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Report of Review Committee
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Statement of Executive Decisions

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REVIEW OF THE CSIRO DIVISION OF COMPUTING RESEARCH

February 1984

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REVIEW OF THE CSIRO DIVISION OF COMPUTING RESEARCH

STATEMENT OF EXECUTIVE DECISIONS



Introduction

The report of the Committee for the Review of the Division of Computing Research was presented to the Executive in July 1983. Comment was sought from the Advisory Council and State Committees, ASTEC, Directors of Institutes, the Planning and Evaluation Advisory Unit and the Bureau of Scientific Services, Headquarters Secretaries, Chiefs and staff of Divisions, and Staff Associations. Interest generated by the report was widespread with about fifty written responses being received.

Executive consideration of the report and the responses was deferred until the report of an Information Technology Study Group, which had been established by the Executive in April 1983, was available.

Both reports were considered jointly by the Executive Committee in January and by the Executive in February 1984.

Main Issues and Conclusions

The major issue raised by the report of the Division of Computing Research was the separation of service and research functions. The Review Committee recommended that the present Division of Computing Research (less the Systems Modelling Section, Numerical Taxonomy Section and VLSI Program) should become a CSIRONET Centre with the development and operation of distributed computing network services as its sole objective. This objective should include definition of protocols and conduct of high level developmental work in support of the network. It was further recommended that the Executive establish a Division of Computer Science and Engineering to conduct research primarily of a disciplinary orientation; other divisions would continue their applications objectives. The Centre and the new division should be located within the Institute of Physical Sciences.

Responses to the report indicated support for the organizational separation of the two functions, generally along the lines recommended; however various views were expressed about their location, including support for location within the Institute of Physical Sciences, comments in favour of the Institute of Industrial Technology, and complete severance of the service activity from CSIRO. It is notable that several respondents believe that the formation of a separate service unit would result in better service at a more reasonable cost than at present available to them.

Both ASTEC and the Advisory Council supported the concept of a CSIRONET centre with a service function, and a separate research group. The Independent Inquiry into Commonwealth Laboratory Services and Facilities (chaired by Professor I G Ross) also has recommended that CSIRONET should be a service-only organization within CSIRO with associated responsibility to maintain and development the network, and that research not directly related to the development of the network should be conducted separately. CSIRONET services and development should be a charge on users.

On the research function, the Review Committee proposed a Division of Computer Science and Engineering to conduct research which "would be much more disciplinary oriented (though not totally theoretical) and whose principal interactions would be with the Australian computer industry and, perhaps, Telecom". Broad research fields were suggested. The Committee proposed also that current research in other divisions directed towards the application of computers in industry and agriculture should be further encouraged.

Several respondents, including ASTEC and the Advisory Council, commented on the lack of definition and on the theoretical and academic emphasis of both the research areas and objectives of the proposed new research division, particularly in the light of the weight given this issue in the terms of reference for the review. Advice to the Executive from its Information Technology (IT) Study Group favoured a concentration of effort in software technology and related hardware, man-machine interface, information management, computer networking, and device and systems hardware technologies. The IT Study Group recommended the formation of an Information Technology Unit to perform advanced core research and participate in collaborative projects in information technology. The IT Study Group also recommended the establishment of an Information Technology Fund within CSIRO to promote collaborative projects on an Organization-wide basis between CSIRO, Australian industry, tertiary education institutions and other government bodies. Both these aspects of the strengthened approach would be carried out with the aim that results can be turned into products as soon as possible.

Other important issues raised by the Review Committee included

- . the standards of service and research;
- . the futures of the VLSI Program, systems modelling and numerical taxonomy groups;
- . contacts with industry and research; and
- . internal communications.

Each of these was raised in comments on the report. Many respondents expressed concern at the harshness of the Committee's criticisms, noting that the Division has been fulfilling the role determined by the Executive, and both the Review Committee and respondents acknowledged that constraints and conflicting priorities had been imposed on the Division from time to time.

The Committee recommended that the VLSI Program (which was commended by all as a model for research and technology transfer) should run its full course, and should operate as an autonomous unit in the Institute with staff appointments extended until the new division is established, at which time the program might become an element in its research program.

Recommendations related to the relocation of the Systems Modelling and Numerical Taxonomy Sections and the termination of the latter, drew considerable critical comment from respondents together with requests from staff directly involved that they participate in consultations leading to decisions on the future of the groups and their work.

The Committee's comments on industry contacts were particularly strongly contested in the Division's response to the report. The Division provided as an annex a list of 36 collaborative projects and 54 examples of industry usage during 1982-83. The Division also proposed several organizational options, favouring the formation of an Institute for Information Technology with both vertical and horizontal responsibilities in the broad field of information technology.

Decisions

A schedule setting out the recommendations of the Review Committee and the corresponding decisions made by the Executive is attached.

The Executive has decided that

1. CSIRONET will be separated from the Division and become an independent unit known as CSIRONET.
2. A revised charter will be prepared on the advice of the Policy Committee on Computing.

The Policy Committee will also explore ways in which CSIRONET can become more commercially independent, advise on the future operation of CSIRONET and report back to the Executive.

3. CSIRO will establish a Division of Information Technology to perform core research in information technology and to participate in collaborative projects with industry, Government establishments, Universities and with other research groups. The objectives of this Division will be as endorsed by the Executive's response to the report of the Information Technology Study Group which includes a listing of priority areas for core research and project development.
4. CSIRONET, for the time being and subject to 2 (above), will report to the Director, Institute of Physical Sciences.

It was decided also that this and consequential changes should formally come into force on 1 January 1985.

- | | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>R10. The Executive member responsible for CSIRONET and the Director of the Institute of Physical Sciences, and their successors, should be cosignatories to all agreements entered into by the officers transmitting any information acquired by virtue of such agreements. Steps should be taken, if necessary by signed agreements, to ensure that the Visitors Committee had adequate access to all information covered by commercial-in-confidence agreements.</p> | <p>Deferred subject to 9b.</p> |
| <p>R11. The management of CSIRONET should make a much greater effort to keep all CSIRONET staff, and also all users, as fully informed as possible on likely options for the development of the system.</p> | <p>Agreed. An annual CSIRONET Strategic Plan will be an important element in this information and reporting process.</p> |
| <p>R12. CSIRO should establish a significant group working on computer science and engineering research and related areas.</p> | <p>CSIRO will establish a Division of Information Technology to perform core research in information technology and to participate in collaborative projects with industry, Government establishments, Universities and with other research groups. The objectives of this Division will be as endorsed by the Executive's response to the report of the Information Technology Study Group which includes a listing of priority areas for core research and project development.</p> |
| <p>R13. The new research group (R12) should be known as the CSIRO Division of Computer Science and Engineering and should be located in the Institute of Physical Sciences.</p> | |
| <p>R14. The objectives of the new Division of Computer Science and Engineering should be:</p> | |
| <p>To conduct research into both the theoretical and practical aspects of computing and the manipulation, processing, transmission, storage and retrieval of information, and to explore the application of the results of this work for the benefit of the community.</p> | |

REPORT OF THE REVIEW COMMITTEE
ON
CSIRO DIVISION OF COMPUTING RESEARCH

JULY 1983
CANBERRA

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1. PREFACE

The CSIRO Executive agreed in principle (E421.5) in December 1981 to a review of the Division of Computing Research (DCR). The Executive Committee (on 22 April 1982) (EC39.11) subsequently considered the terms of reference and the membership of the Review Committee. This decision took cognizance of two important points: the extended term of appointment of Dr P J Claringbold as Chief of the Division will expire on 15 December 1983; and the recent (tabled May 1981) review of the Division's work by the Computing Policy and Facilities Advisory Committee did not examine the quality or scope of the research conducted within the Division. A considerable fraction of this research is now funded (\$1.5m in 1982/83) from Appropriation funds, and is thus strictly competitive with other CSIRO research.

The CSIRO Executive accordingly appointed a Review Committee for the Division of Computing Research in May 1982. The Committee membership was:

Dr J R Philip, FAA, FRS, (Chairman)
Director
CSIRO Institute of Physical Sciences

Professor B D O Anderson, FAA, FTS,
Department of Systems Engineering
Australian National University

Professor R P Brent, FAA,
Department of Computer Science
Australian National University

Dr R H Frater, FTS,
Chief
CSIRO Division of Radiophysics

Dr A K Head, FAA,
CSIRO Division of Chemical Physics

Professor J Weizenbaum
Laboratory for Computer Science
Massachusetts Institute of Technology, USA

Dr P W Ford was Secretary to the Committee.

The Committee's terms of reference are given in the following paragraph.

For the convenience of the reader we set out after each term of reference the pertinent sections and relevant recommendations of the report.

1. Advise the Executive on the appropriateness of the Division's present research objectives. (Chapter 5)
2. Advise the Executive on the extent to which the present research objectives are being achieved, taking account of the resources involved. (Chapter 5)
3. Comment on the quality of the research of the Division. (Sections 4.3, 4.4)
4. Examine and advise the Executive on research into the application of computers in science and technology going on elsewhere in CSIRO and the effectiveness of the interactions between participating CSIRO Divisions, including the Division of Computing Research. (Sections 6.3 and 6.4)
5. Taking account of Executive decisions on the report of the Computing Policy and Facilities Advisory Committee, examine and make recommendations on the relationship between the research and service components of the Division. Chapter 5, Section 4.2 R1, R2, R3, R4, R5, R6, R7, R8, R9, R11
6. Taking account of the Executive decisions of recent reviews, examine the relationship between the research programs of DCR and those of other parts of the Organization and report on how this relationship may be improved. (Chapters 5 and 6; R10, R11)
7. In the light of the above, advise the Executive on the future direction and organizational arrangements for CSIRO research in computing and related areas. (Chapters 5 and 6; R12, R13, R14)

The full Committee met in Canberra for the first time on 2 August 1982, and visited the Division's headquarters in Canberra on 3-5 August

inclusive and the Very Large Scale Intergration (VLSI) program in Adelaide on 9 August. Additional discussions with Divisional staff were held in Melbourne (6 August) and Sydney (10 August). Members of the committee met subsequently on 2 September, 9 November, 21 December 1982, and 23 May 1983. The Committee had discussions also with officers of other Divisions and with informed people interested in computing science. All these discussions are gratefully acknowledged, and are listed in Appendix 1.

The Committee invited submissions, and received also a number of unsolicited submissions. They are listed in Appendix 2. These were of considerable assistance to the Committee, and are gratefully acknowledged.

This report is based on the state of the Division during our review in August 1982. Subsequent significant changes are reflected in the footnotes.

2. SUMMARY AND RECOMMENDATIONS

We have reviewed the research of the Division of Computing Research and examined the interactions between the Division's research and the operation of the computing service network (CSIRONET). Much of what the Divisional submission has described as research is really advanced development and application specifically directed towards maintaining and improving CSIRONET. The research, as such, is relatively small in volume and with some exceptions not of acceptable standard. The motivations, demands, and scales of values required to maintain (and improve) the network are incompatible with that of a research group. A plethora of bureaucratic constraints regarding cost recovery, accountability, equipment acquisition, and confidentiality further inhibit the maintenance of a satisfactory research environment. We are convinced that it is impossible to establish and maintain a high-quality, main-stream computer science research group within the same organizational entity as CSIRONET. It is an inevitable consequence of the existing orientation of the Division that it has few points of contact, and fewer common interests, with most Australian computing science researchers and with the Australian computing industry outside the major equipment suppliers. The

opportunities for communication and collaboration with industry are thus few, and then only with a relatively narrow sector. The VLSI program, a commendable initiative of the Chief, is a striking exception to the above disappointing analysis. The program has accomplished its initial technology transfer objectives most impressively. It is, however, too early to form an opinion on its research. The program should be allowed to run its full length (until mid-1984) without further review. Continuation beyond that date will depend crucially on the available leadership.

