Behind the Scenes at the Manufacturers

David Weatherall visits four PLASA member companies involved with the manufacture of electronic products for the entertainment industry, and finds out how they have become international experts in high quality small-batch production, tailored to suit customer's precise needs.

We've all got problems: venue managers have problems, installers have problems, rig designers have problems, retailers have problems. But I feel for the poor manufacturer - he has the biggest problems of all.

The manufacturer has to design good, reliable, marketable products; make them properly, provide good customer service, fight off the competition **and** make a profit - all at the same time!

If he gets any of those things wrong, he goes to the wall. Getting them right is not just important - it is essential.

Fortunately, Britain is in the forefront when it comes to the electronics side of the entertainment lighting and sound industry, and PLASA members **are** getting it right. How has it been accomplished? I visited four PLASA companies who have a strong electronics product line, to discover the secrets of their success.

Zero 88 Lighting Limited

Zero 88 was started in 1972, in an attic. The original four partners all had an engineering bias, so although the company made good products it grew only slowly until 1976 when a sales manager was appointed. Then things started to take off. Since 1981 they have been growing at around 25% a year, and about two thirds of their production is exported.

Zero 88 has a wide range of products - from small power packs to the Eclipse modular lighting control system. The usual products number around 60, with three or four variants each, and the Eclipse range adds another 80 items to the list. "The main difficulty is supporting all the market-places, all with the right products, and all at the same time," said Peter Brooks, the company's managing director.

Doing that takes a lot of organising, so just a year ago they installed additional computerisation to help in controlling their work. Orders are typed into the computer as they arrive. The computer then calculates when stocks of those products will run out, and prints recommendations on what to manufacture next. Manufacturing needs raw materials, so they have to be ordered in good time. The computer prints out a schedule of orders which takes that into account, so that the needed components are present on time - without being too early.

"The resulting improvement in control," said Peter Brooks, "doesn't only apply to us. People across the country are thinking about their businesses, and how they can do it better. Our new system, with programs we wrote ourselves, has enabled us to decrease overall stock by up to 20%, whilst at the same time we have increased output by 35%. It has also changed the balance of stock. We used to hold vast quantities of parts and part-finished products, whereas now it's much more in actual finished product."

Citronic Limited's MPX 9-31 top of the range 'no compromise' mixer.

Work in progress (partly completed work awaiting the next production stage) has also been reduced "from three or four weeks to half a day." As space is at a premium in Zero 88's St. Albans factory, the reduction in the piles of part-completed products has been a great help.

Of course, before anything can be made it must be designed. Designing any electronics takes time, but much of it is sheer slog in drawing diagrams and planning how to lay

'Technology in Control' - the message from NJD Electronics of Nottingham.

Heads from Zero 88's Computer Production Schedule:

Production Number
Description of product
Balance in stock
Planned to make
Long mean (52 weeks)
Short mean (13 weeks)
Minimum stock level
Out time (in weeks)
Order quantity on factory
Man hours for batch
A 'star' column for priority

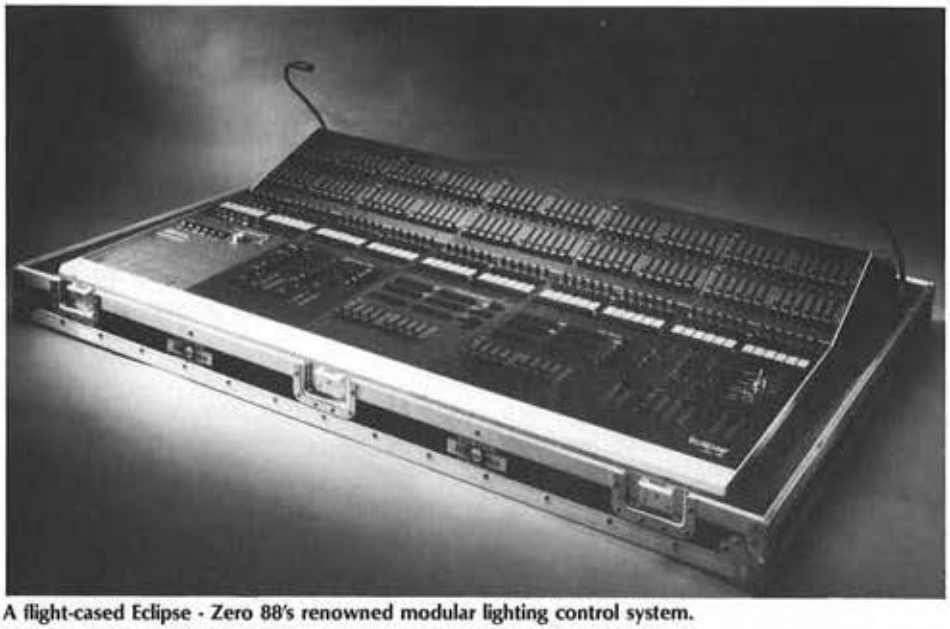
(The Minimum stock level and Order quantity on factory are calculated statistically.)

