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Abstract

A general computer design system called GICE is progressively being set up in order to draw and manage all the documents of an aircraft electrics drawing file. This system allows optimization of the design to cost of all the definitions of this drawing file, that is to say from the conception of the electrical data in the Design Office until the Production and Product Support Departments assume it.

The necessity of cooperation for an aircraft project requires an exchange of data between partners. This exchange can only develop from the creation of a central data bank for which the GICE system is destined to become the working support.

1. What is the objective ?

From the design scheme stage to airline operation the design of the electrics of an aircraft requires a considerable exchange of data which will appear in diverse forms adapted to each stage of the project.

Nowadays, the considerable amount of money required for financing a project makes cooperation between several countries inevitable, and this entails division and exchange of the data to be processed.

The use of CAD, or computer assisted design, has now enabled all this process to be computerized but only to an intermediate stage which is still very close to the manual method used initially.

The next step, which is the real objective, is an entirely new reconsideration of working methods and data processing in order to allow real computer assisted design.

It is only at that stage that the data processing tool will be perfectly integrated in its context and it will be possible to optimize costs and programmes to a maximum.

2. What is an aircraft electrics drawing file ?

The electrics drawing file is a set of documents which allow the Production Department to make the wire bundles and ensure that they are correctly connected to the aircraft. It also enables the Product Support department to provide the customer airlines with documentation (Wiring Diagram Manual) which is representative of the condition of the aircraft as it has been delivered.

2.1 - Documents produced

For a civil aircraft project such as the Airbus, the drawings required for designing the electrical installation in the Design Office represent a considerable volume of documents.

These documents mainly comprise four types of drawings :

a) Schematics, which are made at the initial design stage by the various specialists and draftsmen to define the operation of the aircraft electrical circuits and prepare the wiring diagrams.

b) Wiring diagrams, which are consistent with the previous drawings, show the various identifications of the cables and equipment installed on the aircraft. They also take into account the additional breaks that are added, with respect to the schematics, for production purposes.

c) Lists of equipment, which call up the items of electrical equipment shown on the wiring diagrams.

d) Routing diagrams, which show the exact runs of the cable looms through the aircraft. The data in these documents will generate other "Production" documents which will be used to manufacture the cable looms for installation and for inspection on the aircraft.

2.2 - Complexity of electrics drawing file evolution : problem of applicability

The interaction of the various modifications on the electrics drawings leads to a complex management requiring maximum attention. To summarize and for simplification, one can say that the electrics drawing file for each aircraft is created according to the following criteria :

a) a standard complying with the Technical Specifications.

b) a customer version which is created on the basis of one of the standards to which the modifications requested by the customer are added.

The definition of the aircraft immediately after delivery is thus provided by the standard and the customer version corresponding to this customers request.

Note : the standard evolves according to the number of improvement modifications included in it as the progress of the assembly line permits.

Volume of information

As an indication, after 10 years exploitation, the Airbus electrics drawing file comprises :

- 100.000 definitions of cables and connections
- 20.000 definitions of equipment
- 4.000 definitions of modifications
- 200 standard, unallocated or customer effectivities.

2.3 - Product support requirements for documentation delivered to the customers

After being used for building the aircraft, the electrics drawing file is used by the Product Support department for producing the documentation to be delivered to the customer.

In order to avoid costly duplication of this file, the partners' Design Offices and Product Support departments agree to define jointly the rules for drawing up the file.