Consistent with the analysis of the preceding paragraph we recommend that the present Division minus some elements become the CSIRONET unit of CSIRO.

The Executive must face the central question of whether CSIRO should attempt to establish a coherent computer science and engineering research effort or rely on other Divisions whose principal objectives do not lie in computer science and engineering. We believe that the scientific and commercial opportunities, the paucity of a national expertise in this area, CSIRO's statutory responsibilities, and the likely resources required to establish groups with a significant impact, when taken together, provide a convincing case for creating such a Division. The Division should have primarily a disciplinary orientation, whilst other CSIRO Divisions should continue to pursue applications of computer science and engineering in pursuit of their principal objectives. We offer suggestions on the most appropriate way of working towards the long term goal of creating a CSIRO Division of Computer Science and Engineering, working on areas within computing science and electrical engineering. Possible research areas in agriculture and manufacturing industry are indicated. We offer also suggestions on ways of improving the responsiveness and accountability of CSIRONET to the CSIRO Executive. Our recommendations are as follows:

- R1 The Division of Computing Research (less some elements) should become a service unit of CSIRO to be known as the CSIRONET Centre. The Centre's sole objective should be:

- the development and operation of computing network services in accordance with policies determined by the CSIRO Executive in the normal way and the carrying out of the high level development work necessary to support this operation.
- R2 The CSIRONET Centre should be located for administrative purposes in the CSIRO Institute of Physical Sciences.
- R3 The Divisional location(s) of the Systems Modelling Section and the Numerical Taxonomy Section should be decided by the Directors of the Institutes of Biological Resources and Physical Sciences.
- R4 The work of the Numerical Taxonomy Section should be terminated by the end of 1983 and the resources released should be reserved for redeployment to the new CSIRO Division of Computer Science and Engineering (R13).
- R5 The VLSI program should be allowed to run its full course until mid-1984 without further review. The program should remain in Adelaide.
- R6 Where necessary, terms of appointment to the VLSI program should be extended to provide reasonable overlap with the proposed Division of Computer Science and Engineering (R13), consistent with the provision of effective leadership.
- R7 The CSIRONET Centre should foster the further development of a distributed computing network within CSIRO and actively work to achieve this in cooperation with CSIRO Divisions.
- R8 The CSIRONET Centre should have responsibility, in full consultation and collaboration with CSIRO Divisions, for the definition of communication protocols and general requirements for that Divisional computing equipment which is linked into a distributed computing network based on the existing CSIRONET. Such protocols should, as far as possible, comply with international standards.

R9 A CSIRONET Visitors Committee be established. Its membership should be distinguished, disinterested, technically expert computing specialists, together with people with the appropriate management skills. They should be appointed by the Executive on the recommendation of the Policy Committee on Computing to advise the Executive on the future development of CSIRONET with special attention being given to meeting the needs of CSIRO. The functions of this Committee shall be:

- . to advise the Executive on the future development of CSIRONET with special attention being given to meeting the needs of CSIRO;
- . to monitor progress in the development of the CSIRONET Centre and report to the Executive.

R10 The Executive member responsible for CSIRONET and the Director of the Institute of Physical Sciences, and their successors, should be cosignatories to all agreements entered into by the officers of the CSIRONET Centre which constrain them in transmitting any information acquired by virtue of such agreements. Steps should be taken, if necessary by signed agreements, to ensure that the Visitors Committee has adequate access to all information covered by commercial-in-confidence agreements.

R11 The management of CSIRONET should make a much greater effort to keep all CSIRONET staff, and also all users, as fully informed as possible on likely options for the development of the system.

R12 CSIRO should establish a significant group working on computer science and engineering research and related areas.

R13 The new research group (R12) should be known as the CSIRO Division of Computer Science and Engineering and should be located in the Institute of Physical Sciences.

R14 The objectives of the new Division of Computer Science and Engineering should be:

To conduct research into both the theoretical and practical aspects of computing and the manipulation, processing, transmission, storage and retrieval of information, and to explore the application of the results of this work for the benefit of the community.

In the Terms of Reference, especially 5 and 6, we are asked to take account of recent reviews of the Division of Computing Research and the Executive decisions of the Report of the Computing Policy and Facilities Advisory Committee. Since 1975 there have been five reviews of aspects of the work of the Division of Computing Research (not counting this review). In this chapter (and the associated Appendices 3-6) we summarize the findings of these reviews and, where appropriate, the relevant Executive decisions. As background to these reviews, and for completeness, we give in this chapter a brief account of the history of the Division of Computing Research and the earlier history of computing science and engineering research in CSIRO.

3.1 Historical perspective on CSIRO's involvement in computing research

The Division of Computing Research is not CSIRO's first involvement in computing. Work on "mathematical instruments" was going on within the Division of Electrotechnology in Sydney in 1945. The CSIR 1947-48 Annual Report referred to work in the Section "on the application of electronic techniques to high speed digital computation. A considerable amount of basic work has been done in developing electronic circuits for counting in both decimal and binary systems, and experience has been gained in assembling and controlling these circuits for transmitting, adding, and multiplying numbers With existing electronic techniques, binary arithmetic appears to have distinct advantages in the operation of high-speed electronic computers."

Parallel work was going on in the Division of Radiophysics and the previously cited CSIR Annual Report noted that "progress has been made on both practical and theoretical aspects of the design of high speed computers. A survey of various aspects of the design of such devices has been made and arising out of this the main design principles for such a computer have been fixed and a specification has been prepared for a preliminary model electronic computer A large amount of developmental work is involved and it is not expected that the preliminary model will be in full scale operation before the end of 1949". The Mark I electronic high speed computer was demonstrated in Sydney in

August 1951 and by October was in regular use. This computer, known as CSIRAC, was one of the first stored program computers in the world. It was transferred to Melbourne University in 1956. The Melbourne Science Museum holds parts of CSIRAC following its dismantlement. The CSIRO work in computing research stopped in 1955.

3.2 History of the Division of Computing Research

The Executive considered in early 1959 a proposal from Dr E A Cornish, then Chief of the Division of Mathematical Statistics, for the establishment of a Computer Laboratory with a large machine in Adelaide and smaller computers in Canberra, Melbourne, and Sydney.

Extensive consultations then took place with several Australian universities and were followed by deliberations by the Interdepartmental Committee on Automatic Data Processing. In May 1962, CSIRO proposed to Government that CSIRO establish an integrated network for scientific computing and data processing for the use of Commonwealth Departments, instrumentalities, and universities. The central computing unit was to be located in Canberra and an additional four subsidiary units were to be acquired. A Computing Research Section was established, and proceeded to acquire the major unit for Canberra (CDC 3600) and subsidiary units (CDC 3200) for Adelaide, Melbourne, and Sydney. The Division developed rapidly an interactive operation system (DAD) providing terminal access within the central office of the Division in 1965. This innovation preceded commercial developments by some years and was ahead of similar developments in the USA. In 1971 the acquisition of five PDP 11/20 computers (located in Adelaide, Brisbane, Canberra, Melbourne, and Sydney), together with the development of packet switched networking software, provided widespread access to the CDC 3600 system. This network (known as CSIRONET), linking the various CSIRO sites and other Government agencies, gradually expanded. CSIRONET was a very major achievement and was an advanced development effort of world rank at the time. CSIRO was initially the major user of the network, but in recent years CSIRO use of CSIRONET as a fraction of total revenue has decreased to about one-third of the total. The principal users now are Commonwealth government departments. Table 1 presents a brief chronology of some of the major events in the history of the Division.

TABLE 1CHRONOLOGY OF SIGNIFICANT EVENTS FOR
DIVISION OF COMPUTING RESEARCH

| | |
|------------------|---------------------------------------------------------------------------------------------------------------------------|
| 1962 | Government approves CSIRO proposal to establish a Computing Research Section |
| 1 February 1963 | Dr G N Lance appointed Officer-in-Charge of Section |
| June 1964 | CDC 3600 delivered and installed in new computer building Canberra |
| November 1964 | CDC 3200s installed in Adelaide, Melbourne and Sydney |
| 4 March 1966 | Initial version of "DAD" operating system for 3600 installed |
| 28 August 1967 | Section given Divisional status. Dr G N Lance appointed Chief of Division |
| December 1971 | PDP 11 network "CSIRONET" - Adelaide - Melbourne - Canberra - Sydney - Brisbane established |
| 1973 | CYBER 76 acquired |
| June 1974 | Advisory Committee on Computing |
| May 1976 | Fernbach Review initiated |
| 17 June 1977 | Dr G N Lance resigned as Chief Dr P J Claringbold appointed Chief |
| 25 August 1977 | Report of the Independent Inquiry into CSIRO (Birch Report) |
| 1 September 1978 | Executive decisions on recommendations of Working Group on Future Functions and Structure of the DCR Network promulgated. |
| 1979 | Computing Policy and Facilities Advisory Committee established. |
| August 1979 | Connection of CSIRONET to MIDAS gateway to overseas data bases |
| June 1980 | CYBER 170/720 computer installed. NOS/BE Service commenced |

| | |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------|
| October 1980 | VLSI group established in Adelaide |
| January 1982 | CSIRONET node at Kansas City, Missouri, USA |
| 30 April 1982 | CYBER 835 replaced CYBER 720 |
| June 1982 | Executive decisions on recommendations of Computing Policy and Facilities Advisory Committee promulgated. Divisional Review announced |

3.3 Previous Reviews

3.3.1 Fernbach Report

In May 1976 Dr S G Fernbach, Deputy Associate Director of the Lawrence Livermore Laboratories, was invited by the Chief of the Division of Computing Research to examine and report on the structure, management, and performance of the CSIRO computing service (CSIRONET) and comment on ways of meeting the users needs.

Dr Fernbach's report was delivered in June 1976. He urged* a substantial restructuring of DCR management, consulting, and operating groups; a quite major increase in staff; an improvement in communication with users regarding DCR computer policy and plans; forward planning for the acquisition of additional computing equipment; and acquisition of "off the shelf" hardware and software. The then CSIRO Executive did not accede to these proposals (the major staff increase was rejected).

3.3.2 Independent Inquiry into CSIRO

The Report of the Independent Inquiry into CSIRO (Birch Report) devoted particular attention to the Division of Computing Research. The Division was one of three CSIRO Divisions explicitly mentioned in the Report's recommendations (the others were the National Measurement Laboratory and the Division of Mathematics and Statistics). The Report urged a

* Appendix 3 is a statement prepared by Dr Fernbach summarizing his recommendations.

reshaping of the Division to become purely a computing service network servicing CSIRO and Government agencies. Its research efforts were to be directly related to users needs and the operation was to recoup all costs via user charges. The Government adopted all these recommendations. The question of whether CSIRO would (or should) conduct research in computing science or related areas under its general statutory function (specifically Section 9(a) of the Science and Industry Research Act (1978)) was not addressed. The Inquiry also recommended the rationalization of individual computers within CSIRO Divisions to avoid duplication of any CSIRONET service. Rationalization of scientific computing in all Commonwealth Government supported activities, including universities and colleges of advanced education, was recommended for consideration in the next upgrade of CSIRONET central computing capacity. The recommendations of the Independent Inquiry relating to the Division of Computing Research are set out in Appendix 4.

