CHAPTER VIII

Indigenous Development
The ECIL Experience

THE ECIL SET UP

The Electronics Corporation of India Ltd., was established in April 1967 as a commercial venture under the Department of Atomic Energy. Nearly 300 scientists and technicians from the Atomic Energy Establishment (later designated the Bhabha Atomic Research Centre), Trombay, were transferred to Hyderabad, bringing to ECIL the expertise they had accumulated at Trombay. ECIL's main aim was to commercially exploit the designs of electronic equipment and systems developed at Trombay. It was believed that self-reliance in the field of electronics could be achieved without the import of know-how or technology.

The Atomic Energy Establishment (Bhabha Atomic Research Centre) had started development of a 12-bit real-time computer designated as the Trombay Digital Computer-12 (TDC-12). S. Srikantan was head of development. Srikantan, a 1954 electrical engineering graduate of the Madras Engineering College had joined BARC as a trainee in the AEC Training School. During training he worked mostly with A.S. Rao's electronics group. During the period 1957–60, he developed an analogue computer for simulating nuclear reactor dynamics and in 1961 proceeded to the Moore School of the University of Pennsylvania, USA for graduate work, where he earned his Master's and Doctor's degrees. Back with BARC, he initially worked with a group in TIFR which was engaged on the development of a real-time computer. He found the TIFR approach somewhat academic, as they were more interested in path-breaking than in developing systems which were actually required for scientific and other work. Their design had an unusual 14-bit architecture. Christened

the 'OLDAP'(on-line data processor), the computer was based on germanium circuit devices.

A.S. Rao and Srikantan proceeded independently with the TDC-12 development based on the American DEC PDP-8 system. The production engineering of the TDC-12 system was carried out at ECIL. In the first design, an attempt was made to maximize the number of indigenous active and passive components. This later proved to be one of the main causes of poor system reliability.

In order to prepare ECIL for leadership in the computer field a committee consisting of R. Narasimhan, P.V.S. Rao, S. Srikantan and A.S. Rao (the Managing Director of ECIL) examined the requirements of small and medium size digital and analogue computers over a five-year period. Their report was submitted to Vikram Sarabhai, Chairman, Atomic Energy Commission. The committee placed the demand for small computers at 71 systems and for medium and medium-large computers at 74 systems for the five year period commencing 1970–1. Narasimhan's own estimate made earlier was higher than this. The committee proposed a national effort according to the following plan (Table 8.1).

Table 8.1

ECIL's Projections

(Rs. crores)

Item	Estimated Cost
Development of CPU systems	2.00
Development of software for the above systems	1.13
Capital outlay for the manufacture of computer systems on a commercial basis	4.73

SOURCE: 'Expansion Programme (1971–6), Computer Division, ECIL', *Report of the Committee,* Hyderabad, December 1970, p. 2.

The total cost of manufacture of the 145 systems during the five-year period was estimated at Rs. 18.4 crores (sale value). A three-year gestation period was anticipated, with a very attractive 45 per cent IRR (Internal Rate of Return) and a net profit (after taxes) of 21 per cent.[1] Sarabhai was particular about such matters.

The programme was to give direct employment to about 2050 engineers, scientists, diploma holders and skilled tradesman. It was also expected to give a fillip, in terms of meaningful employment, to hundreds

of engineers, scientists and managers in research and industry through the provision of indigenous computers.

The Committee stressed that an indigenous base for peripherals should be set up and suggested that the 'Government should take steps to generate this base and sustain it in the early years'. In other words, ECIL wanted the government to entrust the job of peripherals development and production to other agencies in India. The import of technology for peripherals was considered necessary. The Committee stressed:[2]

> There is at present no group with the manufacturing know-how and experience with the exception of ECIL who have made headway in the productionization of the real-time version of the TDC-12 computer. The Committee recommends that the responsibility for the manufacture of computers in the country be entrusted to the Electronics Corporation. Since development of software must proceed in parallel to the manufacturing programme, ECIL should also assume overall responsibility for the development of the software packages needed for the computers. As regards the electro-peripheral equipments, ECIL should assume a leading role, specify in qualitative and quantitative terms the various kinds of electro-mechanical peripheral equipment required for the computers and explore and identify competent organizations which can take up the design, the development and production in the country.

ECIL had an ambitious programme covering a range of computers for various applications. The business version of TDC-16 was targeted for delivery in April 1974 and the TDC-32 in July 1975. The broad features of these systems and the software programme are summarized in Table 8.2.

The Electronics Commission provided financial assistance by way of grants and loans to ECIL and TIFR in support of the programmes. Apart from such grants, the Department of Atomic Energy, who were the major users of such real time systems in the early days, also financially supported ECIL.

In a note to the PAC (1975–6), ECIL elaborated its plans for the complete indigenization of computer manufacture. It stated:[3]

> It is the objective of ECIL to market a totally indigenous system, indigenous in design, assembly and materials. So far as design capability and assembly is concerned, it may be stated that complete indigenization already exists at ECIL, and keeps pace with all new developments. It is only in the field of materials and components used in the manufacture of computers that there is dependence on imports. ... In so far as raw materials for the fabrication of PC (printed circuit) boards is concerned, indigenous availability of the required quality of double sided glass epoxy boards is steadily increasing and we expect that shortly there will be no more dependence on imports for this basic item. There are many

Table 8.2

The Proposed Range of ECIL Computers

	TDC–12 Real-time version	TDC–12 General purpose version, business option-2, card version	TDC–12 General purpose version, business option-2, tape version	TDC–16 Real-time applica-tions	TDC–16 General purpose applica-tions, business option-1, tape version	TDC–16 General purpose applica-tions, business option-2, disk version	TDC–32 General purpose scientific and real-time applica-tions, option-1, tape version	TDC–32 General purpose and real-time applica-tions, scientific option-2, disk version
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Features								
Word length	12-bits	12-bits	12-bits	16-bits	16-bits	16-bits	32-bits	32-bits
Memory capacity	4K words	4K words	4K words	8K words	8K words	8K words	16K words	16K words
Memory cycle time	2 μ sec	2 μ sec	2 μ sec	1 μ sec	1 μ sec	1 μ sec	1 μ sec	1μ sec
Memory capacity	32K words	32K words	32K words	32K words	32K words	32K words	128K words	128K words
Technology	discrete	discrete	discrete	IC	IC	IC	IC	IC
Software facilities								
Basic assembler	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Extended assembler	Yes			Yes	Yes	Yes		
Fortran II	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fortran IV				Yes	Yes		Yes	Yes
Extended Fortran IV, Online debugging system	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Hardware diagnostics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Autocoder translator		Yes	Yes		Yes	Yes	Yes	Yes
Short merge routines			Yes		Yes	Yes	Yes	Yes
Cobol compiler							Yes	Yes
Commercial equivalent systems	PDP 8 DDP 116 SDS 92	IBM 1401H IBM 1401C	IBM 1401E IBM 1401C ICL 190A CDC 160A IBM 1620	IBM 1130 DDP 516 PDP 11	IBM 1401E IBM 1401C ICL 1902A	IBM 360/20 ICL 1903A	IBM 360/20 IBM 360/44 IBM 1904A	IBM 360/40 IBM 360/44 ICL 1904A
Typical cost (Rs.)	6 lakhs	10 lakhs	15 lakhs	12 lakhs	20 lakhs	30 lakhs	35 lakhs	50 lakhs
Time by which available	Dec. 1970	July 1972	Dec. 1972	Dec.1973	April 1974	April 1974	July 1975	July 1975