out the components and wiring tracks on the printed circuit boards (PCBs). Here also, computer technology comes to the rescue - with CAD, which is used extensively at Zero 88.

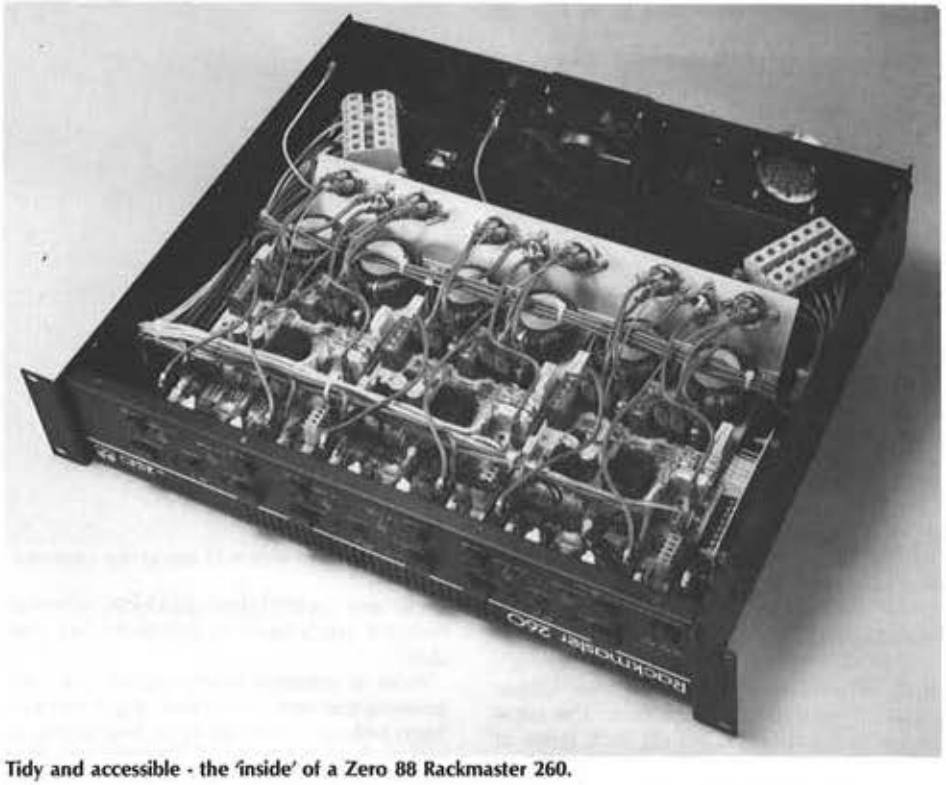
CAD is short for Computer Aided Draughting (or Design, depending on who you talk to). Circuit diagrams and physical component layouts can be drawn directly on a computer screen. That is no faster than drawing it manually, but once the drawing is in the computer, amendments can be made much faster using the computer than can be done by hand. In addition, if the computer is told which components are connected to which other components on the circuit board, it can further reduce the tedium by having a stab at deciding where the printed wires should go. Once that job is done (with a bit of human help), it can even produce a drawing to be used as a master copy for making the PCBs themselves.