3.3.3 Working Group on the Future Functions of the DCR Network

Following the Government's decisions on the Birch Report, the Executive established a working group on the future functions of the DCR network directed towards giving effect to the Government decisions bearing on the operations of the computing network. The working group reported back to the Executive Committee (Policy Development) on 15 September 1978. The Executive Committee adopted a number of recommendations. Six of these, when taken together, constituted the charter for CSIRONET. It affirmed the service role of the Division with its remit extending to "research into, and development and provision of computing services".

The Executive reaffirmed that the Division should have achieved full cost recovery on its computer network operations by 30 June 1981. The Executive subsequently accepted the view that some of the Division's work, deemed to be research not directly related to the network operations, should be funded from Appropriation sources. This allocation now (financial year 1982/83) amounts to \$1.5m.

The Executive decisions and those recommendations relevant to this Review are given in Appendix 5.

3.3.4 Report of the Computing Policy and Facilities Advisory Committee

The Computing Policy and Facilities Advisory Committee was established in 1979 to advise the Executive on the role CSIRO and DCR should play in computing research, the requirement for computing facilities, the charter of CSIRONET, the range of customers to be serviced by CSIRONET, and the mechanisms for providing the Executive with policy advice on CSIRONET. The Advisory Committee reported in May 1981, and the Executive decisions were promulgated in June 1982. The CSIRONET charter was broadened to include research in computing, the network's permitted range of users was expanded, and limits on the revenue from, and computer time available to, external users were reviewed. The Committee's Terms of Reference, together with its recommendations and the Executive decisions thereon, are set out in Appendix 6.

3.4 Resources, Research Programs and Objectives

The central purpose of this review is to examine the research of the Division of Computing Research. The approach the Committee adopted in the first instance was to consider and evaluate those aspects of the Division's work which the Division itself identified as research or as having a research component. What the Division considers as research is inextricably mixed with the general service activities of the Division. In the Division's view of the 162 staff 77 have exclusively service responsibilities (administration and general services - 30; controller (operations) - 30; and controller (user services) - 17.

Two programs (VLSI Architecture, and Modelling and Information Systems - 30 persons) are seen by the Division as exclusively research, whilst three programs (Computer Communications, Operating Systems, and Information Display Systems) have both research and service activities attributed to them. The Review Committee's views on these attributions are set out in Chapter 4. The detailed allocation of staff resources is set out

in Table 2. In addition, the Divisional staff make quite extensive use of the Division's computing facilities. The Division's Computing costs (calculated at standard rates) for 1981/82 were \$1.69m for research, and \$0.845m for advanced development.

TABLE 2

DIVISIONAL STRUCTURE AND ALLOCATION OF STAFF

| <u>Program</u> | <u>RS</u> | <u>EO</u> | <u>T</u> | <u>O</u> | <u>Total</u> |
|-------------------------------------------------------------|-----------|-----------------|----------------|----------|--------------|
| Management and Administration (includes Office of Chief) | 4 | 2 | 2 ^a | 22 | 30 |
| Controller (Operations) | | 5 ^b | 24 | 1 | 30 |
| Controller (User Services) | | 14 | 3 | | 17 |
| E Modelling and Information Systems | 6 | 8 | 1 | | 15 |
| F Information Display Systems | 4 | 9 | | | 13 |
| G VLSI | 3 | 7 | 3 | 2 | 15 |
| H Operating Systems | 3 | 14 ^c | 2 | | 19 |
| J Computer Communications | 5 | 11 | 5 | 2 | 23 |
| | 25 | 70 | 40 | 27 | 162 |

Source: Table 2, Division of Computing Research Submission to Review Committee.

- (a) Includes 1 Department of Social Security (DSS) staff (Technical)
- (b) Includes 5 DSS staff (Experimental Officer)
- (c) Includes 1 DSS staff

Apart from the VLSI research program in Adelaide, the Division's research effort is concentrated in Canberra with only a few research scientists located in Sydney, Melbourne, and Brisbane. Details are shown in Table 3.

TABLE 3LOCATION OF RESEARCH SCIENTISTS

| <u>Location</u> | <u>Number (RS)</u> |
|-----------------|--------------------|
| Adelaide | 3 |
| Brisbane | 1 |
| Canberra* | 15 |
| Melbourne | 2 |
| Sydney | <u>1</u> |
| | 22 |

* Excludes Chief and 2 Assistant Chiefs based at Canberra.

The objectives of the research programs and subprograms are as follows.

Program E - Modelling and Information Systems

Objectives: To foster the use of computers for systems modelling, information systems and numerical classification by participating in collaborative application projects, producing new applications software and techniques, and promulgating effective computing practices.

There are three subprograms:

EA - Systems Modelling Section

Objectives: To apply simulation and other computer-assisted mathematical modelling techniques in an innovative way to explain the dynamic behaviour of biological or other complex systems, and to obtain or develop improved modelling tools where needed.

EB - Information Systems Section

Objectives: To conduct research in information systems technology with some emphasis on data structures, data languages and the manipulation of large quantities of data.

EC - Numerical Taxonomy Section

Objectives: To develop readily available computer programs applicable to numerical classification.

Program F - Information Display Systems

Objectives: The investigation of computer representations, computational techniques (algorithms), and computer systems for the entry, formatting, manipulation, analysis, and display of graphic and image data.

There are two subprograms:

FA - Image Systems Section

Objectives: The research and development of image processing facilities on CSIRONET. In addition to the development of software facilities, the Section operates an advanced image processing laboratory (based on a PDP-11), which is made available to CSIRONET users.

FC - Graphic Systems Section

Objectives: The provision and development of graphics facilities to support graphics and typesetting applications on CSIRONET.

The Section is mainly concerned with low-level graphics software and with utilities for scientific data display and typesetting. Special projects have been established to develop systems for geographic data processing, interactive colour mapping, and mathematical typesetting.

Program G - VLSI

The objectives of the VLSI Program are, within three years:

- To establish a research centre with an international reputation in VLSI design;

- To demonstrate this capability by the design and remote fabrication of a 100,000 transistor chip; and
- To facilitate the technology transfer of design methodologies to Australian industry.

Program H - Operating Systems

Objectives: To carry out development work in operating systems on the Control Data (CYBER) and Facom computers. The Program installs, supports, and maintains these operating systems, and provides enhancements where manufacturer-supplied code does not meet the needs of CSIRONET. Particular emphasis has been placed on the connection of the packet switched network to the central mainframes, and the interconnection of the central host computers to produce a unified computing facility.

There are three subprograms:

HA - Cyber Systems

Objectives: The enhancement of the standard SCOPE operating system, the development of a high performance interactive system (CYI) and the setting up of a local area network (via the HYPER channel).

HB - FACOM Systems

Objectives: Install and maintain the OSIV/F4 operating system on the Facom computers and to connect these three machines to CSIRONET and to integrate them into a central facility. Research into standards governing the interconnection of computers.

HE - Interactive Systems

Objectives: The development of a high performance interactive computing environment.

Program J - Computer Communications

Objectives: Research into the design, implementation, performance and standardisation of computer networks and related areas with particular reference to the Australian scientific computing environment. Manage the development and maintenance of the CSIRONET packet network and local area network.

There are four subprograms in this program:

JA - Information Storage Systems

Objectives: Development of a centralized storage facility based upon the Braegen Automated Tape Library, in a multi-host environment.

JC - Packet Network (in collaboration with Subprogram JJ)

Objectives: Research into the design, implementation and performance of packet switched networks. Responsible for the development of the CSIRONET communications network.

JJ - Network Architecture

Objectives: Investigation of heterogeneous host aspects of computer communications networks and research in network host connections, protocol standardization; internetwork gateways, and high level protocols.

JG - Hardware

Objectives: Hardware design and development to support the service, the investigation and evaluation of new technology, and consultation and advice on new equipment.

The staff resources allocated by the research programs are shown in Table 2.

CHAPTER 4

THE COMMITTEE'S EVALUATION OF THE DIVISION AND ITS WORK

4.1 Introduction

This review is primarily a review of the research of the Division of Computing Research. We are requested, however, under Term of Reference 5 to examine the relationship between the research and service components of the Division's work. In conducting our investigations in connection with this Term of Reference, we have gained a clear appreciation of the quality of the service activities of the Division and the Chief's role in their development. Earlier reviews, perhaps more concerned with managerial and administrative aspects, have not explicitly addressed the question of the quality of CSIRONET services. In this Chapter we offer our perceptions on this matter before turning to our main task - our examination of the research work of the Division of Computing Research.

4.2 The Service Aspects of the Division of Computing Research

CSIRONET is big business. It will earn about \$14m revenue in financial year 1982/83 providing computing services to at least 2,000 separate users in CSIRO, other statutory authorities, universities, federal and state government departments, and industry. CSIRONET now uses a number of machines, including the partially obsolescent CYBER 76 machine.* There is considerable effort going into the development of new software for the existing system of machines. The Design and Development Committee (DAD) provides oversight of development work on, modification of, and enhancements of CSIRONET.

* Since the start of this Review the Executive has decided to acquire a CYBER 205 machine. This machine will not be used, however, for general purpose scientific or administrative computing. The configuration of the system post CYBER 76 thus still has to be established.

The network has been able to respond promptly to quite major and sudden demands by non-CSIRO users for large increases in computing services. This flexibility has been achieved, however, at the expense of longer term development work and the Division's research efforts. Research projects have been abruptly stopped, or undergone marked changes in objectives, to accommodate the needs of CSIRONET's customers. In an effort to meet unforeshadowed customer demand, the Division has adopted a policy of maintaining a surplus of capacity over-and-above projected needs. As a consequence, some of the machines have a low use factor and are idle for a considerable fraction of the time.

CSIRONET has coped quite well with a gradual change in the character of its clientele. When established in 1963, CSIRO scientists were the major users. With decreases in the price of computer hardware, the diminution of Divisions' real disposable resources, and the increases in CSIRONET charges, many CSIRO Divisions have sought to develop their own computer systems. Thus, although the total use of the system has increased greatly, the CSIRO proportion has declined. The lack of screen-editing facilities on CSIRONET coupled with CSIRONET's unsuitability for data-acquisition and real time data processing has encouraged the move to Divisional controlled computers. CSIRO now provides only about one-third of the total CSIRONET revenues and this fraction is decreasing. The boundaries between scientific computing and general administrative computing have become very diffuse (if not non-existent). The network, originally established for advanced scientific computing and data processing (see Section 3.2), now performs very large amounts of routine administrative computing.

CSIRONET's success in meeting the manifold demands on it is attributable to the expertise and dedication of the staff*. The Chief has an exceptional command of the technical details of the system and the current commercial constraints of operating the system in a full-cost recovery mode.

* We were especially impressed by the quality of the senior Experimental Officers in the Division, who played an absolutely central role in maintaining the service.

4.3 The Research Aspects of the Division of Computing Research

The research activities of the Division of Computing Research are a heterogeneous and disconnected collection of activities. The VLSI program is, for instance, not heavily dependent upon CSIRONET. In marked distinction to practically all the other research activities of the Division, the VLSI program addresses objectives not directly related to the function of CSIRONET. In this section we comment on the research activities of the Division in general. Specific programs are reviewed in Section 4.4.

The overwhelming impression after surveying the Division's research activities is of the lack of genuine research in computing science. The research output is not commensurate with the quite considerable resources expended (in 1981/82, \$1.69m computing costs, and \$1.5m appropriation funds). Much of what the Division classes as research is, in our view, advanced development work directed towards the maintenance or enhancement of the operations of the network. The results are, nearly always, specific to the network or to component machines in the network or, alternatively, are directed to the needs of specific users of the network. This limited focus is reflected in the Division's publication performance, where the predominant outlets are the "in-house" publications of the various manufacturers' user groups or internal publications of the Division. The Committee's perceptions of a lack of broadly based research were supported by comments of several of the authors of submissions. They noted the Division's lack of impact on, or even connection with, the community of computing science research people in Australia. In a similar fashion, because of the virtually total mismatch between the Division's work (apart from VLSI) and the researches of other CSIRO Divisions, the opportunities for interaction and collaboration on research problems of mutual interest are very small indeed.