SOURCE: 'Expansion Programme (1971–6), Computer Division, ECIL', *Report of the Committee,* Hyderabad, December 1970, pp. 17–19.

connectors used in the computers, some of which are now being imported and which are of special design and shape. Efforts have been made progressively to achieve production indigenization in this area, with coming into existence of promising entrepreneurs. ECIL foresees no major problem for indigenization as far as connectors are concerned. Another basic requirement of computer manufacturing, namely, ICs is also gradually being indigenized with the development at BEL of some of the commonly used types of ICs. In addition, ECIL and some other institutions in the country are also conducting research work for development of new ICs and proprietary ICs. There is good co-ordination between ECIL and BEL in the development and application of computer ICs, ECIL performing the required reliability tests. It may, therefore, be said that IC indigenization is also well under way. ... The large cost of any computer system is constituted by the peripherals which are used for input and output of information to and from the computer. As far as peripherals are concerned the country still has to make considerable leeway in indigenization. Development work is being carried out at ECIL, BEL, and HTL. The major challenge here is the great mechanical engineering complexity of the peripherals and the special alloys or other materials used in the manufacture of the peripherals. The cost of peripherals is high because of the sophisticated electro-mechanical devices involved as also because of expensive tooling required to make the various parts. Therefore, unless offtake is high, it is not an attractive proposition for any industry to take up manufacture of peripherals. This activity will pick up only when enough demand is generated for large volume production of computers and hence peripherals. No reasonably short deadline can be given for completing indigenization of peripherals, but it is very likely that within a decade, the import content of the indigenous computer will have been brought down to a negligible fraction.

Though there were some development efforts at BEL in regard to ICs, it could not be represented to the PAC as a major national effort at that point of time. Neither could it have been the basis for the assertion that India was on the threshold of being self-reliant. It appears that the urge to project a self-reliant image, perhaps, led ECIL to be carried away.

With regard to the manufacturing activity of ECIL in the area of computers, Menon, the Secretary, Department of Electronics informed the Public Accounts Committee:[4]

What ECIL does today is to import the peripherals, many of the ICs and memory cores. What they are doing is systems engineering — putting together the various items. With many of their own items they are now making printed boards or multi-layered boards, which they did not make a few years ago. They have gone over from transistors to IC computers, they are developing software application packages, but they still depend significantly on imports of those items which finally make the equipment.

On being asked whether the manufacturing operations of ECIL only amounted to the assembly of imported parts, the Secretary, Department of Electronics, stated:[5]

It goes beyond simple assembly for the following reasons. They are indigenizing appreciably ... but much more than that, this whole thing has got a certain design philosophy, it has got a language, it has got to have software packages. ... ECIL is developing all these but what we want to ensure is that, even these imports such as core memory and the digital semiconductor components which go into it, like ICs and memories, must be made in India. That is what we are really aiming for, apart from the peripherals which I have mentioned.

With regard to the price structure of computers marketed by ECIL, M.G.K. Menon informed the Estimates Committee:[6]

What I would like to say is that we are fully aware of the need to examine the costing and make sure that it is reasonable from the point of view of national usage, and this is particularly important, because we do provide a significant amount of money in the form of both loan and grant to ECIL for the whole development programme, and since we provide this money, I think we have also a responsibility to ensure that what comes out of it is meaningful in the national context including the price structure. We will be going into this. At present, the prices are rather high. This really is the consequence of the fact that all the peripherals are imported and the heavy duty which adds to the price structure.

An econometric study carried out by IPAG came to the following conclusion:7

... that a computer (4K CPU) priced at 10,000 dollars in USA should not cost more than Rs. 2.9 lakhs in India. This is the worst case estimate. However, the most likely estimate will be between Rs. 1.7 lakhs and Rs. 2 lakhs. The proposed price of TDC-16 (4K CPU equivalent) is about Rs. 8 lakhs. It is concluded that there is a clear case for probing deeper into the costing proposals of manufacture of minicomputers in the country.

ADVERSARIAL ATTITUDES

As the scientists in the Electronics Commission and ECIL had the same roots, it is hard to understand why a frank discussion did not take place to ascertain the reasons for the higher cost of ECIL systems. What were ECIL's real problems? Instead of allowing an adversarial attitude to arise between a public sector body and a government department, should not the reasons for the higher costs have been explored through mutual discussion and an understanding of the real causes be arrived at? The scientists and other staff in the Electronics Commission/DOE had no

exposure to the realities of an industry and were unable to appreciate the problems faced by the ECIL development group, committed as it was to the development of an industry through self-reliance.

In 1973–4, the question of whether all the public sector undertakings in the field of electronics should come under one umbrella — that of the Department of Electronics — was very much in the air. The pros and cons of the issue were discussed with the Estimates Committee (1973–4) where it was suggested that the Department of Electronics, as the nodal ministry should have an adequate say in and control over the vital aspects of the operations of these undertakings, that is:[8]

(i) Framing the objectives of the undertakings.
(ii) Determination of the product-mix, including diversification.
(iii) Complexion of the Board of Directors.
(iv) Appointments to the Board of Directors and to senior management positions like Managing Directors and General Managers.
(v) Personnel and remuneration structure/policy.
(vi) Policy and follow-up relating to development of ancillaries.
(vii) Pricing policies.

The Estimates Committee concluded:[9]

> The Committee recommends that the government should review at the highest level the question of placing units which are charged with the responsibility for manufacturing electronics under the Department of Electronics in the overall interest of development and for these units being used as centres of growth for an accelerated programme of development of electronics industry in the Fifth Plan.

The government did not act upon the recommendation. One wonders whether, had ECIL or BEL been placed under the DOE, if the eventual confrontation could have been avoided. Or, perhaps, the Electronics Commission/DOE may have even acquired some industrial feel which they otherwise so sadly lacked.

ECIL's PROGRESS UP TO 1978

ECIL obtained an industrial licence for the production of 50 computer systems per year. The various computers installed up to 1978 are shown in Table 8.3.[10]

Except for four computers, the other 94 were sold to government departments, universities, the police, and other government bodies. The Atomic Energy Establishments, TIFR and ECIL, alone accounted for 31 systems. This inability of ECIL to increase its production and to enter the

Table 8.3
ECIL Production up to 1978

Year	TDC–12	TDC–312	TDC–316	Micro–78	Total
1971	1	-	-	-	1
1972	4	-	-	-	4
1973	5	-	-	-	5
1974	5	2	-	-	7
1975	5	9	2	-	16
1976	1	12	8	-	21
1977	-	9	22	10	41
1978	-	-	3	-	3
Total	21	32	35	10	98

SOURCE: Om Vikas and L. Ravichandran, 'Computerization in India: A Statistical Review', *IPAG Journal*, vol.16, 3, New Delhi, December 1978, pp. 323–32.