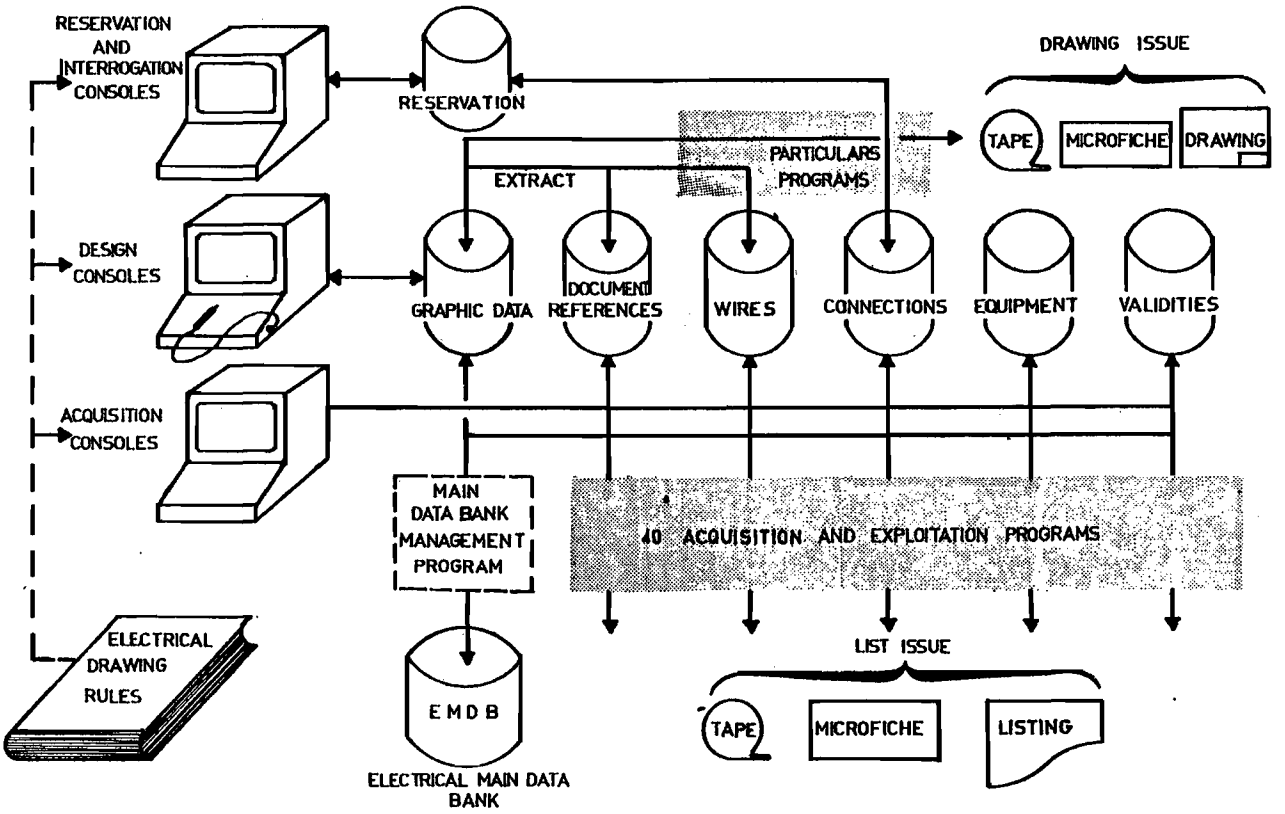
This mainly concerns compliance with ATA 100 (at the revision applicable to that aircraft) and its consequences as far as the functional breakdown of the electrical circuits, symbolization, etc, are concerned.

In order to guarantee the use of common rules, a document called "DRAWING SYSTEM - ELECTRICAL PART" or more simply the "BIBLE ELECTRIQUE" (Electrics bible) has been drawn up taking the aforementioned requirements into consideration. This document is the first step towards the two objectives, viz :

- to improve the content of the electrics drawing file ;
- to reduce its cost and time.

As we shall see later, computer processing will play an essential part in achieving these objectives.

3. The "GICE" system



"GICE" SYSTEM

Figure 1

3.1 - Purpose of the system

The "GICE" system is an essentially computerized tool made available to the draftsmen responsible for producing the electrics drawings.

It mainly consists of a set of programmes based on several reel time or batch access files.

The objectives pursued in creating this system are threefold :

a) To improve working methods by eliminating tedious tasks.

b) To harmonize the tasks between the various departments by eliminating the duplication of work.

c) To standardize the information processed in order to respect constraints such as the requirements of the applicable standards (ATA 100).

d) To reduce the overall cost of producing electrics drawing files.

3.2 - List of utilization rules

It is essential for the rules for using this system to be grouped together in documents which will be used as "bibles" by the draftsman.

The first of these documents to be drawn up is the one quoted in § 2.3. It was defined in collaboration by all the partners of the s same project. The agreement of these partners to respect these rules allows a consistent electrics drawing file to be achieved in spite of the geographical diversification of the tasks and the size of the Design Offices.

Hardware utilisation manuals must also be written, taking full consideration of the particularities of the application. The hardware must be adapted to the "electrics" application.

Remark : It should be noted that the use of new techniques for building up the electrics drawing file causes an important change that requires a considerable staff training effort.