The Division's concentration on advanced development work appears to be an inescapable consequence of operating CSIRONET and the externally imposed constraints governing this task. In a service organization those staff associated with genuine research tasks are almost inevitably called in to deal with the immediate problems of keeping the service operational. This has quite clearly happened in DCR. The demands of operating

CSIRONET thus have had a deleterious impact on the research done within the Division. Only the new VLSI group, at a location remote from the CSIRONET centre, working on non-network research problems, has escaped the effects of the network's demands.

The problems of the Division's researches cannot be attributed solely to the demands of the network. We consider that some of the research problems tackled have been ill chosen, and staff, on occasion, have been ill-matched to the research tasks they have been assigned to.

4.4 Comments on Specific Research Programs

4.4.1 Program E - Modelling and Information Systems

This program really consists of three disparate groups (Systems Modelling Section, Information Systems Section, and Numerical Taxonomy Section). The research scientists in the Systems Modelling subprogram are engaged on long-term consultative and collaborative projects with CSIRO scientists in other, principally biologically oriented, Divisions. The section has chosen to limit its efforts to the biological sphere, which seems unwarranted given the general paucity of theoretical and mathematical inputs to CSIRO research (see DMS Review Report). Contact with other mathematicians in CSIRO (and elsewhere) appears to be slight, and the subprogram's placement in DCR has probably encouraged too great a reliance on computer based approaches. The section maintains the various simulation packages on CSIRONET and advises users.

Paradoxically, with considerable modelling expertise at the Division's command, the section has made no effort to model the network or to study computer network modelling generally. This appears to us to have been a natural task for the group and consistent with the Division's charter. There are a number of issues such as queueing, arbitration, and demand prediction which could have been addressed.

The Information Systems Section maintains and develops software for the manipulation of data bases and the investigation of data base machinery for connection to the network. In our view the work of the group is almost

exclusively engineering evaluation or advanced development in character. The section has staff at Melbourne and Canberra. This is not, in our view, an optimum arrangement.

The Taxonomy Section is based in Brisbane and is engaged in the "tidying up" of a large package of numerical taxonomy programs. This work is seen by the taxonomy community to be high quality research and the suite of programs is widely used by Australian taxonomists. We concur with the Chief's view that this work should cease once the revised package is installed on CSIRONET.

4.4.2 Program F - Information Display Systems

Each of two subprograms (Image Systems Section and Graphic Systems Section) has a substantial budget of activities directed to aiding users of CSIRONET and providing image processing facilities to outside users. The work of the Image Systems Section has also a significant research content and is of a good standard.

4.4.3 Program G - VLSI

This program has three strands: technology transfer, demonstration of techniques for chip design, and research into methods of chip design and problems of circuit architecture. The program has been in existence a short time only, and has, during this time, concentrated on the technology transfer and design technique demonstration aspects of its objectives. It has done everything that could be asked of it in this respect. It is too early to comment on the quality of VLSI research. A good research environment has been created, however, and it appears to have a good chance of achieving its objectives within the agreed time frame.

4.4.4 Program H - Operating Systems

The Operating Systems Program plays a key role in keeping CSIRONET running. It develops and maintains operating systems, and installs, supports, and produces enhancements and modifications of manufacturer supplied code. The Program develops software to facilitate communications

between computers of different manufacturers and their interconnection into CSIRONET. The work of the program is very strictly determined by the unique operating environment of CSIRONET. The results are thus of peripheral interest to virtually the whole computing science community.

In our view the element of the generation of new and generally applicable knowledge is so small that the activities of this program must be considered as advanced development work rather than scientific research.

4.4.5 Program J - Computer Communications

In contrast to Program H (Section 4.4.4), this program has both hardware and software orientated components. Their principal functions are to maintain and develop the communications network linking CSIRONET users to the central computers, and to develop ways of linking the various computers and peripheral devices within the Division. Work on the development of standards and protocols governing intercommunication between different computers is conducted in this program also. We see the standards/protocol work as a valuable advanced development project. In our view, it is not, however, a research activity. The hardware section has played a major role in the development of a "micronode" which will facilitate the interconnection of various varieties of computer, located in Divisions, into the network. It is a step towards establishing a distributed processing system. It struck us as a particularly forward looking development for the network.

CHAPTER 5

A DIAGNOSIS AND PRESCRIPTION

5.1 Introduction

In the previous chapter we have briefly described the activities of the various programs of the Division. While much of the work provides valuable support for the operations of CSIRONET, very little (apart from VLSI) seems to be in the mainstream of computer science research. The Division is not seen by informed outsiders to be a major centre for computer science research, even in the fairly limited Australian context.

In our view, DCR is an environment which has not offered and, in its present form cannot offer, a satisfactory environment for the pursuit of research in computing science.

In this chapter we set out a more detailed commentary on the causes of the Division's difficulties in pursuing research objectives and suggest possible remedies.

5.2 A Diagnosis

As we noted earlier, the character of the Division of Computing Research has been determined by its obligations to provide a "computing bureau-like" service, and to meet the changing needs of a diverse collection of customers. Inevitably, the immediate needs of the system take precedence over the longer term research effort. During our investigations we came across instances where research was abandoned incomplete because the facilities used for the research were required for unforeseen service demands. Very considerable effort was wasted, for instance, when one of the FACOM computers used primarily for research was diverted at very short notice to meet the computing needs of the Department of Social Security. Such an environment is inimical to the development of a good research ethos, and to the attraction of people with the necessary research qualities to the Division. The exigencies of the system operation, and the

imposed constraints lead to an excessive preoccupation with hardware acquisition, the pursuit of more business for the network, the pursuit of arrangements (or deals) to acquire more machinery without resort to capital expenditure, and the entry into collaborative research arrangements, some of which appear to be of doubtful research content.

The leadership of the Division is called upon to act entrepreneurially for CSIRONET and to foster the development of high quality research. Yet, at the same time, it is subject to all the bureaucratic constraints¹ a statutory organization is prey to.

Despite their formal assignment to service, advanced development, or research tasks, staff (apart from the VLSI program), are required, on occasion, to both contribute to the support of, and advanced development of, the system. These requirements are, in our view, unrealistic and have, we believe, impaired the Division's performance both as a service and as a research organization. The Division itself is quite aware of these problems. In a comment on a draft of this report the Chief noted "How can research flourish in an environment dominated by the need to earn ever-increasing revenue, over and above inflation, in order that capital items and buildings be purchased from accumulated revenue, and meet sudden demands imposed by government which are unforeseen by the Chief of Division, or by the Executive?". The success of the VLSI program underlines the point we are making. Good research can only be conducted in an environment free from day to day operational pressures, provided with scientific leadership free to concentrate on the scientific tasks, and staffed by people recruited with a specific research task in mind.

1 One measure of the constraints and scrutiny to which the Division has been subjected is the frequency of reviews. As we noted in Chapter 3, the Division has been reviewed five times in the past seven years. The uncertainties induced by reviews of such frequency, and the consequent changes in direction, have had a deleterious impact on morale and have positively hindered the development of an environment encouraging for research (or even a stable bureau operation).

5.3 Future of the Division

In the light of our principal observations on the research work of the Division of Computing Research and the unsatisfactory environment that the Division currently provides for computer science and engineering research in CSIRO, we believe that CSIRO should now redress the situation which has developed. This should involve an explicit recognition that DCR is not primarily a research Division and that it is dissimilar, in character, function, and structure, to other CSIRO Divisions. Others have urged recognition of this fact. The Birch Inquiry² proposed DCR as the core of a CSIRO Computing Service Network with general computing science research conducted elsewhere. The universal experience in academia and research institutions has been that research and service functions do not both flourish within the one organizational entity. Although CSIRO use of CSIRONET for scientific computing is static and provides a decreasing fraction of CSIRONET revenue, CSIRONET is still a valuable computer service bureau for many Divisions and provides access to facilities which no single Division could command. There are thus considerable advantages to CSIRO in continuing the CSIRONET service, but, in our view, significant computing research cannot be conducted in the same environment. We therefore recommend that:

- R1 The Division of Computing Research (less some elements) should become a service unit of CSIRO, to be known as the CSIRONET Centre. The Centre's sole objective should be:

² Independent Inquiry into CSIRO, loc. cit. R79 "The Division of Computing Research should be reorganized as a CSIRO Computing Service Network, retaining the name CSIRONET. Its services should continue to be available to Government Departments and instrumentalities, universities and other approved users." They went on to comment (p. 175) that "CSIRO research in computing, within CSIRONET, should, we believe, be firmly related to the responsibilities of CSIRONET to its users. Research involving computers related to other CSIRO requirements, should be established by the Institutes or Divisions concerned." We do not accept, however, the Independent Inquiry's view, embodied in the last sentence cited above, that the optimal arrangement of CSIRO's computing research is one involving a multiplicity of Divisions without a focus for disciplinary research in computer science and engineering. We return to this point later.

the development and operation of computer network services in accordance with policies determined by the CSIRO Executive in the normal way and the carrying out of high level development work necessary to support this operation.

We return to the question of the conduct of computing science and engineering research within CSIRO in Chapter 6.

The question arises as to where the new service-oriented CSIRONET Centre should fit within the CSIRO administrative structure. We believe that the CSIRONET Centre should remain within the Institute structure and within the Institute best equipped to evaluate its performance and proposals. We therefore recommend that:

R2 The CSIRONET Centre should be located for administrative purposes in the CSIRO Institute of Physical Sciences.

As we noted in Chapter 4, some of the components of the present Division of Computing Research are related peripherally to the Centre's major ongoing task - the operation of the computer network. We have in mind the Systems Modelling Section, the Numerical Taxonomy Section, and the VLSI program. The new role we propose for the CSIRONET Centre cannot effectively embrace the activities of the Systems Modelling group as well. At the same time, there is a general paucity of modelling and simulation expertise within other CSIRO Divisions and a growing awareness that well-formulated and soundly based modelling inputs, in the form of testable hypotheses, could markedly advance work in a number of areas in various Divisions. The problem is how to ensure that these inputs are deployed to be of maximum usefulness. A number of potential locations seem feasible, but we have had no opportunity to make an exhaustive examination of the possibilities. We therefore recommend that:

R3 The Divisional location(s) of the Systems Modelling Section and the Numerical Taxonomy Section should be decided by the Directors of the Institutes of Biological Resources and Physical Sciences.

Given the personal consequences for the staff of the Section, we believe that every effort should be made to settle this matter promptly if the Executive decides to proceed with this recommendation. The matter should certainly be resolved and the staff advised before the end of 1983.

We noted earlier (Section 4.4.1) that the Numerical Taxonomy Section is largely engaged in the "tidying up" of a large package of computer programs for numerical taxonomy. We concur with the Chief's proposals to close this Section. We therefore recommend that:

- R4 The work of the Numerical Taxonomy Section should be terminated by the end of 1983 and the resources released should be reserved for redeployment to the new CSIRO Division of Computer Science and Engineering (R13).

The VLSI program has clearcut goals and a well defined program for reaching them. When established it was subject to review after 18 months. In our view, the course of the program is now set, the first target has been achieved, and work towards the other goals is progressing. Any further examination is unlikely to reach a contrary view on the effectiveness with which the program is operating. We suggest that our review has fulfilled all the tasks of the 18 month review and therefore recommend that:

- R5 The VLSI program should be allowed to run its full course until mid-1984 without further review. The program should remain in Adelaide.