EDP market may have been caused by the lack of requisite software and high costs.

The performance of ECIL was reviewed by the Committee on Public Undertakings, the following paragraphs being of interest:[11]

The Computer Group of ECIL incurred losses of Rs. 69.24 lakhs, Rs. 165.03 lakhs and Rs. 123.59 lakhs during 1977–8, 1978–9, and 1979–80 respectively. Asked about steps taken to improve the performance of this Group, the Corporation informed the Committee in a note that a Management Board had been constituted (1979) by the Board of Directors, to give a direction to the operations of the Computer Group and to dovetail its long range and short term programme within the framework of the existing policy. The Management Board was stated to have identified the following reasons for the poor performance of the Group:

(i) With liberalized import policy, nearly Rs. 60 crores worth of computers were imported in 1977 and 1978.
(ii) ECIL continued to depend on indigenous development of computer technology while technology developed by leaps and bounds abroad.
(iii) New entrants in computer manufacture commenced at the lower end using imported LSI technology.
(iv) ECIL had undertaken several highly complex projects, and
(v) Development of their software was time consuming.

Regarding the import of computers, the Managing Director of the Corporation claimed before the committee that they could have sold Rs. 10 crores worth of computers had imports not been allowed.[12] While

admitting that the imported computers were much better and more economical, the witness (A.S. Rao) pleaded before the Committee:

This is a national decision whether or not to restrict the consumer to what is available in the country. ... This is where some national policy on computers is required.

According to ECIL, the following measures were suggested to improve performance:

(a) TDC-312 EDP Systems which are already field-proven should continue to be marketed to enlarge the customer base in the market. The capability of the 316 and 332 systems should be enhanced with the features available on the latest systems of similar types, if necessary, by procuring one imported system of latest technology to cut down the development time. (Later, the French IRIS computer was imported.)

(b) The maintenance operations of computers should be treated on a separate footing from manufacturing in order to achieve commercial viability of these operations.

(c) In order to complete the pending supplies of the custom-built systems, increased efforts to make them reliable from the customer viewpoint have to be put in.

While admitting that there had up till then been little marketing effort, the Secretary, Department of Atomic Energy, expressed the hope that the Group would reduce its losses during 1980–1 and would break even by the next year.

With regard to competition from other parties, ECIL communicated the following views to the Committee on Public Undertakings:[13]

The Committee were informed that ECIL was the only major national company licensed to manufacture a range of computer systems covering the scientific, real-time and business application areas. Over the last 4 to 5 years a number of competitors like DCM, Operations Research Group and Hindustan Computers Limited, etc., were stated to have entered the field of marketing computer systems to cater to essentially commercial applications. These companies were perhaps adopting the kit assembly methods by importing fully tested printed circuit boards completely assembled with components. These methods implied almost total import of the process. It was difficult for any indigenously manufactured product to compete with these almost imported products. Operations of these companies were stated to be cutting into ECIL's computer business in a big way because the systems being supported by these companies were covering the EDP range from the small microcomputer to the systems bordering on performance range of ECIL's TDC-312, TDC-316 class of machines.

ECIL informed the committee in a note that ICIM, a subsidiary of ICL,

had been given a licence to manufacture the 2904 series computer systems which were comparable to the medium and large scale computer systems manufactured by ECIL. In this regard the Secretary, Department of Electronics, stated that in terms of specifications, performance and volume of production, ECIL was producing a relatively small number of TDC-312 and TDC-316 computers at the time when ICL was given the licence in 1978 and that they in no way clashed with the ICL 2904 system. The committee were also informed by a representative of the department that at that time the trend in the import of computers was running at a rate of five or six systems a year and that this trend was expected to go up. So the plan was to economize on imports. ECIL's TDC-332 system was still only on paper, in that ECIL were in the process of designing it. There was also a distinct gap between the TDC-316 and the TDC-332. The Department of Electronics wanted to fill this gap by giving a licence to an Indian company. At that time only ICIM could provide the necessary technology. The Secretary, Department of Atomic Energy, informed the committee that they objected to ICL being given a licence for manufacture of 2904 computers. A representative of the Department of Electronics admitted that ECIL had requested the government to wait for a year or so. When asked to state the reasons for not accepting ECIL's request, the witness stated that the import trend was on the increase and the Department of Electronics assessment was that ECIL's TDC-332 programme might not be ready by March 1979. Therefore, it was thought expedient to get another production programme off the ground. In this connection, the Secretary, Department of Electronics stated: 'We are now given to understand that TDC-332 can be made fully operational by the end of 1981. There would be no conflict, since TDC-332 is very powerful.' On being asked whether all these points had been discussed with the Electronics Corporation of India, a representative of the Department of Electronics informed the Committee:

> This particular question was examined on technical grounds and a committee was set up by the then Chairman, M.G.K. Menon. This particular committee, consisting of technical people, people from industries, academic institutions and so on, deliberated on the specifications for 2903, 2904 series with respect to ECIL's product ranges like TDC-316 and TDC-332. We knew the specifications of the systems that they already had. From that point of view, we did have discussions but they were not part of the Committee.

In reply to the question of whether the matter was discussed with the Department of Atomic Energy and whether the department was con-

vinced, a witness stated: 'It was not discussed with the Chairman, Atomic Energy Commission, but it was discussed with the management of ECIL. They did not agree, but we made an assessment.' According to a report appearing in the journal *Computer Weekly International* dated 16 March 1978, ICL would in fact be manufacturing 2903s, calling them the 2904 series. When the Committee desired to know whether the Department of Electronics had taken any precautions in this regard, the Secretary of the Department stated:

> Whether it is a small licensed manufacturer with imported contents or a large computer manufacturer, the licensed party has to provide a phased manufacturing programme and a year by year indigenization programme. We know that they are going according to the phased manufacturing programme. If they are making any deviation, we will know it. We have a standing committee which monitors the entire thing. They cannot get away like that because they have to supply to the various people and the computer professional community in this country is very well integrated. We have an effective monitoring mechanism by which we feel we would be able to look into this aspect and at present, I have no apprehensions.

The Committee were told by ECIL that in an earlier case when ICL were given a licence to manufacture the 1901A computers, the company did not meet the obligations stipulated in the licence. The mere assembly operations resorted to by them neither resulted in any technology transfer nor in any major employment creation. The representative of the Department of Electronics conceded this and stated: 'The facts are like that. They did not carry through the programme. They stopped in between.' When the committee tried to find out what precautions had been taken before granting ICIM the licence for the 2904 series in order to ensure that ICL would now fulfil the terms of the licence, the witness stated:

> Before it was approved, we had detailed discussions with the Indian company as well as the foreign collaborators, what technology they were going to have ... Government had the means to control the company and make them behave. We have used all the means in terms of approving the phased programme and then only the licence is issued.