That speeds things up - especially when changes need to be made at late stages in the design process. But where this system really helps is in imposing discipline on the designers. Many electronic products reach the market-place with the original circuit diagrams virtually drawn on the backs of envelopes, so dealers can't make needed information available to purchasers. CAD, however, forces the diagrams to be drawn correctly long before the circuit is produced. That improves the product documentation, which itself improves customer service.

The design is very important in other ways. The Eclipse lighting control system, for example, is designed to be modular. That design decision has resulted in quite



A flight-cased Eclipse - Zero 88's renowned modular lighting control system.



Tidy and accessible - the 'inside' of a Zero 88 Rackmaster 260.

Running a test programme prior to 'hot room' treatment.

Above and below: two sections of Zero 88's assembly areas at their St. Albans factory.

Computers aid all processes at Zero 88 from preparatory work (above) through to labels for despatch (below).

remarkable customer service. Zero 88 can often provide a custom-made Eclipse within 48 hours, by putting the modules together almost as if it were Lego.

But before any item can be sent to the customer, its reliability needs to be confirmed. The most usual way for electronic products to fail is through getting too hot, so at Zero 88 each completed item is left on in a hot (86°F) room overnight. After having spent the night in that room, the unit is tested again. If it passes the tests, that piece of equipment will prove reliable in the field, and it is ready to be packed.

Naturally, any failures at this stage cost money to rectify, so it is in everyone's best interests to ensure that the final test is little more than a formality. To quote Peter Brooks: "At the moment (touch wood) it's not catching much at all, which is good news! And there is precious little returned - it's so small an amount we don't even count it."

NJD's Kevin Hopcroft: "We are serious about the industry, and we are doing things properly."

Alan Bolton, production manager at NJD, co-ordinates a finely-tuned manufacturing schedule.

NJD's Nottingham base is soon to be doubled in size.

Computers play a major role at NJD - even with simple tasks such as cable cutting.

N.J.D. Electronics Limited

A smaller company, with a turnover of roughly £1 million a year, is N.J.D. Electronics Limited, based in Nottingham. They are such a good success story that their bank has made a video about them - but at the start they weren't so well known.

Kevin Hopcroft and his partner, Brian Binns, set up N.J.D. Electronics Limited in 1973 and became contract electronics manufacturers. From their factory came all sorts of controllers to be marketed under other names - Squire, RSC, Venue, Damon, Norman and others. Then, in 1980, they put their own badge on some equipment: the SA220 sound amplifier and some popular lighting controllers (the SC4000 among them). The same year they shared a stand at the BADEM exhibition.

That was the turning point. Kevin Hopcroft explained: "People kept coming up to us and saying 'Oh, it's you! We've been wondering where these products came from.' " Since then, the company has developed well and is currently growing at around 18% a year, and now that the name is known in Britain, N.J.D. are also attacking the export market. Their first exports were made in 1984, and have grown to represent about 10% of their total output, exporting to 12 countries. Plans are also under way to acquire the premises next door, which will double their factory space.

Reliability is very important in any product, as the people at N.J.D. are well aware. For that reason, only branded components are ever used in N.J.D. equipment. "It's simply not worth it to save a few pennies on cheaper components when they are not so reliable," says Kevin. "The customer must be able to rely on the equipment working."

Another factor in the quest for reliability is the number of separate items in a product. The more items, the greater the number of things to fail - even including things like wires. For that reason, as much interconnection as possible is done by using the printed circuit board, and wires are kept to a minimum. Not only does that reduce the number of potential fault points, but assembly time is also reduced, which helps keep the price down.

Every piece of equipment leaves the factory thoroughly tested. Each circuit is tested once assembled, using equipment with electrical characteristics matching those found in real use. Once confirmed as working correctly, the circuits are then assembled into the casing and wires attached to the bits and pieces inside the cabinet. But before screwing it all together it goes to the final test area, where it is tested with real lights and sound to ensure everything is working perfectly. Only then is the cabinet finally screwed shut and the unit packed. The customer can be confident the equipment will work first time out of the box.

N.J.D. make 60 products that carry their own label, plus another 30 or so manufactured for others, with each product having three or so variants, making a total of almost 300 products. But the space available is only enough to make five different products simultaneously - which means that properly organised production is essential!