From the time of the creation of the CSIRONET Centre we suggest that as an interim measure until the new Division of Computer Science and Engineering (R8) is established, the VLSI program should operate as an autonomous unit within the Institute of Physical Sciences.

The VLSI program is quite exceptional in the context of CSIRO, with all research staff recruited on fixed term appointments. Provided the necessary leadership continues to be available, the VLSI Group should not be permitted to disintegrate due to the expiry of terms of appointment

before the new Division is established. Quite clearly the Executive will need to inform the staff of its intentions well ahead of this date. We therefore recommend that:

R6 Where necessary, terms of appointment to the VLSI Program should be extended to provide reasonable overlap with the proposed Division of Computing Science and Engineering (see R13), consistent with the continued provision of effective leadership.

A VLSI research programme could be a valuable element in a continuing CSIRO computing research program.

5.4 The Network

The present form of CSIRONET is the result of incremental additions to a network conceived in the late 1960's and early 1970's, and the changing pattern of constraints regarding the financing its operations and the granting of access to the network. The form reflects the then prevailing economies of sending data around the country and the relative costs of computer hardware and software. The principal machine of the network (CYBER 76) is obsolescent and the strategic plan for CSIRONET is at present being formulated³. Whilst recognizing that long term predictions on future directions of computer hardware development are notoriously difficult, there is no doubt that computing equipment will become cheaper (for equivalent performance). Divisions are increasingly acquiring their own computer facilities, mainly for interactive work, the manipulation of large data sets, and the control and monitoring of experiments - all tasks which CSIRONET is not well suited to doing cheaply or conveniently if at all. This trend will intensify in the future and much of CSIRO's "bread and butter" use of computers will inevitably be done in the Divisions.

There is thus an apparently inexorable expansion of computing capacity within Divisions. There has been also a quite major development of expertise in computing within Divisions. No Division's resources can, taken individually, rival those of CSIRONET. Taken together they are, however,

³ This was correct at the time of the Review Committee's visit to the Division (August 1982). A strategic plan has subsequently been presented to the Policy Committee on Computing.

of commensurate size. Combining these Divisional resources with those of CSIRONET would certainly benefit CSIRO users. To achieve these benefits will require a total reorientation of CSIRONET from its present role as a supplier of services on machines it controls to an expanded role as custodian and organizer of a distributed computing network. This should be a central task of the CSIRONET Centre (R1). We therefore recommend that:

- R7 The CSIRONET Centre should foster the further development of a distributed computing network within CSIRO and actively work to achieve this in cooperation with CSIRO Divisions.

The establishment of a distributed computing network relies crucially on the existence of a comprehensive set of standards and protocols applying to the computing machinery linked into the network. The Division of Computing Research is already doing worthwhile work on both the hardware and software aspects of these questions. The Division's development of micronodes which will facilitate the interconnection of spatially separate computers in Divisions with CSIRONET is a positive step towards establishing the distributed network we envisage. We see work on the hardware and software aspects of distributed processing as an appropriate continuing function of the CSIRONET Centre.

In carrying out this work, the CSIRONET Centre should take proper cognizance of the development of standards and protocols elsewhere in the world. Communication protocols should, as far as practicable, comply with international standards in order to facilitate communication with other networks. The Centre should seek to develop a system which facilitates the integration of the most widely used commercially available computers and peripheral devices into the network. We therefore recommend that:

- R8 The CSIRONET Centre should have responsibility, in full consultation and collaboration with CSIRO Divisions, for the definition of communication protocols and general requirements for Divisional computing equipment which is linked into a distributed computing network based on the existing CSIRONET. Such protocols should, as far as possible, comply with international standards.

5.5 Upward and Downward Transfer of Information

In the course of our investigations it became apparent that there were deficiencies in the transfer of information concerning the development of the network both within the Division, and between the Division and the Computer Policy and Facilities Advisory Committee and the Executive. These impediments often arise from confidentiality constraints imposed by commercial suppliers of computing equipment, the secrecy provisions applying to Cabinet submissions on equipment acquisition and policy advice, and a lack of any codification within the Organization as to who may commit the organization to "commercial-in-confidence" agreements, and the extent to which information should be freely provided to the Executive's advisers (including review committees). Against this background, we formed the view that the Executive has, in the past, been required to make long term commitments, and determine the general direction of CSIRONET, without the benefit of detailed and expert advice other than that provided by the Division of Computing Research. In retrospect, we consider that the Computing Policy and Facilities Advisory Committee, established to subject the Division's proposals to dialectical examination and to provide the Executive with sound advice on these proposals, has not been as fully informed as it should have been, nor has it had sufficient technical expertise to fulfill these tasks. That Committee's tasks were made more difficult by the absence of any detailed strategic/corporate plan against which piecemeal proposals for equipment changes/acquisition could be assessed.⁴ Given the importance of a high quality computing service to the Organization's researches, and the potential impact of CSIRONET'S performance on the Organization's relations with other government agencies, we see it as crucial that the Executive have its own sources of technical advice and expertise on CSIRONET in addition to the Division's inputs (if R1 is accepted these will come, in future, from the CSIRONET Centre). These technical inputs will inform and complement the policy and strategy advice from the recently formed Policy Committee on Computing.

⁴ Against this background the study of the relative costs of centralized versus distributed mini-computing undertaken jointly by DCR and the Division of Mathematics and Statistics stands out as an exceptional success.

We therefore recommend that:

R9 A CSIRONET Visitors Committee be established. Its membership should be distinguished, disinterested, technically expert computing specialists, together with people with the appropriate management skills. They should be appointed by the Executive on the recommendation of the Policy Committee on Computing to advise the Executive on the future development of CSIRONET with special attention being given to meeting the needs of CSIRO. The functions of this Committee shall be:

- . to advise the Executive on the future development of CSIRONET with special attention being given to meeting the needs of CSIRO;
- . to monitor the progress in the development of the CSIRONET Centre and report to the Executive.

Adoption of this recommendation will require a consequent change in the terms of reference of the Policy Committee on Computing.

In the matter of "commercial-in-confidence" agreements we consider the present uncodified situation most unsatisfactory. The Executive have been remiss in tolerating the present situation and the Institute Director should have been more insistent in his protestations. Clearly these issues go well beyond the operations of the computing network and will require further investigation and promulgation of organization-wide principles. In the interim we recommend that:

R10 The Executive member responsible for CSIRONET and the Director of the Institute of Physical Sciences, and their successors, should be cosignatories to all agreements entered into by the officers of the CSIRONET Centre which constrain them in transmitting any information acquired by virtue of such agreements. Steps should be taken, if necessary by signed agreements, to ensure that the Visitors Committee has adequate access to all information covered by commercial-in-confidence agreements.

We formed the view also that the Division's dissemination of information and advice on the likely development of the network was deficient. Both in submissions and in our discussions, users complained of a lack of information regarding DCR's long term plans. We consider that our investigations were overly protracted as a result of undue reticence in the supply of information.

The same problems also seem to occur, on occasion, within the Division. Staff do not have, and are not given, an adequate picture of the likely (or even the chosen) directions for the development of the system as a whole. Their work is compartmentalized and their long term goals uncertain. The DAD (Design and Development) Committee is supposed to exercise coordination and control on all changes to the system. Its functions appear to have a confessional as well as a coordinating role, and we were told of instances of its oversight of research. It is not fitted by membership or structure for this latter function. We see the solution to these problems in a greater openness in communication, both upwards and downwards, and therefore recommend that:

R11 The management of CSIRONET should make a much greater effort to keep all CSIRONET staff, and also all users, as fully informed as possible on likely options for the development of the system.

Discussion on research leadership will be taken up in Chapter 6.

CHAPTER 6

CSIRO'S ROLE IN COMPUTING RESEARCH

6.1 Introduction

In the preceding chapter we have established that the existing arrangements for the conduct of computer science and engineering research in the Division of Computing Research are most unsatisfactory, and, as a consequence, the output of good research is small. While a number of factors contribute to this situation, the dominant factor is the need to maintain a large-scale service function (CSIRONET). We see no possibility that a significant mainstream computer science and engineering research function can be conducted in administrative association with CSIRONET on a long term basis (Chapter 5). For the moment CSIRO is obliged to continue to operate CSIRONET. Therefore, a separate CSIRO computer science and engineering research group must be established if the Organization intends to maintain its presence in this field. In this chapter we address the question of whether there is an appropriate role for CSIRO in computer science and engineering research and how such a role could be fulfilled.

6.2 Computer Science and Engineering¹ and the National Interest

Computing science is an increasingly pervasive element² in the development of modern industrial society. The application of computers in commerce, telecommunications, medical science, and manufacturing processes has led

¹ There are problems of nomenclature which arise from the growing convergence of traditional computing research (that is the science and technology of automatic data manipulation), electrical engineering (which provides the machinery to perform such manipulations), and telecommunications, a major user of information manipulation equipment and the principal technique for linking spatially separate data manipulation devices). We use the term computer science and engineering to cover this complex of fields.

² Some commentators see computers and associated information manipulation/transmission technologies as the key industry in the late 20th century. Barry Jones (Sleepers, Wake, O.U.P., Melbourne 1982 p.100) asserts that "Computerization is the lead technology of the post-industrial revolution and will help to create a post-service society marked by unprecedentedly rapid changes in the nature of work, society, communication and personal experience."

to growth in productivity and efficiency. The development and elaboration of the capabilities of the computer has generated an enormous, and still rapidly expanding, industry. This industry is very heavily dependent upon research for its continued progress and, conversely, there appear to be many areas of both computing science per se and its applications in science and technology where further research could be both fruitful and of considerable commercial potential. Computer science and engineering is thus a key element in the development of a modern industrial economy and the maintenance of a competitive position in international trade. Seen against this background, present Australian efforts in computer science and engineering research seem inadequate and certainly not commensurate with the central role computing science will play in the nation's development. Despite some successes in establishing local computer assembly companies and the development of an indigenous software industry, Australian research efforts in computer science and engineering are now insignificant on the world scale. This is a sorry decline from the late 1940's and early 1950's, when the CSIR(O) initiative put Australia amongst the world leaders in high speed digital computing. The causes are manifold. In industry, the fragmentation and small scale of locally controlled enterprises, the dominance of multinational computer and electronics companies, and timidity and lack of vision by both government and industry, have all conspired to produce an Australian computer hardware industry currently unable to generate for itself the research funds it needs to become creative and competitive internationally. In academia the demands of teaching and the continuing contraction of university resources have hindered the development of strong and effective computer science departments in universities and institutes of technology.³ The effects of these external constraints are exacerbated by the lack of recognition that much of computer science is an experimental discipline and hence requires significant capital funds. In the specific area of computer science and engineering closest to CSIRO's other research

³ ASTEC came to the view in 1978 (Science and Technology in Australia 1977-78, Vol. 2, p. 539) that ... "it can be concluded that there are many small departments with resources spread thinly, giving little opportunity for academic staff to conduct intensive research". The situation appears to have deteriorated, relatively speaking, since then.

activities, and to the general concerns of secondary industry, namely scientific and technical computing, the position is equally disturbing. In 1978 ASTEC came to the conclusion that:⁴ "The picture which emerges is that, apart from isolated areas of excellence, Australia is behind comparable countries in its use of computers, in its scientific and technical R and D, and in its educational programs on computing science. This is particularly so for R and D aimed at improving the art and science of computing as such, but also true of that R and D having a significant component of scientific and technical computing". Our discussions suggest that the situation in general has deteriorated since ASTEC came to this disturbing conclusion.