This worry about licensing ICL/ICIM or any other private sector company to enter the market with systems basically built with imported subassemblies arose because ECIL's own systems were being priced out of the market. The private companies were able to offer cheaper solutions for many EDP applications. The DOE, faced with persistent user pressure, was contemplating a policy shift — the 1978 policy announced after years of delay had not really improved the situation regarding the

availability of computer systems. The presence of very attractive systems in the world market was therefore forcing the government to look for alternative policies in 1979–80. The TDC-332, meanwhile, was still under development and there were doubts whether it would fill the requirements of a powerful mainframe which was then needed for various tasks in India.

S. Manikutty, has noted:[14]

> Both the Electronics Commission and the ECIL expected in 1971 that the 12 and 16-bit computers ... would be introduced in the market by 1974 with the full range of software needed for both scientific and EDP applications. But the technological difficulties in development proved to be enormous. The machines had to be designed from scratch ... and the problem of patents (*sic*) made them incompatible with the existing machines ... the software had to be developed at ECIL and by different agencies like TIFR ... which lead to considerable delays. ... Even though ECIL could put into the market TDC-312 and TDC-316 by 1974, they were in fact machines with very limited capabilities. They could not be used in most EDP applications at all, because the EDP applications, by and large, needed much more software and input/output devices. ... The business language compiler COBOL was not available (ECIL developed its own version of COBOL called E-COBOL, but this being a non-standard language did not gain much popularity among users); the ECIL machines had few applications packages. ... Thus the machines introduced by ECIL were unsuitable for practically all EDP applications, and even for scientific applications their capabilities were limited.
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> The problems faced by ECIL with regard to the 32-bit computers were still more difficult. As early as 1971, the Electronics Commission, realizing the need for large systems both in scientific and EDP applications, started applying pressure on ECIL to commence their development. The Commission hoped that by 1974, these systems would be available in the market. It was prepared to offer fund support to the extent of Rs. 2 crores for this project. But 32-bit systems were far more complex systems to develop than 16-bit systems, and the difficulties encountered in 12 and 16-bit systems led ECIL to realize that it would be necessary to master the design of a 16-bit system first before venturing into 32-bit system. Thus only in 1973 did ECIL commence the design of a 32-bit system, named System-332.
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> ECIL had by this time also realized that if it followed the route of developing everything *de novo,* it would be undertaking a truly enormous task. Hence it decided to compromise. It would import a French machine, IRIS-55, that could serve as a model for hardware design, and, more important, the entire software that was available in IRIS could be straight-away used in System-332. It was thought that, by this method, ECIL could skip most of the software development; hardware development also would be much easier.
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> This option, however, had its price. IRIS was a system not compatible with IBM or with ECIL's own other systems, with the result that no cross utilization of

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packages was possible. The IRIS system being unfamiliar, it took a much longer time to debug the errors, and sort out the problems; and considerable work had to be done in adapting the IRIS system based on programmes and output messages in French to English.

To assist ECIL in its problems, no references could be made to CII-Honeywell-Bull of France (who were the manufacturers of IRIS) for there was no formal collaboration agreement. Perhaps C-H-B was willing to look the other way, while ECIL was doing its System-332 development, but it could hardly be expected to assist ECIL directly.

Therefore, ECIL had to face the difficulties all alone, and these difficulties were formidable. As one ECIL executive stated, 'We just did not realize what we had taken up'. To just give the reader an idea of the magnitude of work involved in developing a 32-bit computer, it had cost US $ 5 billion, and taken five years for IBM to develop its celebrated System 360. To be sure, by importing IRIS-55, the task of ECIL was comparatively much simpler, but still was difficult enough.

As a result of these difficulties, ECIL's product range in the field of mainframe computers was very limited. It had only two models in its range: TDC-312, and TDC-316 (the obsolete, second generation TDC-12 had been discontinued from 1974). Even these models had very limited capabilities in terms of equipment and software.

In the field of microcomputers, major developments were taking place abroad. ECIL's response to these developments was very hesitant. Srikantan, the Head of Computer Division, and many of his colleagues did not feel that it was worth while for ECIL to take up manufacture of microcomputers. Microcomputers hardly posed the kind of challenge posed by TDC-312 or TDC-316; the value added in their production was small, and it was felt that these microcomputers would have only very limited capabilities and would never find many applications in the EDP market or the scientific market, but would be confined to stand-alone real-time applications. Only by 1975 was it appreciated that with the availability of more powerful chips, they could find broader applications. Even so, the possibility in the EDP field was felt to be very limited, and the Division started developing a microcomputer, Micro-78, for scientific/real-time applications. This could hardly be completed by 1976, so that as at the end of 1976, ECIL's product range did not include a microcomputer.

It could be asked whether the Computer Division would have developed its products more quickly, if there was competition. Evidently, no clear-cut answer is possible, and the ECIL executives seemed divided on the issue when questioned. Many agreed that with better co-ordination with personnel in different groups, or with product-centred teams rather than activity-centred teams as was the case, quicker development would have resulted. Pressure from competition would probably have forced ECIL to go in for products of newer technology; one executive who was in the design wing of the computer group and who has subsequently left the company stated that there was in fact not much thinking on the usage of alternative components and subassemblies that were becoming

available at lower prices. In interviews, Srikantan, the Head of the Computer Division till 1981, felt that even though looking back one could say that so many things could have been done, at that time they did what they thought was the best. A.S. Rao himself felt that though the Division did very well till 1974, a slackness set in then, and much more could, and should have been achieved. In his view, the Division could have easily achieved and even surpassed its target if it had exerted more.

It cannot, however, be disputed that there was a significant shortfall as regards product development, and this contributed to the inability of the Division to attain its target in sales.

A.S. RAO RETIRES

A.S. Rao, the moving spirit behind ECIL and a devoted adherent to the philosophy of self-reliance, retired in 1978, somewhat dispirited because of setbacks and also because his views no longer commanded attention at Delhi. Disillusionment had, perhaps, set in even earlier — in 1974 when ECIL's performance was not up to his own expectations. He was reported to have asked all his senior colleagues to go on leave in March 1974, so that he could reflect on the position. After a week, he called them all back and even promoted some; but to many, the working atmosphere within ECIL was never the same again and the easy dialogue with A.S. Rao disappeared.

Self-reliance also requires a good measure of self-denial. Om Vikas noted:15

> Self-reliance requires not only determination but also the strength to develop and use the capacity for autonomous decision making on all aspects of development ... technological autonomy does not mean isolation although it may involve selective de-linking from the world market systems for periods of time or sector of economic activity while indigenous problem solving capabilities are being tested and developed. The developed countries during their industrialization, had erected high tariff walls to protect their nascent industries — obviously a clear case of selective de-linking.

But the policy makers at Delhi were no longer able to carry the political leadership or withstand the lobby pressure from various other groups complaining about the slow progress in the field of computers.

