where it had been found impossible to reach agreement on any integrated systems."

I was working abroad in 1968/69 and so missed a lot of what must have been a marvellous piece of political infighting judging by the vitriol of some of the remarks made to me later by some of the participants. The end result of this attempt at co-operation (or coercion depending on your point of view) was that most of the Universities in Sydney and Melbourne missed out on three years of capital funding for computing, and the one Regional Centre that got underway started in the place thought least likely, and in fact did not get a mention as such in the Commission's report. Funds were however granted so that "The equipment of the University of Western Australia should be improved."

The reasons for a Regional Centre emerging in W.A. are probably accidents of time and circumstance. The Centre had offered government departments access to the PDP-6, and over 50% of the Centre's running costs were covered by outside income in 1970. Figures for all Universities on running costs for that year were published in the fifth report of the A.U.C. in May 1972. The UWA net costs were the lowest in Australia as a proportion of the Recurrent Grants, being .7% compared with a national average of 1.3%. This was one major factor, the University was offering a service and while not trying to rip anyone off it was benefitting financially. The second was probably the most important - there was no large scientific/engineering computer in Perth and there was a real demand for such a service in government departments. The third was a function of the city of Perth itself - the town is large enough for things to happen but small enough for people to talk to each other. Finally two principals in the action - the then Deputy Vice-Chancellor and the current Under-Treasurer, were men whose minds were broad enough to allow them to wander outside their own back yards. Many regional centres, and now networks of computers, exist outside of this country. Many of them came about because of financial coercion from funding agencies. I think it says a lot for all concerned, and we had a very large committee, that the Regional Centre evolved internally, rather than from external pressures.

The basic argument for the Regional Centre was that of economy of scale. The basic argument against it was that centralization could lead to a bureaucracy that would not, or could not, respond to customer demands and problems, and would unduly favour one user above another. Both arguments of course have some merit. The absence of any real computing power in the State probably carried the day, but what success the Centre has enjoyed has depended to a large extent on a conscious effort to act as an independent service organisation which treats all users as equals. This fails to some extent in that there is a continual problem in identifying user difficulties at remote sites. From the Centre's viewpoint problem reporting and fault identification have been the major problem in administrating the system.

Having accepted the concept in principle and used an independent consultant to arbitrate on the capital contributions to be made by the participants, the next step was to get it approved by both the State and Commonwealth. University funding for capital equipment was then on a 50/50 basis. Correspondence seemed to sit on John Grey Gorton's desk for a very long time. He was now Prime Minister rather than Minister for Science and Education and perhaps it was not surprising. It was however a good lesson in the need for patience when instituting change in the public sector. Finally approval came through and some years after setting out, there then came the problem of putting it into practice. The sum required was much greater than that available in the triennium and initial funding had to be split across two triennia. A difficult moment occurred when financial negotiations associated with discounts resulted in an agreement that a sum of money was to be paid as a deposit and it was found that there was no procedure to pay anything without an invoice. This was overcome by writing a petty cash voucher for $250,000.

The Cyber was a new version of the 6000 series and due to the nature of the service to be offered a reliable, high performance batch and remote batch machine with good local support was sought. All with the usual requirement of a minimum cash outlay. With the exception of the money shortage, it was a complete change as far as a style of machine and risk were concerned. This was to some extent deliberate - it is found that the PDP-10 and the Cyber complement each other very well.

The Centre operates as an independent organisation although legally it is part of the University. It has a Board of Management on which the University has only one representative in 9, but it does supply the Chairman.

.. 11

It runs on strict business lines, paying for many of the overheads such as power, rent and administrative overheads which are normally hidden in University accounts. It must raise money for any capital expansion and meet all costs, whether capital or running, from charges made to its participants.

The Centre's role as the one central source for a scientific/engineering computing service for government and education has changed over the years. There has been no attempt made to retain a monopoly and the Centre was associated with recommendations for computers at WAIT, the Main Roads Department and the S.E.C., all of which have affected the Centre's business to some extent. The growth of the mini computer in the market has also had its impact. On the whole the introduction of new machines into the system has been fairly smooth in that the introduction of major new mainframes has occurred during periods of heavy utilization so that the financial impact on the Centre has never been disastrous, although there have been some anxious moments. It is hoped that such co-operation between all parties concerned will continue so that public spending on computing in this State will continue to result in value for every dollar.

One further major co-operative development which has resulted in considerable savings in operating costs has been the siting of the central machine of the network to service the hospitals at the WARCC. There are savings in management and operations staffing and in non-duplication of specialist staff. Important for many users is the ability for the WARCC machine and hospitals machine to back each other up.

The 1970's have seen considerable growth in computing in the public sector and education in Perth. The bulk of this growth has not been at the University of Western Australia and perhaps the Centre should no longer bear the title 'Regional' as other major centres now offer similar services. It does however still have a wide range of customers - as some larger users have migrated to their own machines, smaller departments have begun computing or expanded usage. Access to the considerable facilities available offers a very cheap entry into computing - not only because of the advantages of economies of scale but because packaged programs in engineering, scientific and statistical computing have become of major importance in many application areas. In the period in question the Centre saw the upgrade of the PDP-6 to a PDP-10 and a remarkable growth in the secondary storage capacity. The two Cybers can address

.. 12

some 2.5 billion characters between them on current capacity. Data communications has also been a very strong growth area and it is in the field of communications that the Centre may well play a major role in exposing its user community to the potential of computer networking, and taking a leading role in their development.

