It is also clear that interactive remote observing, in the way it was tested, offers entirely new working conditions to astronomers. Flexible scheduling, a few hours work on a telescope, recovery of lost nights at La Silla are all concepts which find a solution under remote control from Garching.

The test run also provided us with a lot of feedback in terms of desirable improvements which should be made in order to have a friendly-and-easy-to-use permanent remote control facility in Garching. We now feel confident that future implementations of RC, like in the case of the NTT, can be based on experience and are technically understood.

The net price of RC features, when cost of operations in Garching versus costs at La Silla are taken into account, seems to be reasonable. RC from Garching becomes therefore an open option, even for the near future.

Acknowledgements

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Computer Aided Design of Printed Circuit Boards at ESO

H. KASTEN, ESO

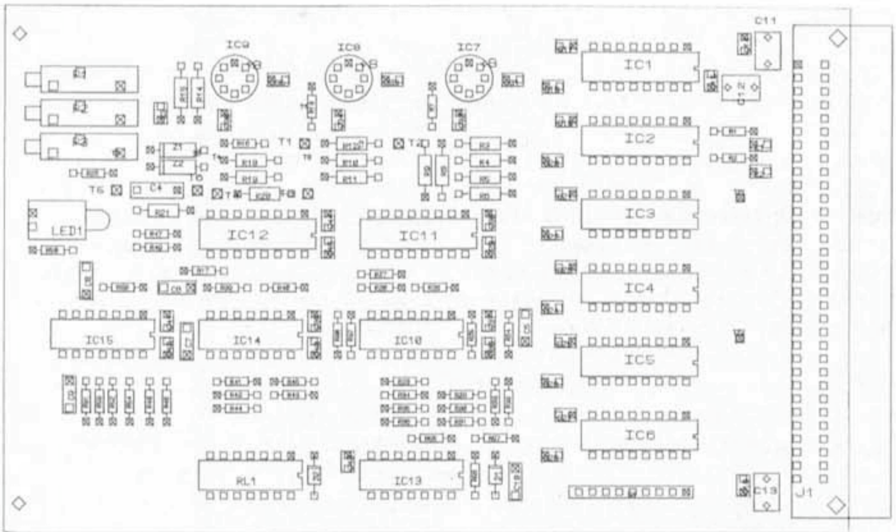
Whenever a new ESO instrument is made available to visitors, they receive a well functioning device which has been tested over and over again. The astronomer of course expects this, and when he sits in front of the computer terminal, happily monitoring this or that celestial object, he is unlikely to think of the amount of work that has been performed before. He is rarely aware of the densely packed electronics racks in the other room and even less of the rows and rows of "cards" within them.

ESO designs its own instruments because it would be very difficult, if not impossible, to contract this work to outside firms. However, after the initial design phase, industries in the member countries are often asked to build parts according to the detailed plans produced at ESO. This is also the case for some electronic components. In order to accommodate modern electronics and to facilitate maintenance, it has since long been customary to design Printed Circuit Boards which can easily be plugged into the cabinets. The design of such boards (PCB) was always rather difficult and time-consuming, but a new computer-supported technique (CAD = Computer Aided Design) has now for some time greatly facilitated this kind of work at the Electronics Group at ESO.

The new system increases the reliability and precision and significantly reduces the time needed to design a board. It is based on a Prime Computer 2250 and two software packages, Autoplan and Autoboard. The CV-Grado system was installed in early 1984 and has since been used extensively. The production rate is now several dozen of new boards/year, each having up to 300 electronic components. The starting point is a "messy" circuit diagram and the result is a well organized, (near)-optimal configuration of the PCB, with all wiring, etc. specified.

The operator starts by inputting the connection list, i.e. which components shall be connected with each other at which points. The programme then places the components within the board perimeter. This can be done automatically or interactively to obtain the best possible component-to-board area