Thus, at a time when computing, and computers, are assuming a position of considerable importance in the life of the community, and where their effective exploitation will determine in the long term the success, or otherwise, of much of Australian industry, there is an inadequate research and development effort going on in the country. The existing centres of computing research located within the tertiary education institutions are not of a scale appropriate to the breadth of the subject nor attuned to its industrial applications. They are further constrained by their prime responsibility for teaching and the aforementioned lack of funds. The industrial research base, especially at the level of strategic research in computer science and engineering, is financially impoverished and, at present, too small.

6.3 A CSIRO Role in Computing Research?

As noted earlier (Section 4.3) we have come to the view that there is little genuine computing research in the Division of Computing Research.⁵

⁴ Science and Technology in Australia 1977-78. A Report to the Prime Minister by ASTEC, Vol. 1B, p. 94, 1979, AGPS Canberra.

⁵ The exceptions to this somewhat general statement are the VLSI Program in Adelaide, and elements of the Image Processing and Graphics group in Canberra. There is computer research work related to the mainstream objectives of other Divisions going on elsewhere in CSIRO, i.e., robotics and robot sensors at the Division of Manufacturing Technology, signal processing at the Division of Radiophysics, and image processing at the Division of Mineral Physics.

On the national scene (see 6.2) there is a very large gap between an optimum level of research in computer science and engineering and what is done now. Should CSIRO attempt to partially bridge this gap? We believe that CSIRO does have a national responsibility to enter the field in a substantial fashion. It is an area of growing national significance, yet the total national research effort is fragmented, diffuse and, taken as a whole, too small. Many of the research opportunities arising in strategic computer science and engineering are such that the benefits cannot be harvested by a single inventor. The development of a national competence in this area would provide a counterweight to the current international domination of the Australian market.

We see two clearly differentiated (but not mutually exclusive) pathways by which CSIRO could contribute to the enhancement of local efforts in computer science and engineering research:

- . by conducting strategic research of direct relevance to the nascent indigenous computer industry;
- . by research related to industries which use, or have the potential to use, computers and related devices.

There is already some work going on in CSIRO concerned with developing applications (largely software based) of computers. Some examples are: SIRATAC - a computer model for the control of pests in cotton, computer based methods for irrigation scheduling, the enhancement of satellite images for mineral prospecting and resource evaluation, and the application of computer techniques in town planning. Many of the scientific instruments recently developed by CSIRO rely heavily on computer technology for their success. Somewhat more general aspects of computer science and engineering research are pursued in other CSIRO Divisions as part of their mainstream objectives, e.g. robotics and robot sensors at the Division of Manufacturing Technology, signal processing in the Division of Radiophysics, and image processing at the Division of Mineral Physics.

Research in the category of strategic research in computer science and engineering (the first category listed above) could be regarded as the

legitimate task of the Division of Computing Research. As we show elsewhere in this report, due to the exigencies and constraints of operating CSIRONET, this has not, nor is likely to, come about. Apart from the VLSI program there is thus little significant CSIRO research effort in the disciplinary core areas of computer science and engineering research. The Organization is thus very poorly placed to contribute to theoretical advances in the subject and severely disadvantaged in attempting to exploit commercial applications inherent in such advances. The Organization is thus, at present, in no position to provide advice and assistance to, or to conduct collaborative research with, Australian firms seeking to develop commercially useful devices.

In our view the development of CSIRO research in computer science and engineering should follow both lines set out above. There should be further encouragement of research directed towards the application of computers in industry and agriculture. Possible areas include robot vision systems, and robots in agriculture and mining. We attach higher priority, however, to the establishment of single entity whose work would be much more disciplinary orientated (though not totally theoretical) and whose principal interactions would be with the Australian computer industry and, perhaps, Telecom. Possible fields of study⁶ include:

- . Computer architecture (including concurrent architecture). This would be largely a theoretical investigation of the optimum way to arrange and interconnect the basic elements of a computer, and to explore ways to conduct various computational processes in parallel within a computer system. At one end this work would interface with the VLSI program, at the other it would bear on problems of signal processing being explored elsewhere in CSIRO.
- . Distributed processing (including computer networking). This is the investigation of the ways for conducting computations on several physically separated computers.

⁶ Since initiating this review the Executive has established several expert groups to examine in detail various aspects of information technology. Their deliberations may identify additional fruitful fields of study.

Image processing/graphics. This work has two aspects, the manipulation (especially enhancement) of information contained in images, and the use of computers to produce, display and modify graphical or diagrammatic information.

Expert systems (including natural language systems). There are combinations of computer soft and hardware which can mimic the performance of a human expert within a defined event of expertise, i.e., medical diagnosis, translation, interpretation of legal codes. Natural language systems are operating systems which facilitate communication with the computer via everyday language rather than by the formalized and restricted language of a programming code.

VLSI. This work involves the development of computer based methods for the efficient and economical design of very large scale integrated circuits and theoretical investigations of chip architecture (with special emphasis on highly concurrent digital processing).

We therefore recommend that:

R12 CSIRO establish a significant group working on computer science and engineering research and related areas.

The precise delineation of research fields will be dependent upon the skills and interests of the people recruited to the new Division. The studies of the group should not be exclusively theoretical. Whilst primarily disciplinary in character they should extend, on occasion, to prototype engineering. The stimulation of the Australian computer industry should be a major objective of the group. We would expect that a strong symbiotic relationship will develop between this new group and the CSIRO Divisions working on applications of computers.

6.4 Form and Function of the CSIRO Computer Science and Engineering Research Group

The CSIRO computer science and engineering research group should be established as a Division. The group needs the status of a Division to

attract to the position of Chief a person with the requisite eminence and capacity for scientific leadership. The new Division should be founded by assembling under its Chief, several groups, each working on a selected area of computer science. The formation of the VLSI group offers a possible model (but not a paradigm) which might be applied again - where a group is established under distinguished leadership for an initially finite lifetime, and with the clear intention of commercialization of the results of the group's work. We reiterate that the research objectives of the groups would depend crucially on the research areas of the persons appointed to lead them. The groups must be formed about people chosen primarily for their intellectual potential, performance, and capacity for leadership, and not because they have had nominal experience in some field preordained at Executive and/or Institute level. The areas we listed in Section 6.3 offer some guidance as to research fields.

We therefore recommend that:

R13 The new research group (R12) be known as the CSIRO Division of Computer Science and Engineering⁷, and should be located in the Institute of Physical Sciences.

R14 The objectives of the new Division of Computer Science and Engineering should be:

To conduct research into both the theoretical and practical aspects of the manipulation, modification, transmission, storage and retrieval of information, and to explore the application of the results of this work for the benefit of the community.

⁷ The Review Committee could not reach unanimous agreement on the name of the proposed new CSIRO Division. Some members favoured "Division of Information Technology", which emphasizes the outcome of the work (technology for dealing with information) as opposed to the devices (computers) used to achieve this result. Other members preferred "Division of Informatics". "Informatics" embraces computer science, microelectronics, telecommunications, and information retrieval and manipulation. The Academie Francaise has recently sanctioned the use of "informatique" (Time News magazine, 13.9.82, p.43)

The Division will be a focus for computing research within CSIRO. Its existence should not preclude, however, other Divisions pursuing applications of computing to problems which arise in pursuit of their main objectives in other fields. Its investigations, results, and expertise should underpin work going on elsewhere in CSIRO. Every effort should be made to foster contact and collaboration between the Division of Computer Science and Engineering, other CSIRO Divisions, and the CSIRONET Centre.

The establishment of a centre of computing science excellence within CSIRO would be of great benefit to computer related work elsewhere in CSIRO also. We gained the impression, but cannot prove, that there was much routine and repetitive development of applications of computers and computing going on in CSIRO. On the other hand, there appear to be areas of CSIRO's research where more computing competence could lead to a much more fruitful pursuit of the principal objectives of the Divisions involved. The presence of a group of genuine professional researchers provides not only a reference point, but also a source of up-to-date advice.

In establishing the new Division, every opportunity should be taken to foster closer cooperation with the universities and other tertiary institutions. Collocation of the CSIRO groups on academic campuses, funding joint research projects and the deliberate fostering of the exchange of staff between CSIRO and the tertiary institutions are all means to this end.

6.5. Staffing of Division

There is a world wide shortage of good computer science and engineering researchers. Because of the industrial importance of much of its work and the correspondingly higher salaries paid in the United States, the focus of computer science and engineering research, it is unlikely that standard CSIRO salaries and run-of-the-mill working conditions will alone be sufficiently attractive to talented people. Given the national importance of an effective Division, we believe that every effort should be made to provide the most attractive employment conditions possible. The principal

measures to achieve such conditions are offering of high quality research facilities, including access to very substantial amounts of computer time, the relative freedom of research opportunities, and maintaining the perceived high quality of the Division's goals and the initial appointees. Leadership of the highest calibre will be crucial in making the new Division an attractive place to work on the international computer science scene. A further specific problem we foresee is the impact of the present excessively restrictive constraints on overseas travel. The problem, of course, impinges on all Australian scientists working in rapidly developing fields, not only those in computer science and engineering research. There is no question, however, that good potential appointees to the Division will expect annual access to the USA, and the Organization must resolve this issue if its recruitment efforts are to be successful.

DISCUSSIONS*

The Review Committee had discussions with the following people:

(a) Division of Computing Research

Dr P J Claringbold (Chief)
Dr R J Dakin (Assistant Chief)
Dr J F O'Callaghan (Program leader)
Dr P R Benyon (Program leader)
Dr B J Austin
Dr P J Sands
Dr B Nagorka
Dr J Smith
Dr D J Langridge
Dr D Fraser
Dr G Wolfendale
Mr R H Hudson
Mr H G MacKenzie
Mr P W Milne
Mr D M Ryan
Mr P de Chazal
Dr W S Ford
Mr J W Firth
Dr D J Harper
Dr J C Mudge (Program leader VLSI)
Mr M L Paltridge
Mr C R Watson
Dr R J Potter
Dr M Dale
Mr J E Paine
Dr J I Fernandez
Dr B R Lederer
Mr A J Vezis

(b) CSIRO Division of Chemical Physics

Mr A Moodie
Dr P Taylor

(c) CSIRO Division of Building Research

Dr J F Brotchie (Assistant Chief)

(d) CSIRO Division of Manufacturing Technology

Dr M P Harding
Dr R W Gellie

* Only formal discussions with full Committee are listed here. In addition a number of discussions took place with individuals during informal visits by committee members to the Division.