On Computer Networks

Ivan T. Frisch and Howard Frank in a 1975 AFIPS conference proceedings on computer communications write -

> "One of the best journalist historians is James Martin. After all, he published a book in 1971 called "Future Developments in Telecommunications" and much of this book intended as almost science fiction for the year 1980 is a good history of the years 1971 - 1974."

Successful as Martin may have been as a futurologist, it is much easier to be one in Australian computing despite the rapid change in computer technology. All you have to do is look at what has survived well for four or five years in the States and predict that is what will happen here. Such is the sum of the problems of late awareness, delay in staff preparation, slow release of information and hardware to the technological colonies, and the conservative nature of Australian business and its institutions. This does not imply that I advocate wholesale acceptance of the latest and greatest. The new mathematics is an example of an imported concept which I believe has had disastrous results. Perhaps the competent will survive any educational system but the title of a book by J.M. Hammersley, who is currently visiting Perth, "The Enfeeblement of Mathematical Skills by 'Modern Mathematics' and by Similar Soft Intellectual Trash in Schools and Universities" reflects my attitudes. Particularly distressing is the wedge it has driven between parent and child - a problem that is exacerbated these days as the schools seem to take over more and more of the social, political and moral development of children and leave the 3 R's to the parents. Fortunately there has been a reported swing away from the new maths overseas so in time perhaps we will again follow suit, but perhaps this is the wrong time to ride this hobby horse.

Computer networks are of course very old. Air defence communication networks were operational in the late 50's and airline reservation systems since the early 60's. Banking systems are of the same vintage. Time sharing networks date from the middle 60's. ARPANET, the first of the packet switching multi-

host networks was well underway in 1969. Educational networks are very common in the USA and Europe - these have developed very quickly due to the financial squeeze on education that is now world wide. CSIRO developed one of the earliest networks for general purpose computing in this country and the Regional Centre was from its inception a star network.

Some four or more years ago a conscious effort was made by the Centre to raise the activities of the Data Communications Group to a level where it could better anticipate developments in this field. Earlier attempts to upgrade participation in this field headed off into a direction with far too much emphasis on hardware innovation, although they did result in some very interesting developments.

The brief of the group was, and is, to anticipate developments in data communications and develop those skills required for the early introduction and support of new technology as it becomes available. The maintenance and support of existing data communications with its myriad of problems is also this group's responsibility.

Within the severe restraints of the financial resources available and the demands of the day to day responsibilities of servicing a complex data-communications system, developments in the Centre in this area have been most promising. Products developed include a terminal concentrator for Cybers which has already been sold some 15 times throughout the State and more recently an extension to DEC's DECNET networking software has allowed us to experiment with multi-host computer networking with a Cyber and two DEC system 10's. It is hoped to expand the network to include the Main Roads Cyber as a host and build a gateway to IBM computers. Particularly important will be connecting of minis and midis to the network in a way that will allow them to do both local processing and submit jobs to any one of the larger hosts. As an example there is an obvious immediate application for Conversational Remote Job Entry in the educational sector in which users edit locally and submit the resulting files for batch processing to the machine of their choice. There is also the longer term impact on the computing scene of personal computing and how it will fit into the scheme of things. Word processing is also likely to be a dramatic growth area. In many cases personal computers will be free standing and the user will obtain all he requires from his device alone. In other cases he will want to access data bases, occasionally submit jobs to larger machines, use specialized packages or transmit a document to someone in the system. In such cases cheap and flexible data communications are essential.

The arguments occasionally heard on the merits of large vs. mini computers are considered to be in the same class as my previous comments on time sharing vs. batch. There is just no generalisation which is meaningful. In the transportation industry we have ten ton trucks and racing cars, we have oil tankers and tramps steamers, and despite the Concorde, DC3's are still flying. Each application implemented should result in a choice of equipment type which is most suitable and economic, and today this is likely to be a mixture of machine types. It is the marriage of computers to data communications that gives enormous flexibility in our decision making and power to make systems supply what the end user wants.

In order to give you an idea of the current state of play in network development in this State, a schematic of some existing governmental and educational networks is attached. This excludes some networks such as those run by the TAB and the Forests Department, and excludes developments in Technical Education etc. This networking is still mainly of the star variety although it is now possible for most users to use a "set host" command on their interactive terminals to access the WAIT KL10, the WARCC DEC-10 or the WARCC Cyber. Files may also be transferred between the WARCC DEC-10 and the Cyber.