To help with that, computers have been brought into the N.J.D. offices. Kevin and Brian ran into difficulties when they first tried to find some programs with the facilities that they needed. There just weren't any available, so they sat down with some software people and designed the entire system from scratch. Now orders are entered directly into the computer, which immediately allocates items in stock to that customer, decides if any more need manufacturing and decides when they should be made. It also helps with scheduling production, as the time needed to make any item is known by the computer. Multiplying the time needed for one item by the number of items in a batch gives an idea of how long that batch will take to manufacture. Priorities are also advised by the computer, and that information is very useful in deciding what to manufacture and when.

Efficient production isn't just about computers, though. People are important, and

Three in the NJD range . . .

Logic 8000 - 'total lighting control for all applications'.

The M400 Mosfet professional power amplifier.

The MkII Lancaster twin deck console.

On test at NJD, using one of the company's in-house designed and programmed units that asks all the necessary questions.

good quality work can't be produced by untrained people. So N.J.D. take on some YTS employees each year to start a two-year course. To date, every one who has completed the course has been taken on as a full-time employee. That's good news for N.J.D., and good news for the local youngsters, too.

Pulsar Light of Cambridge Limited

Pulsar Light of Cambridge Limited is a larger company, started in 1970 in a bedsit and now situated in a 20,000 sq. ft. factory turning over £3.5 million a year. They make lighting controllers, lanterns, strobes and disco spots - over a hundred products, each with four variants, making a total of 400 products. In the past few years they have been growing at around 20% a year and two thirds of their production is exported - mainly to France and Germany.

I talked to commercial director, Ken Sewell, who formed the company with his partner Paul Mardon. On the subject of quality assurance, he pointed out that it is not profitable to have equipment returned for repair; so they lay heavy stress on ensuring that once equipment has left Cambridge it never returns. The company evidently has a good measure of success with that, because only one man in the company looks after all the repairs, and it's only part of his work-load. With over 100,000 units out in the field, that is a testament to the reliability of Pulsar kit.

Pulsar is the most 'vertically integrated' of the four companies visited. That is, almost everything is actually made on the premises - including the circuit boards and metalwork. The resulting extra degree of control ensures good quality results.

Much of their metalwork and PCB manufacturing equipment is computer-controlled, which has two benefits. First, it makes for a more accurate job. Holes can be drilled and punched very accurately - much more so than would be possible doing it by hand. Secondly, computer-control means that the machinery can follow a complete sequence of instructions without human intervention. For example, the computer-controlled punch can punch unlimited numbers of holes in stainless steel sheet at a rate of roughly three a second, using up to 15 different tools, totally automatically. That saves a lot of work - which reduces the cost to the customer while increasing the quality of the product. Pulsar's computer-controlled drills produce similar benefits in the manufacture of their PCBs.

Once the PCBs are made and the components are inserted in the correct places, they need soldering. That is done on a whole board at once using a flow solder machine. This machine has a bath of molten solder with a wave in it about 5mm high, made by pumping solder up through a channel into the bath. The boards are passed over the top

Pulsar's factory at Henley Road, Cambridge.

Printed circuit boards flowing through the infra-red dryer. Panels are also printed in this department.

Computerised punching in the Pulsar factory - up to 15 different tools can punch three holes a second in stainless steel sheet.

Ken Sewell: "Application of computers to organisation is probably more important than their application in actual production."

of it and wherever metal on the board touches the wave it comes away soldered.

Pulsar boards are often double-sided - with switches, for example, on the reverse side. Those are manually fixed after the board has been through the solder bath. Then comes the testing of each board, their interconnection and further testing.

Meanwhile, the metalworking shop cut out the box from metal sheet, bend it to the required shape, do the necessary welding, insert any extra items (like bolts), spray-paint the whole thing and do the printing on the front. All that is needed is to marry the electronics and the case, give the whole thing a final test and pack it for shipment.

As with the other companies visited, the production and stock control is automatically controlled by computer. Production is planned for up to 15 weeks in advance, and the ordering of supplies is based on that production schedule. An interesting feature of this system is that it keeps statistical information on buying patterns to help with forecasting the likely demand for various products. That helps to optimise the production schedules and keep stocks down.