(e) CSIRO Division of Mathematics and Statistics

Dr C C Heyde (Acting Chief)

(f) CSIRO Bureau of Scientific Services

Mr S E Lattimore (Director)

TELECOM

Mr F Symons

INDIVIDUALS

Dr T Thomas (Director, Edinburgh Regional Computer Centre, SERC)

Professor T Cole (Department of Electrical Engineering, University of Sydney)

Professor J Bennett (Director, Basser Department of Computing Science, University of Sydney)

Professor G A Rigby (University of New South Wales)

Mr A Hackett (FACOM)

Mr P G Kemmis (Koranya Data Base Intelligence)

Professor T Reinfelds (Department of Computer Science, University of Wollongong)

SUBMISSIONS RECEIVED BY COMMITTEE

CSIRO Divisions

1. Dr J V Possingham, Chief, Division of Horticultural Research
2. Dr M G Ridpath, Officer-in-Charge, Darwin Laboratories
3. Mr T S Holden, Assistant Chief, Division of Computing Research
4. Mr I T Chappel, Division of Applied Physics
5. Dr J I Fernandez, Division of Computing Research
6. Dr D E Weiss, Director, Planning and Evaluation Advisory Unit
7. Dr A E Martin, Chief, Division of Soils
8. Dr L T Chadderton, Chief, Division of Chemical Physics
9. Dr M J Manton, Division of Cloud Physics
10. Mr A B Whitehead, Acting Chief, Division of Mineral Engineering
11. Dr B J Austin, Leader, CYBER Systems Section, Division of Computing Research
12. Dr J H B Christian, Chief, Division of Food Research
13. Dr G L Wolfendale, Leader, FACOM Systems Section, Division of Computing Research
14. Dr R D Hughes, Discipline Leader, Ecology & General Biology, Division of Entomology
15. Mr R H Brown, Chief, Division of Manufacturing Technology
16. Mr D M Ryan, Information Systems Section, Division of Computing Research
17. Dr B N Nagorcka, Division of Computing Research
18. Dr C Hackett, Division of Water and Land Resources
19. Dr J L Smith, Leader, Information Systems Section, Division of Computing Research
20. Dr G B Tucker, Chief, Division of Atmospheric Physics
21. Dr R J Millington, Chief, Division of Water and Land Resources

22. Dr M Tomczak, CSIRO Marine Laboratories, Cronulla
23. Dr E R Rumbo, Convenor, Instrumentation Management Committee, Division of Entomology
24. Mr A G Brown, Assistant Chief, Division of Forest Research
25. Mr P R Benyon, Leader, Systems Modelling Section, Division of Computing Research
26. Dr C C Heyde, Acting Chief, Division of Mathematics and Statistics
27. Mr P W Milne, Division of Computing Research
28. Dr A C Hurley, Division of Chemical Physics
29. Dr W G Crewther, Chief, Division of Protein Chemistry
30. Dr J K Mackenzie, Division of Chemical Physics
31. Mr P J Judge, Officer-in-Charge, CILES
32. Dr J F Brotchie, Assistant Chief, Division of Building Research
33. Dr P A Coppin, Division of Environmental Mechanics
34. Mr H G Mackenzie, Division of Computing Research
35. Dr D F Mahoney, Chief, Division of Tropical Animal Science
36. Dr K G McCracken, Acting Chief, Division of Applied Geomechanics
37. Dr M J Goodspeed, Division of Water and Land Resources
38. Dr A Sibatani, Genetics Research Laboratories, Molecular and Cellular Biology Unit
39. Mr J W Firth, Division of Computing Research
40. Dr D J Gauntlett, Officer-in-Charge, ANMRC
41. Drs T McAllister & A J C Nicholson, Division of Chemical Physics
42. Dr O Sitnai, Oil Shale Process Project, Division of Mineral Engineering
43. Dr E F Henzell, Chief, Division of Tropical Crops & Pastures
44. Mr R A Footner, Chairman, South Australian State Committee
45. Mr I A Barger & Dr W H Southcott, Division of Animal Health
46. Dr C H J Johnson, Division of Chemical Physics

47. Dr R H Frater, Chief, Division of Radiophysics
48. Dr P R Taylor, Theoretical Chemistry Section, Division of Chemical Physics
49. Mr J A Pattison, Secretary, Victorian State Committee
50. Dr R Mykytowycz, Acting Chief, Division of Wildlife Research and Statistics
52. Dr J F O'Callaghan, Information Display Systems Group, Division of Computing Research
53. Dr T W Scott, Chief, Division of Animal Production
54. Dr R N Caffin, Division of Textile Physics
55. Dr R W Gellie, Division of Manufacturing Technology

Universities, Colleges and Institutions

1. Dr V X Gledhill, Dean, Faculty of Mathematical & Computing Sciences, New South Wales Institute of Technology
2. Prof J Reinfelds, Chairman, Department of Computing Science, University of Wollongong
3. Dr H T Clifford, Reader, Department of Botany, University of Queensland
4. Prof P L Arlett, Head, Department of Electrical & Electronic Engineering, James Cook University of North Queensland
5. Dr W R Birch, Department of Botany, James Cook University of North Queensland
6. Prof T C Chambers, Chairman, School of Botany, University of Melbourne
7. Prof T W Cole, School of Electrical Engineering, University of Sydney
8. Prof J M Bennett, Basser Department of Computer Science, University of Sydney
9. Prof H K Messerle, Head, School of Electrical Engineering, University of Sydney
10. Dr B Jamieson, Reader, Department of Zoology, University of Queensland
11. Prof P C Poole, Chairman, Department of Computer Science, University of Melbourne
12. Prof G A Rigby, School of Electrical Engineering & Computer Science, University of New South Wales

13. Mr J Hiller, President, Institution of Radio & Electronics Engineers Australia

Government Departments and Statutory Authorities

1. Dr E Sandbach, Director, Research Laboratories, Telecom Australia
2. Mr B Richardson, Acting Director, Department of Home Affairs and Environment
3. Mr D J Ives, Deputy Secretary, Department of National Development and Energy
4. Mr D J G Griffin, Director, The Australian Museum
5. Mr G E Barlow, Deputy Chief Defence Scientist, Department of Defence
6. Dr T Lau, Biometrician, New South Wales State Fisheries
7. Mr M O'Connor, OTC Australia
8. Messrs P M Pepper & G Hammer, Queensland Department of Primary Industries

Industry

1. Dr P D Jones, Managing Director, Techway
2. Mr P F Kemmis, Managing Director, Koranya Data Base Intelligence
3. Dr K N O'Sullivan, Principal Research Geologist, Remote Sensing, CRA Exploration Pty Ltd
4. Dr J H Rattigan, Exploration Manager, Minerals Division, CSR Ltd

SUMMARY OF RECOMMENDATIONS PREPARED BY DR S. FERNBACH

Two basic areas of user complaint exist. The first and foremost is the failure of DCR to provide reliable, stable and adequate computing support to the many users of CSIRONET. The second is the lack of facilities, both hardware and software, desired by the users. There are numerous minor problems but they can be easily resolved if the major ones are taken care of.

It should be stated in fairness to DCR management, that it has done a very competent job so far as the limits of manpower would permit. The types of complaints concerning the CSIRONET facilities are commonplace in the computer centres throughout the world. Computer centres that operate as non-profit making service organizations generally try to run on a very low budget, and thereby hurt both their users and themselves.

The recommendations summarized here are to be considered as a first step in remedying the situation. Following steps will become clearly evident after these recommendations have been taken care of.

1. Restructure DCR Management

The management staff should be increased in number. Well defined responsibilities should be assigned to each manager and he should be given full authority to carry them out.

2. Increase the Administrative and Systems Staffs

The DCR administrative and systems staffs cannot carry out their workloads on a timely basis. There should be a 50% increase in staff.

3. Restructure the Consulting Group

The consulting staff should be research oriented with assigned research tasks, well supervised and coordinated with CSIRONET systems needs. This staff should consist of well trained specialists in areas of user needs and it should be distributed in reasonably sized groups to the various centres reached by CSIRONET. Upon request by user Divisions, the consultants should be made available to support them in programming tasks for variable periods of time at appropriate consulting fees.

4. Restructure the Operators Group

The operators group should be completely within DCR, should be extremely well trained in the CSIRONET system and its operations. Its personnel should be at such a level that they can function as technicians and duty consultants as well as machine operators. There should be clear lines of responsibility to the top operations manager in Canberra. There should be one person or office which assumes complete responsibility for seeing each problem arising in the field through to a successful conclusion.

5. Add Documentation and Education Staff

Staff should be added to provide users with proper documentation and education to use CSIRONET effectively. The use of videotape is suggested as a very useful medium in the educational process.

6. CSIRO and DCR Computer Policy and Plans should be Published

The users should be kept fully informed as to the policies and plans relating to computer acquisition and usage. They should be allowed to participate in the formulation of these as well.

7. Plan Now for Additional CSIRONET Hardware and Software

There are user needs not being met and unlikely to be met for some time. The Cyber 76 will be reaching saturation in a relatively short time. Planning to augment the computer centre's capabilities and at the same time meeting user needs should be going on now.

8. Acquire Well Established Hardware and Software When Possible

Costs are too high both from the operations and users points of view to solve all the problems associated with developing, checking out and supporting individually tailored products. Well established, reliable hardware and well documented software should be sought from external sources when additional capability is needed.

It is assumed that if the above first steps are taken there will be more staff time devoted to correcting the more difficult user problems. There are no simple remedies to improve reliability and stability. With care these can improve in time. With the present state of the computer art, perfection is unattainable. With additional staff the important scientific research needs may be met.

RECOMMENDATIONS OF THE INDEPENDENT INQUIRY INTO CSIRO
RELATING TO THE DIVISION OF COMPUTING RESEARCH

Recommendation 79

"The Division of Computing Research should be reorganized as a CSIRO Computing Service network, retaining the name CSIRONET. Its services should continue to be available to Government departments and instrumentalities, universities and other approved users".

Recommendation 80

"Charges for CSIRONET services, including CSIRO work, should be based on a policy of recouping all costs. Within this restraint CSIRONET should pursue a policy of maximising the use of its services, and be managed with appropriate regard to the commercial nature of the service".

Recommendation 81

"Provision of individual computers in Division should be rationalised closely and should not duplicate any possible CSIRONET service".

Recommendation 82

"The Commonwealth Government, in next considering the need to upgrade the central computing capacity of CSIRONET, should consider the rationalisation of scientific computing in relation to all Government-supported activities including universities and colleges of advanced education".

Recommendation 83

"CSIRONET research efforts should be directly related to user needs, including those of CSIRO, and be funded by the users".

RECOMMENDATIONS OF THE WORKING GROUP ON THE FUTURE
FUNCTIONS AND STRUCTURE OF THE DCR NETWORK AND EXECUTIVE
DECISIONS THEREON

* R.1 "The sole responsibility of the Division of Computing shall be to develop and operate computing services in accordance with policies determined by the CSIRO Executive in the normal way".

* R.3 "DC should have the responsibility for the research into, and development and provision of, computing services including a specialist consultative service".

* R.4 "DC should give priority to the introduction and provision of advanced computing services (i.e. those not available commercially in Australia) of benefit to Australian science, Government or industry".

* R.5 "DC should provide a range of standard computing services (which may be produced as a by-product of advanced services) unless directed not to provide particular services".

* R.6 "DC services should be available to arms of Government, tertiary educational institutions and industry. During periods when a service is overloaded, preference should be given to established users of that service".

* R.7 "CSIRONET service charges should be set at such a level that the projected revenue meets all estimated direct and indirect costs. CSIRONET should recognize categories of users for the purpose of service charges. Charges made for standard computing services provided to trading companies, societies or individuals should be comparable with commercial bureau rates. Actual categories and charges should be determined by the Executive on the recommendation of the Chief, Division of Computing".

Decisions R.1 and R.3-R.7 are a charter for CSIRONET and were approved by the Executive.

R.2 "In view of the present and intended future functions of the Division, it is recommended that the Division of Computing Research become known as 'Division of Computing' (DC) with CSIRONET as its trading name".

Decision deferred pending the establishment of the Institute structure within CSIRO.

R.8 "The Executive delegate to the Chief, Division of Computing, the authority to determine the charging category for individual users in accordance with guidelines approved by the Executive".

R.9 "Divisional proposals for major computing systems (i.e. hardware and software that fall in the major items category costing in excess of \$25,000 or expansion of systems that take the total system cost in excess

of \$25,000) should be referred to the Chief, Division of Computing, for comment on these proposals in relation to Recommendation 81 of the Independent Inquiry into CSIRO".

R.10 "The Executive approve a questionnaire being sent to CSIRO Divisions by the Secretary seeking information on the extent and usage of existing computers and staff employed for their operations".

Decision on R.9 and R.10 deferred pending further consideration of a procedure for assessing total CSIRO resources devoted to provision of computing facilities.