Sarabhai had selected S.R. Vijayakar (Commercial Superintendent of the Ahmedabad Electricity Company, a mechanical and electrical engineer) as the General Manager of ECIL, a post Vijayakar occupied till A.S. Rao retired. But as General Manager, Vijayakar, was confined to administrative duties. All the technical managers reported directly to

A.S. Rao. The General Manager was mainly responsible for personnel, purchase, and public relations. The technical managers took most of the decisions themselves or consulted A.S. Rao. The General Manager was nowhere in the picture. When Rao retired, Vijayakar became the Managing Director.

Vijayakar was not wedded to the idea of self-reliance nor did he have the missionary zeal of A.S. Rao. As a manager, he wanted to improve the balance sheet and adopted the tactics of the private sector in doing so. He decided to import technology and to undertake phased manufacturing programmes — CKD/SKD to start with. As he approached the DOE as a supplicant, he was welcome. On the other hand, the injured stance of A.S. Rao pointing out the fall of standards in relation to the concepts of self-reliance — the basic concepts which had brought into being the Electronics Commission — had made him unwelcome, especially as powerful trade interests had subverted various officials of the DOE who were more receptive to quick-fix ideas rather than towards genuine industrial development.

S. Manikutty in his dissertation on ECIL states:[16]

> A major function of general management has been noted in the business policy literature as that of ensuring 'a match' on a continuing basis between characteristics of the organization and those of the environment. ... In the early years, the government gave ECIL protection from imports and competition. In 1976–8, the government liberalized its import policies for computers and licensed competitors to manufacture computers. ECIL response was mainly to attempt to influence the policies to nullify the effect of these changes. Its ability to do so, however, turned out to be limited, because ECIL had not been able to come up with a satisfactory range of computers. ... Nor was there any significant changes in overall strategies of the Corporation. This lack of response could be traced to a strong commitment to certain values on the part of its Chief Executive.

S. Manikutty, states in his conclusions, among other things:

> Public Enterprises whose objectives are based on values and whose top management is deeply committed to these values may have difficulties in appreciating the need for strategic changes if it implies change in these values. Thus commitment to values can be a barrier to strategic changes.

He further adds: 'Change in leadership can bring about a different appreciation of the environment and hence a strategic change.' In public service, commitment to values have been considered important. Mrs Indira Gandhi believed and encouraged 'committed' public servants. If values change at a political level, it is indeed difficult for a committed

public servant to change his convictions.

The failure of ECIL to achieve acceptable results in the computer field is the failure of the basic premise of self-reliant development — in a limited time-frame with limited resources — in a rapidly changing technological field where enormous sums of money and effort were being expended elsewhere in the world. There has been no public acknowledgement of this either by the scientific community or the political leadership. The public posture has always been one of commitment to self-reliant development. Denigration of the public sector for pursuing a role publicly accepted by the political leadership but privately doubted, led to the disenchantment of many of the engineers working in ECIL. Many left to join private sector companies which offered better prospects. Indeed, Srikantan left in 1981 to take up the Chairmanship of the Andhra Pradesh Electronics Development Corporation. Vijayakar did little to improve the sagging morale. At least A.S. Rao had remained intellectually honest to the very end, clinging to the values which were being publicly proclaimed and acclaimed but privately doubted and denigrated. But to judge the performance of ECIL, or for that matter that of any other public enterprise, strictly on business standards, is not valid.

In spite of its many difficulties, ECIL managed to deliver quite a few computer systems for scientific applications and for use by various government departments (see Tables 8.4 and 8.5).[17] Note that very few systems were sold to private parties.

ECIL's main market lay with government departments, co-operatives, public sector, universities, etc.

A summary of the investments made by ECIL in the computer area year by year, and the profit/loss position of the computer division are shown in Table 8.6.[18]

Table 8.4

Total ECIL Computer Sales to Private Parties

	Private Sector Sales	Total Systems Produced
TDC–12	1	19
TDC–312	8	48
TDC–316	9	141
Micro–78	8	128
Micro–32	1	138

SOURCE: Data from ECIL.

Table 8.5
ECIL Computer Deliveries up to (1986–7)

Type	Qty.	Amount (Rs. lakhs)	Year	Delivery Qty.	Value
TDC–12	19	218.63	1970–1	1	8.97
			1971–2	5	66.46
			1972–3	12	136.09
			1982–3	1	7.11
TDC–312	48	632.93	1973–4	8	64.59
			1974–5	6	73.33
			1975–6	6	43.03
			1976–7	9	152.81
			1977–8	2	36.66
			1978–9	2	42.76
			1979–80	8	134.65
			1980–1	6	77.46
			1981–2	1	7.64
TDC–316	141	4,192.91	1973–4	2	33.65
			1974–5	7	197.49
			1975–6	9	266.39
			1976–7	10	269.17
			1977–8	6	209.55
			1978–9	3	45.80
			1979–80	6	147.17
			1980–1	5	117.63
			1981–2	12	345.38
			1982–3	23	496.90
			1983–4	15	561.09
			1984–5	12	299.32
			1985–6	28	711.12
			1986–7	3	492.25
System–332	20	721.44	1981–2	2	91.42
			1982–3	4	150.85
			1983–4	6	234.36
			1984–5	3	87.76
			1986–7	5	157.05
Total	228	5,765.91			
Micro 78	128	444.29	1976–7	8	13.90
			1977–8	13	44.80
			1978–9	25	64.93
			1979–80	13	25.78
			1980–1	12	37.38
			1981–2	26	151.80
			1982–3	6	26.35
			1983–4	13	46.32
			1984–5	12	33.03
Micro 32	138	986.02	1983–4	1	11.70
			1984–5	17	138.98
			1985–6	61	409.47
			1986–7	59	425.87
Total	266	1,430.31			

Table 8.5 (continued)
ECIL Computer Deliveries up to (1986–7)

System Services	Qty.	Amount (Rs. lakhs)	Year	Delivery Qty.	Value
MTDES	11	160.62	1981–2	5	53.75
			1982–3	3	48.95
			1983–4	3	57.92
SFT(M–32)	25	258.68	1981–2	1	6.06
			1982–3	1	70.84
			1983–4	12	108.31
			1984–5	8	52.84
			1985–6	1	6.63
			1986–7	2	14.00
Work Stations	8	124.61	1985–6	1	2.30
			1986–7	7	122.31
Teletext	1	119.25	1985–6	1	119.25
SFMSS(M–32)	1	62.52	1986–7	1	62.52
Enhancements		993.74	1973–4		10.12
			1974–5		30.53
			1975–6		76.55
			1976–7		68.27
			1977–8		87.55
			1978–9		83.35
			1979–80		147.05
			1980–1		56.67
			1981–2		75.46
			1982–3		77.31
			1983–4		54.70
			1984–5		50.87
			1985–6		82.12
			1986–7		93.19
Services		2,931.17	1975–6		21.68
			1976–7		68.79
			1977–8		77.35
			1978–9		131.73
			1979–80		175.99
			1980–1		169.07
			1981–2		199.97
			1982–3		280.50
			1983–4		340.22
			1984–5		387.39
			1985–6		472.14
			1986–7		606.34
Total	72	4,650.59			

NOTE: MTDES — multi-terminal data entry systems. SFT (M-32) — for communication purposes. SFMSS (M-32) — for communication purposes.
SOURCE: Data from ECIL.

