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## **CERN - TS Department**

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### **ELECTRONICS DESIGN OFFICE ORGANIZATION, METHODS AND TOOLS**

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#### **Abstract**

The group TS-DEM offers a global service for the design, manufacturing and assembly of electronics modules for several hundreds of electronics engineers at CERN and its collaborating institutes. The Design Office in DEM determines and controls an overall planning, defines the resources required, solves the technical aspects and invoices the whole project. This involves technical resources provided by service contracts and supply contracts, but also negotiations with clients to be able to provide realistic plannings while still being able to handle urgent cases and high-workload periods.

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## 1 INTRODUCTION

The primary mission of the Design Office in the Development of Electronic Modules (DEM) group in the TS department is to create printed circuit board (PCB) layouts based on schematics provided by electronics engineers at CERN and its collaborating institutes. Being the entry point to DEM opens the opportunity to help in planning jobs for the two other sections in DEM that manufacture and assemble printed circuit boards. As a consequence it has become a logical function of the Design Office to coordinate the activities throughout DEM from schematics to assembled boards. Figure 1 shows clearly these two separate functions of the Design Office: planning and design.

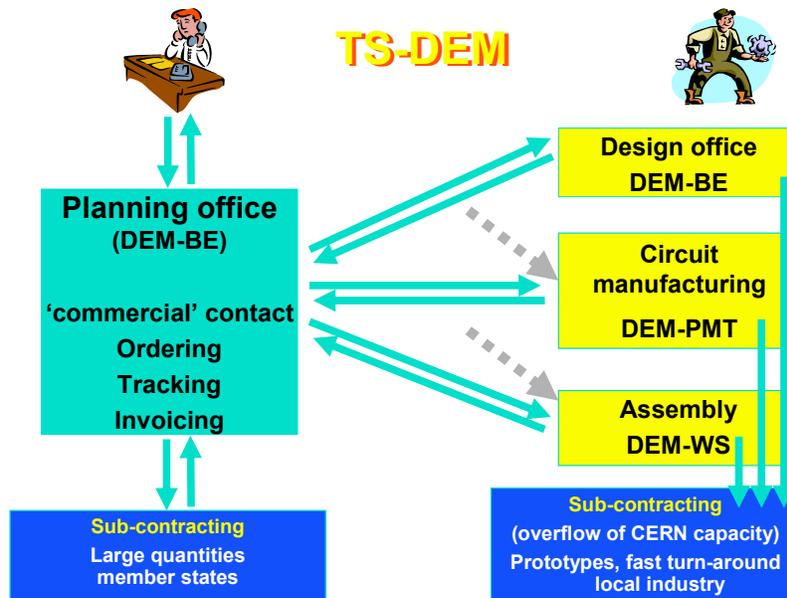


Figure 1: organisation of TS-DEM

## 2 TASKS

Before starting a project, the customer discusses with the section leader of the Design Office the planning and the global technical solutions for the production. Depending on the various requirements the section leader decides if the fabrication of the PCBs and the assembly of the components will be done on the CERN site or if these steps are subcontracted.

Most of the jobs entering the Design Office are for small quantities (1 to 200 pieces) of finished PCBs. This represents a large amount of projects (around 800 per year), but each time with a low cost (150.- CHF to 10'000.- CHF). This implies that we need a strong structure to manage all these small projects. This structure must remain small and flexible in order to keep prices as low as possible.

The most important requirement of the engineers that use our service is that we provide their assembled boards on time. To accomplish this we have defined a global lead-time of ten weeks for standard multilayer prototypes. We estimate for the incoming queue and the time for the layout four weeks, for the fabrication of the circuit three weeks, for the assembly two weeks and finally one week is reserved for transports and unforeseen reasons. Of course urgent projects will be done faster while low priority projects are used to fill periods when there is less work. Only with a tight planning and a strong follow-up we can guarantee the agreed delivery times. To handle periods of overload of the internal services for the design, fabrication and assembly we have selected companies on which we can rely to be able to keep the required lead-times.

The following technical tasks need to be performed to provide this global service of DEM:

- advice the customer to find the best solution in terms of manufacturability
- create component libraries
- design the layout and specific mechanical parts
- solve technical problems with the subcontractors or internal production sections

Also many administrative tasks are performed:

- plan the project
- order parts
- track deliveries
- invoice

All the costs of a project (labor, external orders and components) are temporarily borne by the Design Office. Once the project is finished, a single invoice is sent to the client.