R.11 "The Division should aim to recover all its costs including those for the current 'research' component, with a view to phasing out its dependence on direct Appropriation over a period of three years, and that the current direct Appropriation, while it continues, should be viewed by the Executive as a subsidy".

Accepted after amendment to "three years concluding 30 June 1981".

R.12 "Computer service charges should not be applied to CSIRONET and the existing provision for 'research' activities should be redistributed to user Divisions on a basis proportional to expenditure on computing services in 1977/78".

Accepted.

R.14 "Within the constraints imposed by undertakings given to the Prime Minister that the acceptance of the Facom proposal would in no way commit CSIRO or prejudice CSIRO's relations with Facom or other potential suppliers of computing equipment to the Organization in the future, the Chief, Division of Computing should recommend the Facom equipment to be accepted as part of the CSIRO/Facom joint research and development venture - final acceptance of the agreement being subject to the approval of the Executive and Minister".

R.15 "The Chief, Division of Computing should be encouraged to continue the development of distributed processing facilities, subject to the availability of revenue and the necessary Executive approval to acquisitions".

R.19 "The question of staff ceiling accommodation for DC should be taken up with the appropriate authorities".

R.13, 14, 15 and 19 - It was agreed to prepare a case for submission to Government outlining the Organization's plans for the development of CSIRONET (including the FACOM, CDC and distributed processing equipment) and seeking, as a package arrangement, approval for the FACOM proposal and an increase in the staff level of the Division of Computing Research which would be without prejudice to staffing elsewhere in CSIRO.

R.16 "Every effort is made to ensure that CSIRO is exempted from the procedures set out in Cabinet Decision No. 5591".

Action already in train.

R.17 "The Division of Computing remain a CSIRO Division and that the Executive accept that as a revenue dependent service activity, it will have special requirements and the need for special flexibility in regard to budgetary procedures, building works, staff appointments, staff ceilings, overseas quota visits, and particular interpretations in regard to staff classifications. This special flexibility needs to reflect the commercial nature of the Division's operations".

The needs identified in this recommendation were noted as requiring continuing attention.

R.18 "All low volume nodes be converted to the 'agency' mode of operation, with the control of the node passing to the host Division which will receive credits for peripheral charges".

Approved in principle. Staffing implications were to be referred back to the Executive Committee (Policy Development).

R.20 "The Executive agree to increase the positions and staff ceilings for the Division of Computing by eleven to 140 to enable planning to proceed in regard to the CDC and Facom proposals".

Not approved (at an earlier meeting).

R.21 "The Executive recognize the necessity of redeploying some of the existing DC staff and approve the Staff Section putting in train the necessary action to carry out this redeployment".

Approved.

R.22 "The terminology 'General Manager' be used for the senior management positions leading each of the Groups within DC".

Approved.

R.23 "Particular interpretations be applied to the approved research staff grade definitions to enable recognition of responsibilities for, and ability in, systems development and management as are required in the work of the Division".

Agreed.

RECOMMENDATIONS AND EXECUTIVE DECISIONS ON THE
REPORT OF THE COMPUTING POLICY AND FACILITIES ADVISORY COMMITTEE

| POLICY COMMITTEE RECOMMENDATION | MODIFICATION MADE OR RECOMMENDED | EXECUTIVE DECISION |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. that CSIRONET be retained within CSIRO and its services continue to be made available not only to CSIRO users but also to Government Departments and instrumentalities, universities and other approved users | Unchanged | that CSIRONET be retained within CSIRO and its services continue to be made available not only to CSIRO users but also to Government Departments and instrumentalities, universities and other approved users |
| 2. that CSIRONET services made available to non-CSIRO users continue to be charged for on the 'full cost recovery' basis | Unchanged | that CSIRONET services made available to non-CSIRO users continue to be charged for on the 'full cost recovery' basis |
| that CSIRONET not become overly dependent on external revenue, restricting the provision of computing time to 50 percent and the external revenue to a maximum of 60 percent of total revenue | Deleted by Executive Committee on 22.9.81 | |
| 3. that CSIRONET services should be mainly restricted to those of a scientific and technical nature with charges continuing to be levied on the existing procedure of user categories and priority charging regime | Modified by Executive Committee on 26.5.81 and on 22.9.81 | that CSIRONET operations should not be expanded to cater for general departmental administrative computing requirements but should be restricted to advanced or developmental computing, or to specific computing projects that the Executive might agree from time to time |
| 4. that Divisions should not be compelled to use CSIRONET by being prevented from acquiring in-house computing facilities. Capital outlays for Division/Unit in-house facilities should not be regarded as different from capital outlays for other major items of equipment and, as such, should compete on equal terms within CSIRO's Major Items of Equipment Vote | Unchanged | that Divisions should not be compelled to use CSIRONET by being prevented from acquiring in-house computing facilities. Capital outlays for Division/Unit in-house facilities should not be regarded as different from capital outlays for other major items of equipment and, as such, should compete on equal terms within CSIRO's Major Items of Equipment Vote |
| 5. that it be mandatory for Divisions to seek advice from DCR on proposed computing equipment acquisitions costing in excess of the major items of equipment threshold (currently \$25,000) and that such advice should be taken into account by Directors when finalising CSIRO's Major Items of Equipment Program as should the possibility of connection of such facilities to CSIRONET | Unchanged | that it be mandatory for Divisions to seek advice from DCR on proposed computing equipment acquisitions costing in excess of the major items of equipment threshold (currently \$25,000) and that such advice should be taken into account by Directors when finalising CSIRO's Major Items of Equipment Program as should the possibility of connection of such facilities to CSIRONET |
| 6. that, to ensure a rational distribution of resources within CSIRO, CSIRONET 'full cost recovery charges' should be discounted for CSIRO users by a subsidy designed to offset both the 'full cost loading' and networking costs | Modified by the Executive on 30.7.81 | that in recognition of the lower complexity and assured prompt payment of CSIRO accounts relative to those of external customers, a discounted rate of charging be applied to CSIRO customers |
| 7. that the proposed subsidy for internal users be incrementally increased to achieve a 'net' charge which will ensure that CSIRO uses 50 percent of the available capacity on CSIRONET | Deleted consistent with Recommendation 2 (part 2) having been deleted | |
| that the Executive should specifically approve any further expansion of the network | Unchanged but re-inforced by Executive Committee decision that Chief should produce a strategic plan for re-equipping the network | that the Executive should specifically approve any further expansion of the network |

| POLICY COMMITTEE RECOMMENDATION | MODIFICATION MADE OR RECOMMENDED | EXECUTIVE DECISION |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8. that DCR acquire specialised computing facilities to meet more appropriately the requirements of CILES and Administration and make these facilities available on a lease charge to cover acquisition and operating costs | Unchanged but Executive Committee of 26.5.81 added that the requirements of CILES be subject to the impending review of CILES | that DCR acquire specialised computing facilities to meet more appropriately the requirements of CILES (subject to the outcome of the review of CILES) and Administration and make these facilities available on a lease charge to cover acquisitions and operating costs |
| 9. that CSIRO should proceed with the present planned replacement of the Cyber 76 with a modern category 6 computer under the agreement with CDA | Modified by Executive Committee on 22.9.81 | that the Chief of the Division of Computing Research in consultation with the Policy Committee and relevant external input should produce as soon as possible a strategic plan for equipment options and the development of the computing system as a basis for future development of CSIRONET |
| 10. that there should be a balance between consulting and research, with consulting services being provided to CSIRONET users on a cost recovery basis | Unchanged | that there should be a balance between consulting and research, with consulting services being provided to CSIRONET users on a cost recovery basis |
| 11. that DCR should not expand its activities into the provision of an information service on software and hardware unless CSIRO is requested to do so by Government | Unchanged | that DCR should not expand its activities into the provision of an information service on software and hardware unless CSIRO is requested to do so by Government |
| 12. that CSIRO focus attention on the mode of its interactions with industry in computing research both in DCR and other Divisions, with the objective of playing a leading role in stimulating research in computer science and its application to industry | Unchanged | that CSIRO focus attention on the mode of its interactions with industry in computing research both in DCR and other Divisions, with the objective of playing a leading role in stimulating research in computer science and its application to industry |
| 13. that the first paragraph of the CSIRONET charter be amended to read: 'The Division of Computing Research (DCR) shall be responsible for the development and operation of the CSIRONET computing services and for undertaking research in computing in accordance with policies determined by the CSIRO Executive in the normal way' | Word order modified | that the first paragraph of the CSIRONET charter be amended to read: 'The Division of Computing Research (DCR), in accordance with policies determined by the CSIRO Executive in the normal way, shall be responsible for the development and operation of the CSIRONET computing services and for undertaking research in computing' |
| 14. that the 'Advisory Committee on Computing' be replaced by a 'Policy Committee on Computing' (to provide policy advice to the Executive on computing issues relating to CSIRO). It would be chaired by the appropriate Member of the Executive and include the Director of the Institute of Physical Sciences, one other Director, the Chief, Division of Computing Research, and one other Chief | The Director, Bureau of Scientific Services, and the Secretary (Finance and Administration) were added to the Policy Committee as major users of computing | that the 'Advisory Committee on Computing' be replaced by a 'Policy Committee on Computing' (to provide policy advice to the Executive on computing issues relating to CSIRO). It would be chaired by the appropriate Member of the Executive and include the Director of the Institute of Physical Sciences, one other Director, the Chief, Division of Computing Research, one other Chief, the Director, Bureau of Scientific Services, and the Secretary (Finance and Administration) |
| that the Term of Reference for the Policy Committee be to advise the Executive on, and of, computing policy issues related to CSIRO and CSIRONET | | that the Term of Reference for the Policy Committee be to advise the Executive on, and of, computing policy issues related to CSIRO and CSIRONET |

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be supported by a valid receipt or invoice. This ensures transparency and allows for easy verification of the data.

In the second section, the author details the various methods used to collect and analyze the data. This includes both manual and automated processes. The goal is to ensure that the data is as accurate and reliable as possible.

The third part of the document focuses on the results of the analysis. It shows that there is a clear trend in the data, which is consistent with the initial hypothesis. This finding is significant as it provides strong evidence for the proposed model.

Finally, the document concludes with a summary of the findings and a list of recommendations. It suggests that further research should be conducted to explore the underlying causes of the observed trends.

The second part of the document provides a detailed overview of the data collection process. It describes the various sources of data and the methods used to ensure its integrity. This section is crucial for understanding the reliability of the results presented in the following sections.

The author also discusses the challenges faced during the data collection process. These include issues related to data quality, consistency, and availability. By addressing these challenges, the author demonstrates a thorough understanding of the data and its limitations.

In the third section, the author presents a comprehensive analysis of the data. This includes a detailed breakdown of the data into its constituent parts and a discussion of the relationships between these parts. The analysis reveals several key insights that are central to the study.

The final part of the document is a conclusion that summarizes the main findings of the study. It highlights the most important results and discusses their implications for the field. The author also provides a list of references and a list of appendices for further reading.

The third part of the document discusses the implications of the findings for the field. It suggests that the results have important implications for the way in which data is collected and analyzed. This is particularly true in the context of large-scale data collection, where the ability to handle and analyze vast amounts of data is essential.

The author also discusses the limitations of the study and the need for further research. While the current study provides valuable insights, there are still many questions that need to be answered. This includes the need to explore the underlying causes of the observed trends and to develop more sophisticated methods for data collection and analysis.

In the final section, the author provides a list of references and a list of appendices. The references include a wide range of sources, from academic journals to industry reports. The appendices provide additional information that is relevant to the study, including a list of the data sources and a list of the methods used.

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