Table 8.6
ECIL – Investments/Profit/Loss (1970–87)

(Rs. lakhs)

Year	Investments	Profit/Loss
1970–1		(0.49)
1971–2		21.58
1972–3		19.56
1973–4		21.81
1974–5	397.64 *	37.18
1975–6	98.70	(29.02)
1976–7	126.55	(35.97)
1977–8	47.00	(69.24)
1978–9	81.61	(165.03)
1979–80	161.90	(123.59)
1980–1	65.70	(199.34)
1981–2	(2.04)	(26.61)
1982–3	8.78	53.49
1983–4	80.62	(56.62)
1984–5	41.08	(221.92)
1985–6	(75.59)	81.40
1986–7	274.16	179.21
Total	1,306.11	(513.60)

* Total inclusive up to 1974–5.

SOURCE: Based on a personal communication from J. V. Kanitkar, DGM, Corporate Planning, ECIL, 5 February 1988.

It will be seen that up to 1986–7, ECIL had invested a sum of Rs. 13.06 crores in the computer division, delivered computer systems and services amounting to Rs. 118.46 crores, and incurred a marginal loss of Rs. 5.13 crores. The computer division of ECIL had a staff strength of 1208 as on 1 February 1988, made up of 710 technical and 498 non-technical personnel. No doubt they had also received grants from the DOE and the DAE for design and development, but their delivery in financial terms had been significant, though one could argue over whether prices charged were fair.

The development of software was from the beginning a major task. Developing a major computer system backed by fully supported in-house software is not a task that can be carried out in a short time. That ECIL could partially succeed within the time-frame and the resources available was indeed commendable. ECIL, assisted by TIFR, and to some extent by IIT Kanpur, put in considerable effort and did succeed in producing software (see Table 8.7) for the TDC series. In addition, ECIL developed custom-built software packages for:

1. Data acquisition systems for the Atomic Energy Department.
2. Satellite launch vehicle monitoring, telemetry, tracking for space applications.
3. Rolling mill data loggers, billet cutting system, coiling system, etc., for the steel industry.
4. Engine testing for gas turbines and launch vehicles.
5. Several packages for message switching and communication systems.
6. Enquiries systems for crime, criminal investigation and directory enquiry system for the telephone department.
7. Several packages for banking, insurance, dairy, oil, ordnance factories and coal.

It was unfortunate that the software was not made upwardly compatible and that this lack of compatibility forced ECIL into avoidable duplication of efforts. The computer architecture did not take into account the necessity for the compatibility of system software. Seshagiri, (the then Additional Secretary, DOE,) told *Computers Today*:[19]

> ... but I tell you what happened to the indigenous development of the operating system by ECIL as a case study. See, when TDC-312 and 316 were being developed *they* said that *they* would not buy software, *they* would just develop it locally because of this great ideological principle that since software is manpower-intensive, it is our duty to develop it locally. Let us examine the penalty of this misplaced patriotism. ECIL recruited 100 software specialists and then took three years to develop the software for TDC-312, another three for TDC-316, and another three for TDC-332, by which time TDC-312 became obsolete — *they* could not sell as much as they could have otherwise. This happened for the other two systems also. *They* were actually playing a lag game. Even when *they* did reverse engineering (IRIS), it took three years, and at the end, the total cost of the system was such that the total foreign exchange component was more than the cost of equivalent imported system! Is this the price one pays for indigenization? So there should be some higher rationale governing the whole thing. What is wrong in buying technology? What is wrong in buying source code know-how for system software? (emphasis added)

The 'they' all belonged to the TIFR fraternity of which Seshagiri was also a member. The TDC Working Group was chaired by P.V.S. Rao and with Seshagiri looking after all the TDC work. The question has to be asked whether a dialogue with ECIL and A.S. Rao could have been possible. The Electronics Commission could have discussed the matter openly.

The fault lay with not only with the 'they' but also with the 'we'.

(1)	(2)	(3)	(4)	(5)
System–332	DOS (Multiprogramming operating system)	Sort/merge, Convert, Dump, Editor, Librarian, 1401 Simulator	Fortran, Cobol Assembler, RGP	PPC, Inventory management, FAP, LP, Netpac, Transaction processing, DBMS, Mathematical and statistical library
Micro 78/ BDP 100		Sort/merge, ODS, Editor	Ecobol, Basic, Cobol Assembler	Financial accounting, Inventory control, Invoicing, Inter-branch reconciliation, Oil accounting, Pay-roll, Share accounting, Sugarcane accounting, Netpac, LP
TDC–1200 Multi-terminal data entry system (MTDES)		Data entry, Data validation, Data verification	Basic	
Micro 32	ECIX v2.1 (Unix-like operating system)	Sort/merge, Editor, Word processor, Calendar, Spreadsheet	Cobol, Fortran, Pascal, C, Basic	LP, Mathematical and statistical packages, Netpac, Drafting applications, Spreads (RDBMS)

SOURCE: Data from ECIL.

SOURCE: Data from ECIL.

Table 8.7
System Software Developed by ECIL

Computer system	Operating system	Utilities	Language processors	Applications software
(1)	(2)	(3)	(4)	(5)
TDC–12	KTM 12 (Keyboard tape monitor)	Text editor, Sort/Merge, Linking loader, Floating point package, Runtime routines, 1401 Simulator/assembler	Fortran compiler system (subset of Fortran II), Assembler, Fortran II, Ecobol (EC's own Business assembly language), Basic	Scientific applications package, Statistical applications package Payroll, Bill of materials, (BOM) package
TDC–312	Disk monitor Tape monitor	Disk Sort/merge, Tape Sort/merge, IBM 1401 simulator, 1401 cross assembler, File interrogative system, Update utility, Tape dump, PIP, Text editor/on-line debugging system	Ecobol Plus, Basic, Fortran IV, Macro assembler (MAL)	Scientific library, Mathematical library, Statistical library, Payroll, BOM, Inventory control, Netpac (project management)
TDC–316	Disk operating system (DOS), Tape operating system (TOS)	Text editor Interactive job submission (IJS) 1401 simulator, sort/merge FIS, File Conversion, Conval (Validation), Update, Librarian	Mal Fortran IV Cobol, Ecobol plus	Linear programming (LP) (Simplex) Netpac, Production planning and control (PPC), Financial accounting package (FAP) Mathematical and statistical library

Perhaps, Seshagiri got carried away by the necessity to sell his 1986 policy initiatives to his interviewers.

ECIL's role in the area of computers did not come to an end, but the goal of self-reliant development was abandoned. Faced as it was with basic changes in national outlook, and Vijayakar's desire to put ECIL back in place as a leader in computers, even if it be with imported know-how, global tenders were floated for technology for a super-minicomputer. The DOE floated another tender for a mainframe, Vijayakar seeing to it that mainframe manufacture was not taken away from ECIL. Norsk Data was selected to supply the supermini — a company which started operations at about the same time as ECIL (1967) but which had made phenomenal progress, untrammelled as it was by red-tape.