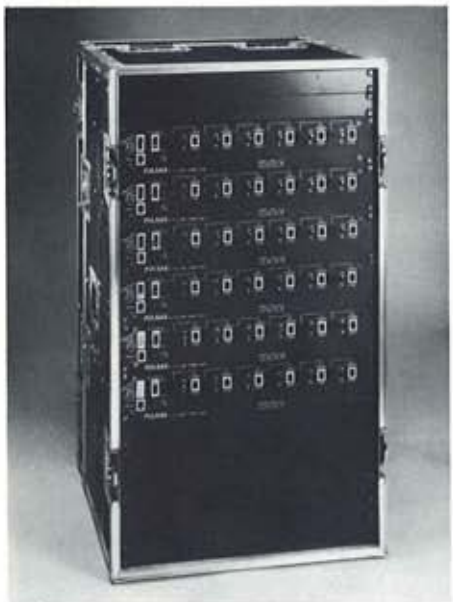
"The key is the production scheduling and the way it reacts to orders as they come in,"

The test area at Pulsar, Cambridge.

John Whittaker (above) keeps a close eye on everything that happens across the wide expanses of Pulsar's production areas.

Two computer controlled PCB drilling machines in operation at Pulsar.

Flow soldering in action.



Professional touring - the Portapak 3 flight-cased dimmer system from Pulsar.

Detailed product testing was a high priority for all four companies interviewed.

Zero 88's Peter Brooks demonstrates the Vacuclamp. It shrink wraps printed circuit boards in order to keep the components in place so that excess wire can be removed prior to flow soldering.

Zero 88's latest - a flow soldering machine in the company's colours.

said Ken Sewell. "Even with a very full order book orders will only be two weeks away at most. It's not 100% foolproof, but it is very good.

"It also means we carry lower stock in relation to turnover. We currently hold the same level of stock we held eight years ago, when turnover was 40% of what it is now. And bear in mind we've improved on delivery dates and we have many more products. In 1979 we had some six month delivery dates - now most items can be delivered from stock. Nothing sits around, but on the other hand we are not held up for anything."

Lastly, I asked Ken Sewell how long it took to get an idea from the back of an envelope into production. The answer quite took me aback - anything from one to three years! This was until recently the main bottleneck in the company. Now, however, due to investing something in the region of £70,000 in CAD equipment, that bottleneck has been considerably reduced, and this should increase the flow of new products from Pulsar.

Citronic's Tony Akers - in the middle of a new £70,000 company-wide networked computerisation scheme.

Citronic Limited

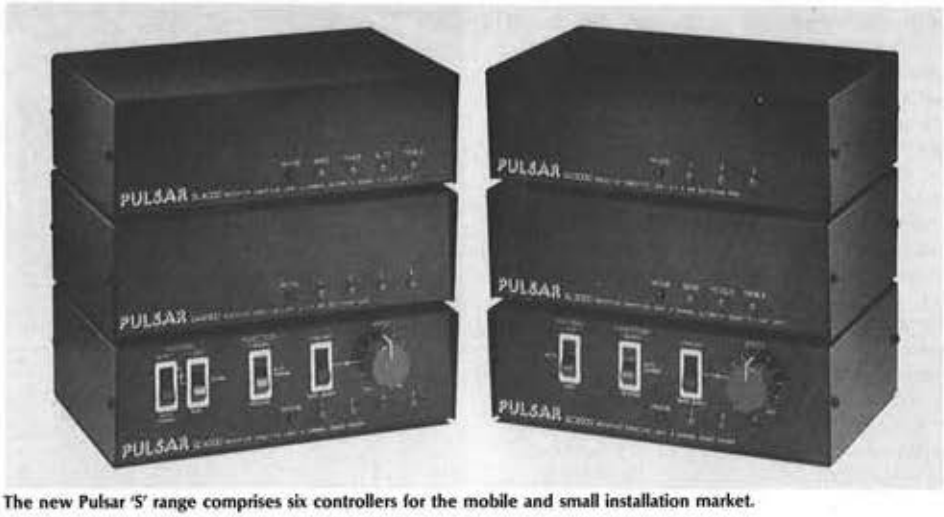
Among Citronic's products are disco consoles, mixers and amplifiers, and with a turnover of over £2 million, a third of its products are exported.