### **3 MEANS**

#### **3.1 Design Office**

Apart from the maintenance of the Cadence CAD library and the section leader who discusses the planning with the clients, all of the activities of the Design Office are subcontracted to an Industrial Support company. To make it easier for our customers to discuss technical aspects this company works on the CERN site. In case of overload of the Design Office we subcontract undemanding jobs to another company outside CERN. This is transparent to the customer who will receive the same service. Besides designing the layout, the Industrial Support creates the manufacturing documentation, orders material and prepares the bill for the CERN client. The bill includes the cost of the Industrial Support contract. The final invoicing of the project to the client is made by CERN staff.

As it is only the section leader who takes in new projects and knows in detail the different subcontracting companies, the full activity of producing CERN electronics is extremely sensitive to the skills and presence of her.

#### **3.2 PCB manufacturing and assembly**

Prototypes and small quantities of urgent boards are manufactured at CERN by two other sections of TS-DEM. Quantities of over ten boards are in most cases manufactured by external companies with which we have established contracts.

#### **3.3 Mechanical parts**

There are generally front panels to be mounted onto the PCBs. These are parts available from the CERN stores that are customized with drilling and screen printing. The Design Office has contracts with several companies spread over Europe and provides them a working stock of parts to reduce delivery delays.

### **4 TOOLS**

#### **4.1 CAE**

Depending on the client, the design of the layout is done with the CAE programs Cadence or PCAD, both of which are supported at CERN. The current trend shows an increasing volume of jobs on Cadence. This means that the employees of the contractor need to be able to work on both tools which is not yet the case for all of them. The mechanical parts (mainly front panels) are designed with the program AUTOCAD. To facilitate the assembly of the PCBs, a CAD-CAM software called Fabmaster is used to generate assembly documents.

All documentation related to a job is stored in the EDMS database. A standard structure of these documents has been defined which allows us to communicate easily the right information to our suppliers. In fact we just provide a link to the EDMS web page on orders placed to external companies.

## 4.2 Planning and invoicing

The administrative part of the activity is linked to several tools such as Filemaker, Excel, MS-project, EDH, JMT and JMT2. This multiplicity of tools leads to a redundant entry of information with risks of misses and mistakes.

## 5 FUTURE EVOLUTION

The objective of the Design Office is to keep up with new requirements of our clients. This evolution is in two directions: a higher technical level and an extended service for series production of modules.

As the Design Office has fully subcontracted the layout work to a company, we must never forget that our performance is the performance of the employees of the subcontractor. They must be able to design PCBs corresponding to CERN engineers' specific requirements such as high-frequency and fine-pitch circuits. Also, to be able to design a layout that will be easy to produce, designers must know the evolution of the production processes both for PCB manufacturing and PCB assembly. Visits to subcontractors could be a solution to update the knowledge. Furthermore we have to make sure that even for specific techniques several designers are able to create the layouts. In any case a strong cooperation between the contractor and CERN is required to define a training policy and program.

To improve the planning, follow-up and invoicing of projects we are developing with the help of the group TS-CSE a single application for all the administrative work. This development is based on an audit done in TS-DEM in 2003. This application will be JMT2 based with DEM specific extensions and should be running before the end of 2004.

The domain of contract manufacturing is very sensitive to the evolution of the market. It is not unusual to hear that an assembly factory has been closed or transferred to a cheaper country. With the type of productions we subcontract we often work with local or small subcontractors that may even be more sensitive to economic downturns than larger companies. Therefore it is important for us to follow the market and to be able to have a fallback solution at hand if a subcontractor suddenly would disappear.

## 6 CONCLUSION

The Design Office of the Development of Electronic Modules group is not only designing the electronics but also planning and organising the fabrication of them. It has subcontracted all of the design work to a company working on the CERN site. This has the advantage of being competitive with industry while still having the designers near the CERN engineers.

However, because of the full subcontracting it means that *no* CERN staff has the knowledge of circuit board layout which makes that CERN does not 'own' the knowledge. If contractor staff leaves, CERN has no control over it and could easily lose the capability to design certain specific circuits. Training the designers so that they all become versatile will relieve this risk slightly.

An even worse problem is that because it is *only* the section leader who takes in new projects and knows in detail the different subcontracting companies, the full activity of producing CERN electronics is extremely sensitive to the skills and presence of her.