NORSK DATA — A CONTRAST

It may be instructive to examine the ingredients which made Norsk Data a success. The story of Norsk Data has been documented in Øyvind Heradstveit's, *Norsk Data: A Success Story*. A brief summary will serve to highlight the growth of the company.[20]

Norsk Data was founded by three technocrats: Lars Monrad-Krohn, Per Bjorge, and Rolf Skar.

Lars Monrad-Krohn was a graduate of the Norwegian Institute of Technology and the MIT, USA. Before starting Norsk he was an employee of the Norwegian Defence Research Establishment (NDRE), where he had worked on the third generation computer SAM2. Per Bjorge, was also an alumni of the MIT, USA, and the young Rolf Skar later went on to the same academic establishment.

The dedication of the team was enormous. One of the team members, Skar, talking about the development of the SAM2 at NDRE said: 'We worked like crazy, 24-hours a day! One group started at 10 in the morning and worked until 2 next morning. Group two showed up at 20 hrs in the evening; they did not leave until they had at least one hour with group one the morning after. In other words, each group worked about 14 hours at a stretch.'

The SAM2 computer which they designed was a third generation computer using integrated circuits and was probably among the first of its type anywhere in the world.

The company was founded on 7 July 1967. The first computer NORD-1 was installed on the ship Taimyr in 1968. The NORD-1 computer could

execute 500,000 instructions per second. The system was designed to protect ships against collision. The computer was to process information from the radar, register traffic in the ship's vicinity, and calculate its course and speed. With this system, the bridge would have a complete picture of all nearby traffic and thus be able to avoid collisions. In addition to the anti-collision system, there were five other functions that the computer system could support; (1) Regulating power supply on board, (2) watching over the ship's machinery, (3) giving notice of any irregularities, (4) calculating the optimal distribution of cargo, (5) and keeping track of the crew's wages. In short, a total system for a ship. And Norsk Data got the order with a resource of only three highly talented computer scientists. Five men from the project group went with the ship on its trial run to the Far East. The ship returned four months later, and it was reported that the computer had functioned as planned, and Norway had become a pioneer in this field.

The most significant thing for India to note is that a computer for ship automation had been designed, developed, produced and delivered within one year, including the provision of all necessary software. The total number of people employed at Norsk Data was 13 only at that time. The infrastructure in Norway was in no way superior to that in India. Norsk bought all the components from the best available source, assembled and configured the system. The whole team are reported to have worked around the clock in order to effect the first delivery.

Other management experts and businessmen joined the Board of Norsk Data to provide support. In 1971, 88 people were employed by Norsk Data and the sales had increased to over 15 million kroner (about Rs. 3 crores); the capital stood at 3 million kroner; profits about half a million kroner. In February 1971, Norsk Data won the contract with the Meteorological Institute in Norway in competition with several large international companies. Their Nordic system was ready in April 1972 and was claimed to be the first 32-bit minicomputer in the world. The value of the system sold to the Meteorological Institute was about 6 million kroner. Explaining how the work for the Meteorological Institute was completed, Skar states that they moved all their material to the work place and worked day and night. He notes that the work rarely ended before 2 a.m. A core group of 25 people were engaged on the Nordic project.

After strengthening the marketing organization, Norsk Data continued to progress. By 1973 Norsk Data had delivered 105 of its systems for ship automation. In December 1972, they won an order for computer systems

for CERN (the European Centre for Nuclear Research) against international competition. The contract with CERN led to the delivery of 24 computers worth 12 million kroner; and by 1976, Norsk Data had supplied 50 computers to CERN alone and the company had become a strong European alternative for the supply of minicomputers which could compete with the big American minicomputer suppliers.

The other major area where Norsk Data made a notable entry was in the field of supplying computer and communications packages. The first such computer package was produced for meteorological forecasting in Algeria. The contract came through a United Nations Organization — the International Organization for Meteorology in Geneva; the contract was worth 14 million kroner. The NORD-5 system was stated to be as powerful as computers that were sold for three times the price. Norsk Data was also able to obtain the contract for the simulation computer for the F-16 (US fighter) programme.

In ten years, the company had reached a sales turnover of 112 million kroner (about Rs. 22 crores). The company had grown at the rate of nearly 45 per cent per year. The total number of employees was only 279. Out of these, 55 were university graduates with science or engineering degrees, 90 had higher engineering or other university degrees, 33 came from vocational schools or commercial colleges, 25 were educated in secretarial colleges, and 18 were engaged in positions where educational qualifications were not required. The profit was 6.5 per cent of the operating revenue; exports represented almost 48 per cent of sales.

Greater attention came to be paid to marketing and raising further capital and the company continued to grow at a fantastic rate, reaching a turnover of nearly 2500 million kroner (about Rs. 500 crores) in 1986. Norsk Data had then become a computer company with an international standing and prestige. The total number of employees stood at 3569 in 1986 and the share prices had skyrocketed and the company's shares were listed on London, New York and other stock exchanges.

If one compares the success story of Norsk Data with the failure of ECIL (or for that matter with any other Indian high-tech company), the stark contrast is clear. The Norwegian company was started by three pioneers and grew because of state-of-art of the products and the extreme hard work put in by all the staff. Obviously, the company must have bought all the components, including memories and all the peripherals. It is not known whether they had their own PCB facilities in the early days. The greatest advantage they had was the intercourse with the USA and the European computer industry. They did not isolate themselves. There

were no import control procedures or stiff import duties; they did not have to contend with rigid rules and regulations causing delays or with foreign exchange problems. They could operate in an atmosphere conducive to free enterprise.

Norsk are currently facing problems because their computers were designed on their own non-standard operating system. The need for Unix compatibility, the difficulty in using standard packages, networking problems, and the availability of cheaper desktops have all made marketing difficult, and the company has run into losses. It has tried to retrieve its position by a change of strategy, but in the fast moving world of information technology such changes of fortune are commonplace even for established companies.

In view of rapid developments in the field of computer technology, production engineering and software, it was necessary for ECIL to have kept abreast of the developments abroad so that their progress could have been measured against world trends. Neither A.S. Rao or Srikantan found time to visit any other computer factories or laboratories. Rao mentioned that he did visit Fujitsu in Japan once along with Sarabhai in the late 1960s; his impression was that at that time Fujitsu was operating at about the same level of technical competence as ECIL. Today, Fujitsu rivals IBM in technical excellence and market domination. Though some of the junior scientists of ECIL did visit factories and laboratories abroad, the main input for the top management was journals and magazines. Srikantan could have acquainted himself with international trends and advised Rao, but he had to contend with the twin problems of guiding development and setting up a production operation. ECIL had a laboratory culture and not an engineering one. Though BEL had acquired an excellent production culture through its collaborations, ECIL's environment remained that of a prototype shop.