As part of a policy of concentrating on what it does best, the company sticks as closely as possible to designing and producing electronics. The naked PCBs are produced outside, but making the boxes is an in-house activity. They cut, bend and weld the frames and boxes for their equipment, but the painting and anodising is sub-contracted.

The printing on the front panels also used to be contracted out in the early days. Unfortunately, the work wasn't always of the required quality. For example, if the ink used is mixed wrongly it might look fine to begin with but wear off over six months or so. After having that happen, it was decided to bring the printing in-house, where the company's devotion to quality could be brought to bear on the job. Now all Citronic's front panel printing is done in-house.

Citronic also use a CAD system to help with the design stage, but even then it can take anything up to 18 months to take something from idea stage to getting it rolling off the production line. The PPX900, their popular sound amplifier, took 18 months to develop.

The actual manufacture of electronic circuits is very similar in most factories. The component leads are inserted into holes made ready for them in the circuit boards, they are soldered by hand or in a flow solder machine, and then tested. But populating the boards with the electronic components is a very labour-intensive process. To speed this up (and keep costs down), Citronic use several semi-automatic insertion machines. These are programmed with information on where the components are to be placed in the circuit board; the operator sits at the machine with the board in front of her and all the necessary components within easy reach.



The new Pulsar 'S' range comprises six controllers for the mobile and small installation market.

In operation, the machine shines a light on to the appropriate spot on the board where the next component is to go. The operator inserts it, and the light moves on to the next spot. By giving the operator help in this way, the time she would normally take to look for the correct place on the board is almost eliminated. The job is thereby made much more efficient, and the cost of inserting the components is brought down. Once all the components are in, the component leads poking through the board are cut by the machine to a standard length and the board is then ready for sending to the flow solder machine.

Once the boards are completed, it is time to test them. Computers help here as well, by partially automating the job. Every board must be tested, so anything that helps speed up the process or make it more reliable is a worthwhile thing. This constant attention to quality and efficiency is helping Citronic gain a secure foothold in the pro-sound market.

Citronic have always used computers, and are currently in the middle of getting a new £70,000 13 terminal network system up and running, and staff are busy learning new procedures. As managing director Tony Akers explained: "You are expecting people to still get on with the job, (Citronic's staff totals 70 people), but they've also got a whole new way of thinking to learn. It's managing **that** that is the main problem. Otherwise computerisation is easy!

"All production is based on careful sales forecasts," said Tony Akers, "and sales director Mike Gerrish runs a very detailed sales forecasting program every month which takes into account four year's sales. Our new system will be able to tell us about problem areas much faster, and management decisions can obviously be made quickly too, as a result. Our next project is to link our CAD system to manufacturing for quality assurance - they use the same basic data.

"Everything we are doing obviously involves a level of commitment, and shows a degree of confidence in the industry, and I'm sure this applies to many other PLASA companies," he said.

Extensive testing (above and below) at Citronic's factory at Melksham in Wiltshire.

Getting down to fine detail - part of the manufacturing area at Citronic.

Setting up for a run on Citronic's CNC punch machine.

and Finally . . .

Three important ingredients for success stand out from these brief views. They are: good design, high product quality, and efficiency in production. Good design makes a product marketable; attention to quality makes for a reliable product and a good reputation; and production efficiency keeps the price down to fend off the competition.

And good design is absolutely essential; nobody will buy a poor product, however cheap it is. It also makes production easier. Peter Brooks remarked on that, saying: "We try hard to design in such a way that it is very easy to install one of our products, and also very easy to service. We are trying to design products that are quick and easy to install, and quick and easy to make."