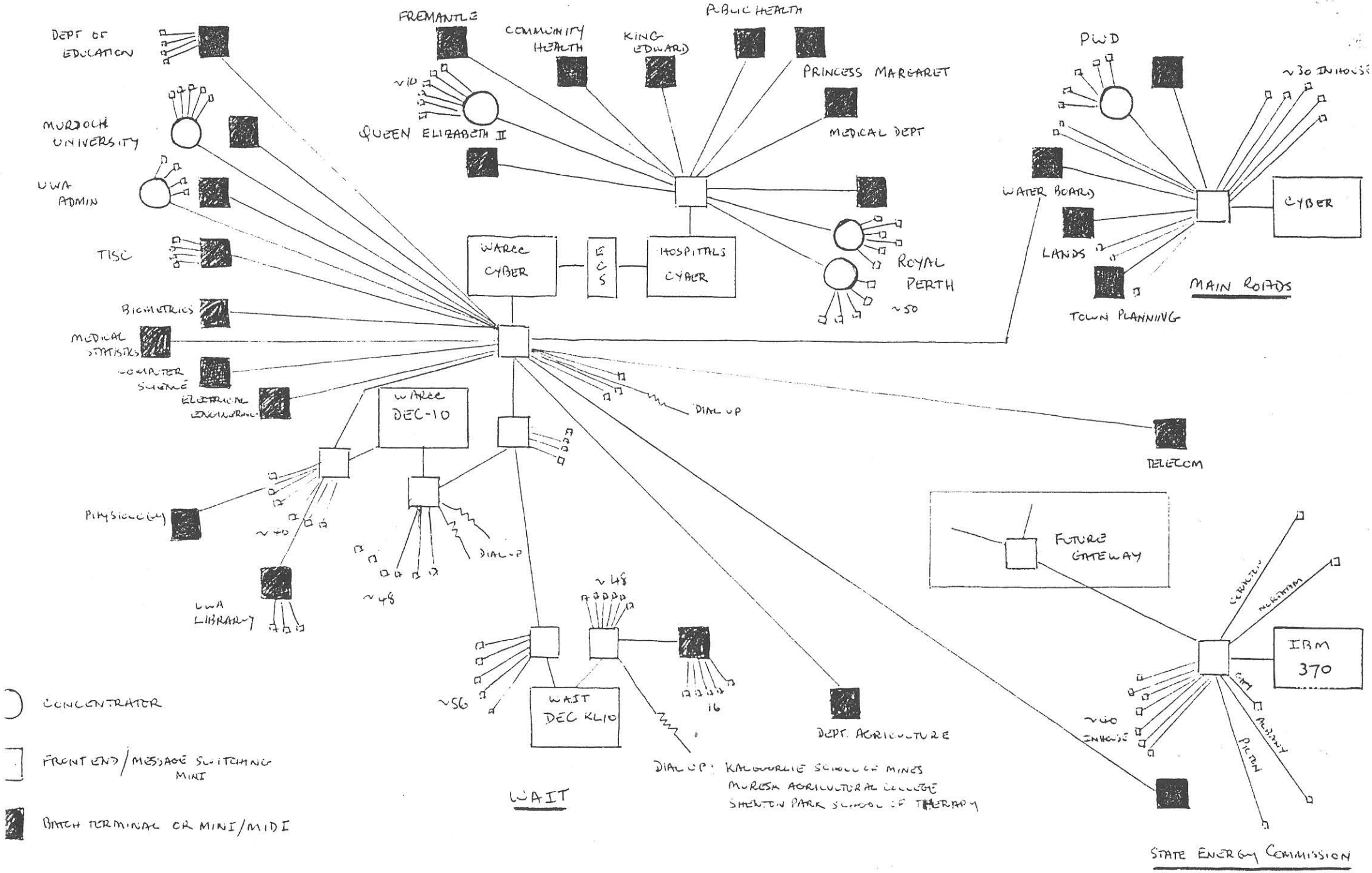
Some of the advantages of a network can be directly measured. For example, this is a large State with a small, widely distributed population. If we are to get information processing to country areas we must make every effort to minimize costs, and line sharing can greatly help here. More importantly there are some developments of great potential value to the State that can only be achieved through networks. An important example is the proposed land data bank which, to be properly effective, must be accessed by nearly every government department, agency and local authority, as well as being of great value to research workers. Access to the widest range of packaged programs at minimum costs is becoming more important as software costs outweigh hardware costs. The same comment could be made about access to highly specialized computers such as array processors.

Developments in W.A. in networking to date in this area have not been terribly well co-ordinated, but we do have several advantages. We are still small enough to be able to talk to each other, but most important of all we have a track record of successful co-operation in computing in the public and educational sectors in this State. There is, I believe, a potential for public good in communications and computers. Decentralization possibilities

are enhanced if information is available on a distributed basis. And for the same reason problems of transportation may be eased if workers only move to local centres rather than to the central city area.

The problems of networks are non-trivial, but the challenges are exciting. It is only hoped that the prophet had a different meaning of word in mind when he wrote in Isaiah 19.9 "and those that weave networks shall be confounded".

D.W.G. Moore
April, 1978.



SCHEMATIC OF SOME

EXISTING WESTERN AUSTRALIAN GOVERNMENTAL AND EDUCATIONAL NETWORKS