Figure 1: *The CAD-PCB system at the ESO Electronics Group in Garching.*



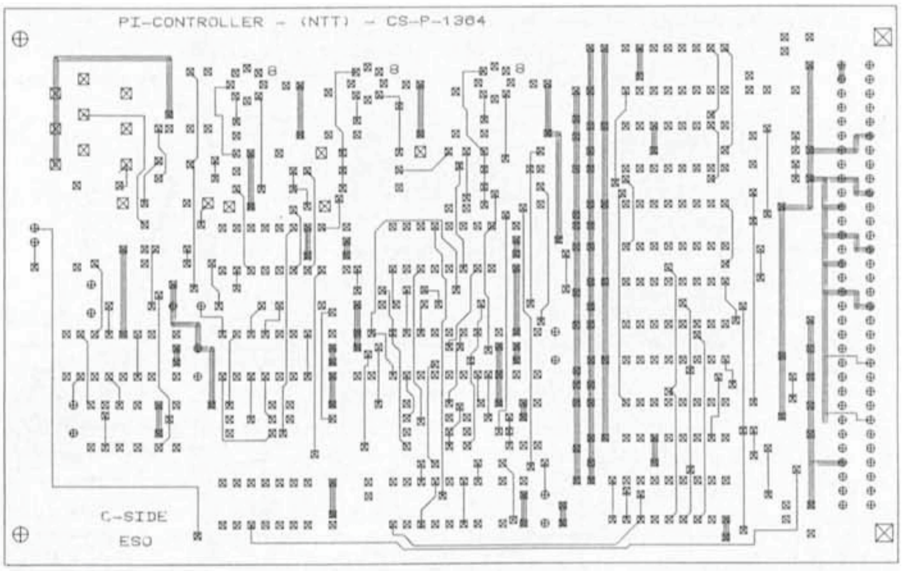


Figure 2: *Example of PCB board design for the PI controller at the NTT. The board measures 100 × 160 mm (Europe size) and contains 82 components with 316 connections; component-to-board ratio is 45 per cent. Upper: Placement of components. Lower: Wiring diagram on component side.*

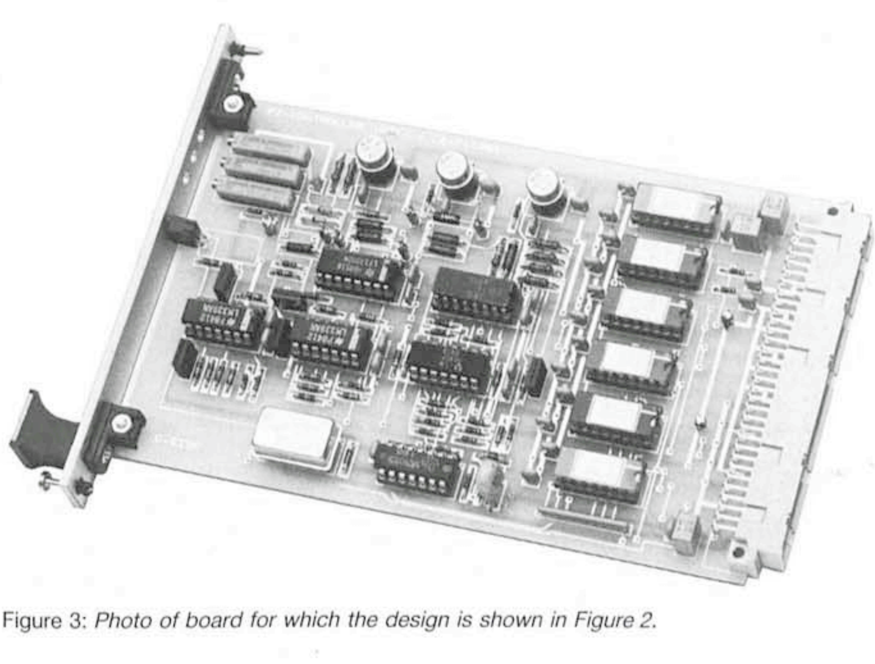


Figure 3: *Photo of board for which the design is shown in Figure 2.*

GRADO-CV-Configuration at ESO

1. CPU: Prime-Computer 2250 (32 Bit)
   Memory – 0.5 MB Autoboard
   – 1.0 MB Autoplan + Autoboard
   Disk – 60 MB
2. Peripherals: System console, printer, tape drive
3. Graphic workstation: Ramtek-Colar-display, Summagraphic Tablet, Alphanumeric Terminal
4. Hardcopy: Facit printer
5. Plotter: Penplotter BENSON, Photoplotter (Quest) GQ-40 (external). All data storage is brought on a magnetic tape-cassette.

ratio; normally around 50 per cent. Then follows the crucial operation: the automatic process to determine the optimal routing of connections (Autorouter). The two algorithms from Stitching and Lee are used. The problem reminds us of the classical one known as the "travelling astronomer" (what is the shortest route, if he has to visit *x* observatories?).

For a dense PCB, the Autorouter routine can take up to 16–24 hours. Therefore, we normally run these programmes overnight or during weekends. Even then, a few connections are sometimes not found. Then an iterative, interactive process is needed. Once the operator is satisfied, detailed drawings of the PCB design are output, including all layers of the board, which are needed for the fabrication. This entire procedure also guarantees full correspondence between the PCB and its documentation, a fact that greatly facilitates maintenance. Moreover, the software automatically rejects "errors", which might otherwise have gone undetected until the board had already been produced.

The work as PCB-designer has changed drastically with the introduction of CAD at ESO. In less time, we can produce more and better boards and on top of it, it is also interesting to use modern techniques.

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