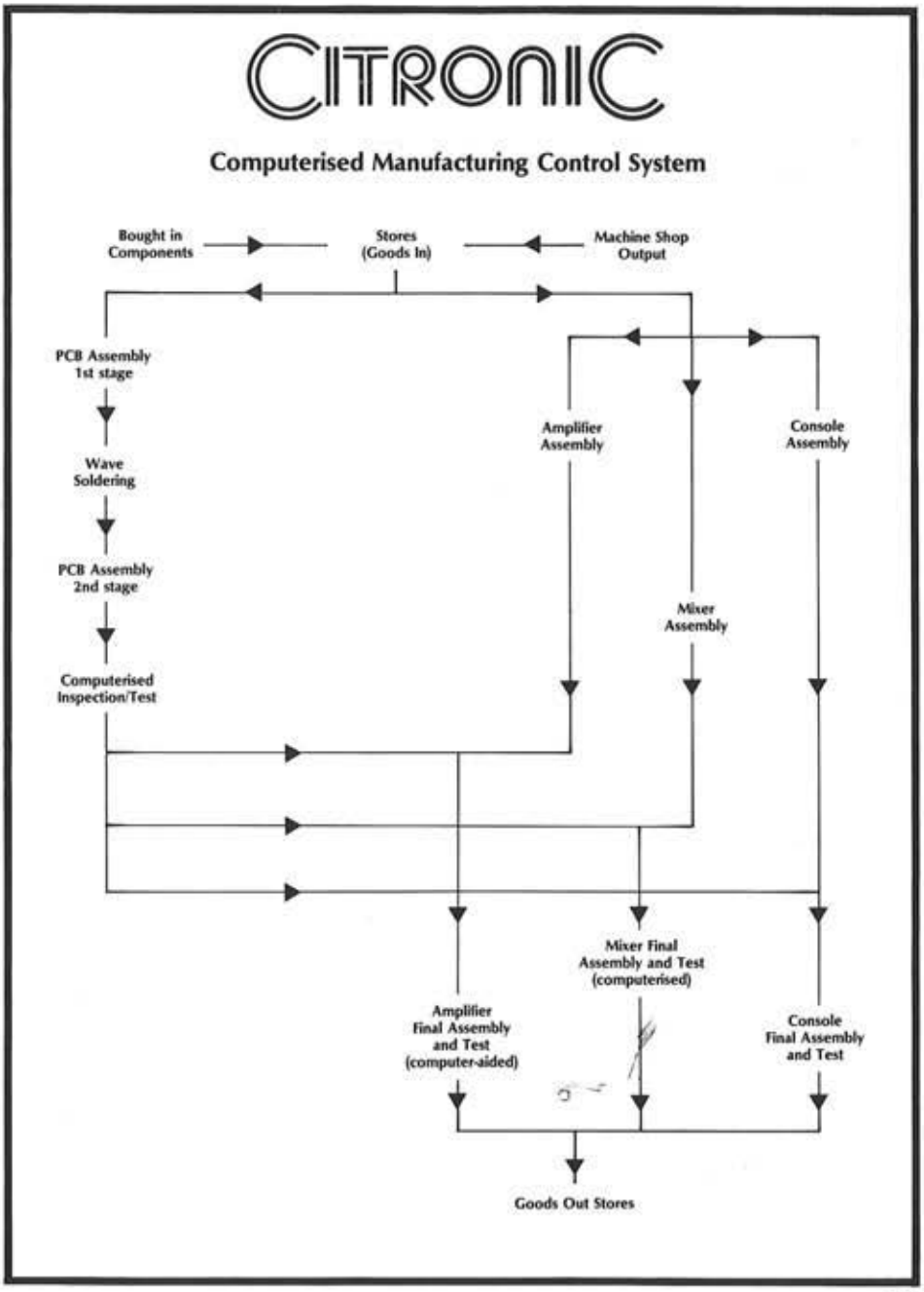
It's also evident from my visits that while investing in production technology (like computer-controlled punches) is important, the primary way of ensuring production efficiency is the use of computers to organise the factory properly. Ken Sewell agreed, commenting that: "Application of computers to **organisation** is probably more important than their application in actual production."

It is encouraging to see these factors being successfully put into action by PLASA companies. That they are doing so is demonstrated by the way they have grown from a cottage industry to the level of other companies in the electronics industry in the space of only a few years. "What is different about our industry is that we are expected to provide **exactly** what the customer wants at the drop of a hat, and we have become expert at quality small-batch production," said Tony Akers. "And we are successful in doing just that."

The manufacturing side of our industry certainly deserves its high reputation both at home and abroad. As N.J.D.'s Kevin Hopcroft said: "We are really serious about it, and we are doing things properly."