ECIL's FUTURE

ECIL still has to face problems in the computer field. The mainframe area has been thrown open to other entrants and the government have selected the CDC computer with an eye to scientific applications. There have already been serious delays in the implementation of the project because of change of the CDC model from the 830 to the 930/932 — though through no fault of ECIL. The assembly of 930s has now commenced at Cherlapally, Hyderabad, but ECIL may have to live with a government/public sector market subject to budget cuts. The Norsk Supermini

has also now become more or less obsolete with the arrival of powerful desktops and workstations with the Intel 80386/486 and RISC chips

The Computer Division recorded sales of Rs. 44.44 crores in 1988–9, and Rs. 52.72 crores in 1989–90 excluding Medha mainframes. Including Medha mainframes, the sales in 1990–1 reached Rs. 119.59 crores (see Table 8.8).

Table 8.8

ECIL Computer Division Performance – Sales

(Rs. lakhs)

	1988–9	1989–90	1990–1
Micro systems	97.94	502.0	198.46
Enhancements	63.01		318.42
Special purpose systems	2,168.63	2,777.0	6,647.26
Super–32	1,061.36	700.0	127.98
Services	1,052.62	1,100.0	1,309.66
Miscellaneous		193.0	1,698.18
Total	4,443.56	5,272.0	10,299.86
Medha mainframes	900.00	810.0	1,659.50
Total	5,343.56	6082.0	11,959.36

SOURCE: Data from ECIL. Balance Sheet figures are slightly different.

The major contribution to ECIL's output came from special purpose systems for defence applications, telex units etc., services and taxes. ECIL does not appear to be serving the private sector or the PC market. They also made no contribution towards export of software.

ECIL sold Rs. 3.50 crores worth of the Medha systems in 1987–8 and Rs. 9 crores worth in 1988–9 — all imported. The Annual Report of the DOE for the year 1989–90 noted that the assembly and testing of the various subsystems of the CDC 930 had started and the first indigenous(!) 930 assembled at ECIL had been 'rolled out'. In 1990–1 the sales of Medha mainframes increased to Rs. 16.60 crores. It is reported that one has been exported to Thailand for census tabulation.

As the Medha mainframe project has been specifically funded by the DOE, it is essential that a detailed financial performance of this project is separately published in the Annual Report of ECIL or that of the DOE. From the meagre information now made available, it is not possible to

evaluate the various aspects of this project. The virus of the SKD/CKD culture has invaded the last bastion of self-reliance in India; and the DAE and ECIL have accommodated themselves to the realities of the present permissive environment.

A report in 1988–9 that DCM Data Products Ltd. will be a marketing arm of ECIL (on a non-exclusive OEM basis for the CDC 830 systems) and will maintain CDC mainframes on a 'value added' basis is disquieting, to say the least. CMC set up as a public sector unit for the very purpose is being cold-shouldered by another public sector company. If CMC are charging higher rates for maintenance, could not ECIL and the DOE have talked to CMC and sorted matters out? (However, for the railway reservation system at Secunderabad, ECIL has entrusted the task to CMC because of their past experience.) The deal between ECIL and DCM is unusual to say the least. Most Medha computers are going to universities, government departments, and the public sector. Why should an 'agent' come into the picture? Chairman, AEC, when asked, stated that it was a decision of ECIL's management. B.S. Prabhakar maintains that DCM is not an exclusive agent and that private sector companies are in a better position to canvass orders even from government departments or the public sector. Anyway, as the CDC 830 has been superseded by the CDC 930s, the tie-up with DCM may have no effect, but the very thought of using an agent exposes ECIL's fear of facing the market on its own.

ECIL can take some comfort from the fact that the private sector company, ICIM, (40 per cent owned by ICL, UK, which is itself now owned by Fujitsu) has also not progressed well. It has also displayed no leadership in capturing the markets or in setting a tone for the computer industry in India, in spite of the encouragement given to it by the DOE in earlier years. ICIM has only served the interests of ICL, UK, by making India the dumping ground for their non-standard products sold at inflated prices. However, the new management at ICIM have entered the PC market and with vigorous marketing have improved performance. With the support from Fujitsu of Japan, ICIM is likely to progress rapidly. There is a lesson in this for ECIL.

For retaining leadership in the computer field, the ECIL management will have to recapture some of the idealism and the spirit of enterprise shown in the earlier days. It must also display initiative in national policy formulation through an active association with the DOE, instead of solely letting itself be ruled by the technical officers of the DOE, who themselves lack the hands-on experience of running an industrial enterprise or of the product-oriented design and development necessary in the field of computers.

NOTES

1. 'Expansion Programme (1971–6), Computer Division, ECIL', *Report of the Committee,* Hyderabad, December 1970, p. 2. paras 4–5.
2. Ibid., p. 4, para 10.
3. Public Accounts Committee, 'Computerization in Government Departments: Department of Electronics', 1975–6, Fifth Lok Sabha, *221st Report,* New Delhi, April 1976, pp. 258–60.
4. Ibid., p. 258, para 7.7.
5. Ibid., p. 259, para 7.8.
6. Estimates Committee, 'Department of Electronics', 1973–4, Fifth Lok Sabha, *66th Report,* New Delhi, April 1974, p. 107, para 3.43.
7. 'Econometric Study — A normative Cost Analysis of Indian Manufactured Computers', *IPAG Journal,* vol. 1, 3, New Delhi, December 1973, p. 355.
8. Estimates Committee, 'Department of Electronics', 1973–4, Fifth Lok Sabha, *66th Report,* New Delhi, April 1974, p. 19, para 1.59.
9. Ibid., p. 22, para 1.68.
10. Om Vikas and L. Ravichandran, 'Computerization in India: A Statistical review', *IPAG Journal,* vol. 16, 3, New Delhi, December 1978, pp. 323–32.
11. Committee on Public Undertakings, 'Department of Atomic Energy: Electronics Corporation of India Ltd.', Seventh Lok Sabha, *19th Report,* 1980–1, New Delhi, p. 2, para 1.5.
12. Ibid., p. 3, paras 1.6–1.8.
13. Ibid., pp. 44–5, paras 4.14–4.21.
14. S. Manikutty, 'ECIL: A Case Study of Environmental Change and Organizational Response in the Public Sector', A Dissertation submitted in partial fulfilment of the requirements for the Fellow Programme in Management, Indian Institute of Management, Ahmedabad, 1987, pp. 160–5.
15. Om Vikas, 'Indigenous Development of Computer Systems, Peripherals and Computer Communication Facilities', *IPAG Journal,* vol. 5, 11, New Delhi, August 1978, p. 773.
16. S. Manikutty, 'ECIL: A Case study of Enviornmental Change and Organizational Response in the Public Sector'. A Dissertation submitted in partial fulfilment of the requirements for the Fellow Programme in Management, Indian Institute of Management, Ahmedabad, 1987, p. 2.
17. Courtesy, ECIL.

18. Personal communication from J.V. Kanitkar, DGM, Corporate Planning, ECIL, 5 February 1988.

19. 'A Dialogue with the DOE', *Computers Today,* November 1985, p. 16.

20. Per Øyvind Heradstveit, *Norsk Data: A Success Story,* J.M. Stenersens Forlag A/S, Oslo, Norway, 1985.