One of the most technically advanced consoles on the market - Citronic's Thames II (above). Below, the PPX range of power amplifiers.

Citronic's semi-automatic PCB assembly line.



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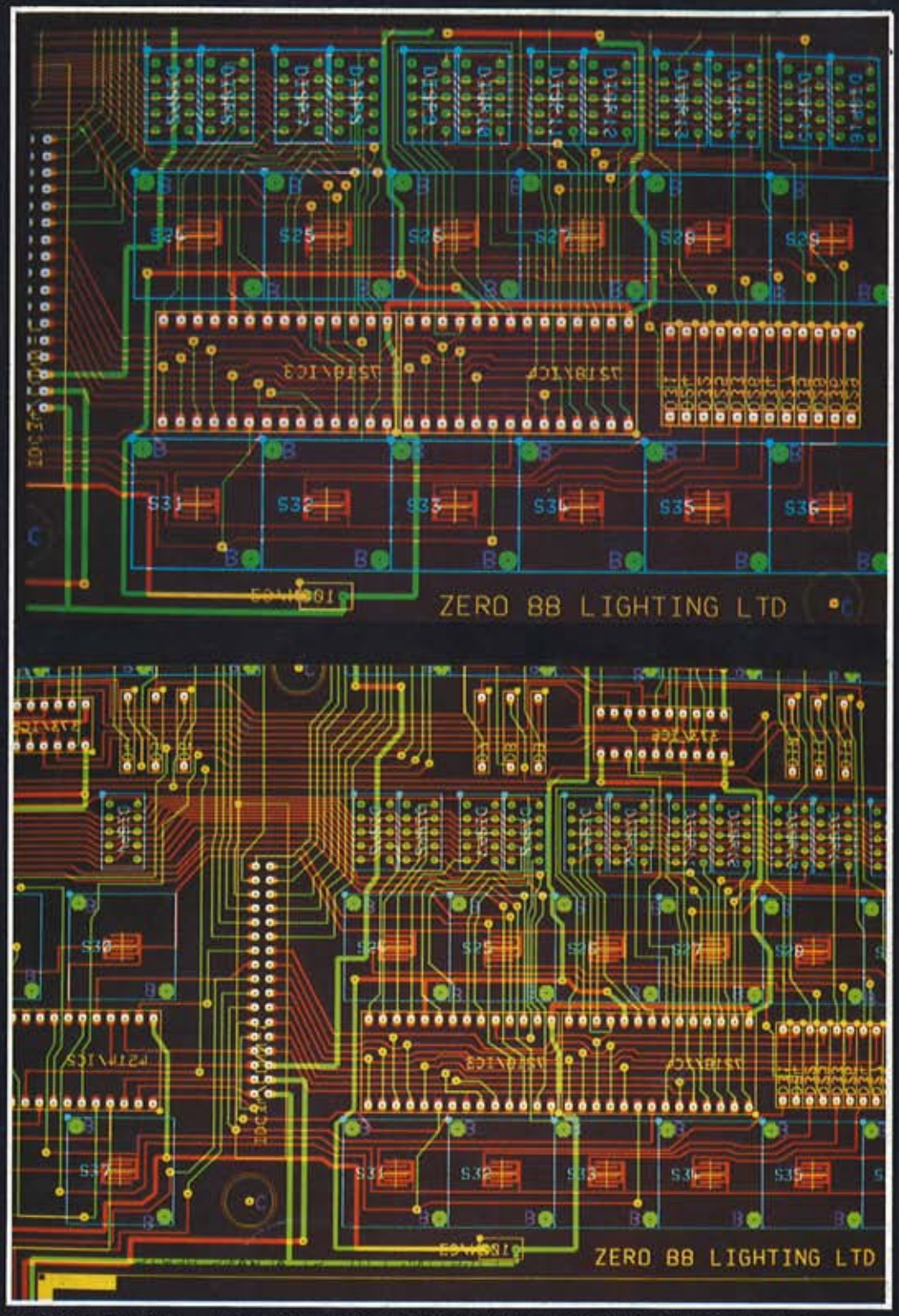

'Insider' Design - an up-front view of Zero 88's new Sirius lighting desk. (see feature 'Behind the Scenes at the Manufacturers' in this issue)

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