3.3 - Production of drawings

3.3.1 - Schematics

The production of schematics on interactive hardware allows these documents to be created and updated in order to provide :

a) The Design Offices with the possibility of ensuring the functional control of these drawings with the corresponding wiring diagrams. This therefore enables the correspondence of the signals between these two documents to be checked automatically.

b) The Product Support department with the drawings required for partially producing the "schematic" part of the documentation to be delivered to the customer.

3.3.2 - Wiring diagrams

As for the schematics, three objectives can be achieved in the Design Office for drawing the wiring diagrams, viz :

a) facilitate the management of these drawings as far as updating and the embodiment of new modifications are concerned.

b) provide the Product Support department with wiring diagrams that can be used directly for the WDM's.

c) allow the Production Planning department to input the "wire" file automatically without having to go through the manual phase which previously required copying the scheme as a punching note then punching cards.

3.3.3 - Reservation of connections for drawing the wiring diagrams

The reservation of connections at connecting items common to several electrical functions (circuit) raises the same problems for the draftsman as reserving seats on an aircraft for a given flight for a travel agency.

This means that the draftsman must be provided with the possibility of interrogating, in real time, a connection file which gives him the occupation condition of the connectors or terminal blocks at all times, simultaneously for several draftsmen, with the additional facility of being able to reserve one or more contacts for the requirements of his wiring diagram of course.

This is provided by an interactive programme that operates permanently on alphanumerical terminals. This programme has eliminated a considerable number of registers which were necessary when this reservation was made manually, and the subsequent checking that was required to make these reservations official.

3.3.4 - Routing diagrams

The routing diagrams, which are drawn in perspective on the basis of the aircraft structure ("Shape" data bank) allow :

a) the loom weight and centre of gravity and wire lengths to be determined sufficiently accurately.

b) the Product Support department to be provided with a document that can be directly used for the WDM.

c) the exact runs of the looms in the aircraft to be defined, together with their bracketry, for installation on the aircraft.

This document, which is drawn up in close collaboration with the Systems and Production Planning departments, must also take mock-up data into account.

3.4 - Drawing up the lists

3.4.1 - Data processed

The main information required for the management of an electrics drawing file concerns cables, connections, equipment, drawings and applicability.

About 40 programmes input this data and issue file check lists or lists per applicability.

3.4.2 - Data acquisition

As we have seen in § 3.3.2, the wire data is input automatically on the basis of the wiring diagrams produced on CAD hardware. This could also be possible for equipment, but equipment data must be provided at an earlier stage. So apart from the wires, all data is input via a punching note which can be displayed on pre-formatted screens.

3.4.3 - Official documents

The official lists which are issued to all the departments who use the electrics drawing file concern equipment and diagrams only. Use of the G.I.C.E system has allowed the number of intermediate documents to be considerably reduced, in particular the higher assemblies which are mainly lists of drawings. It is the computer that directly provides the link between the definition document and the "aircraft" applicability.

These lists are issued per aircraft batch and per version. They can be provided as paper print-outs or on "microfiches" or magnetic tape.

3.4.4 - Domestic documents

As the official documents are not necessarily suited to the domestic requirements of the departments that use them, other documents are produced to solve their problem.

In general, all they do is present the same information in a different form or with special sorting.

Each department can thus ask for the document specific to its application. The redundancy or these documents does not constitute a problem as the data comes from an single source file and updating is performed only once on this file.

4. Liaison with the partners

Cooperation between several countries to perform such a precise task as the creation of an electrics drawing file requires very strict discipline and efficient liaison between each partner firm.

A sound organization must therefore be set up taking the computer facilities of each firm (which are usually different), and the type of data to be input into consideration.

As far as the AIRBUS aircraft are concerned, an electrics data bank called EMDB (Electrical Main Data Bank) is now being created. It will use all the data concerning these aircraft, whether it is for drawings or lists.

The compatibility of this data thus implies that the different data processing systems of each partner should be able to communicate. It is therefore necessary to define interfaces, upstream for the Design Offices and downstream for the Product Support department.

See fig. 2 on the following page

5. Future possibilities

Present technological developments in hardware and software make it possible to envisage for the near future, working assumptions which could never have been considered a few years ago.

We could, in fact, say that we are limited only by our imagination. As far as the "aircraft electrics drawing file compilation" application is concerned, the problem is twofold :

- to define an overall design method,

- to adapt the data processing tool.

5.1 - Overall design method

At the design stage, the objective is to reduce as much as possible the process between the intellectual activity of the engineer who defines a function and the output of the documents processing this function, by the computer.

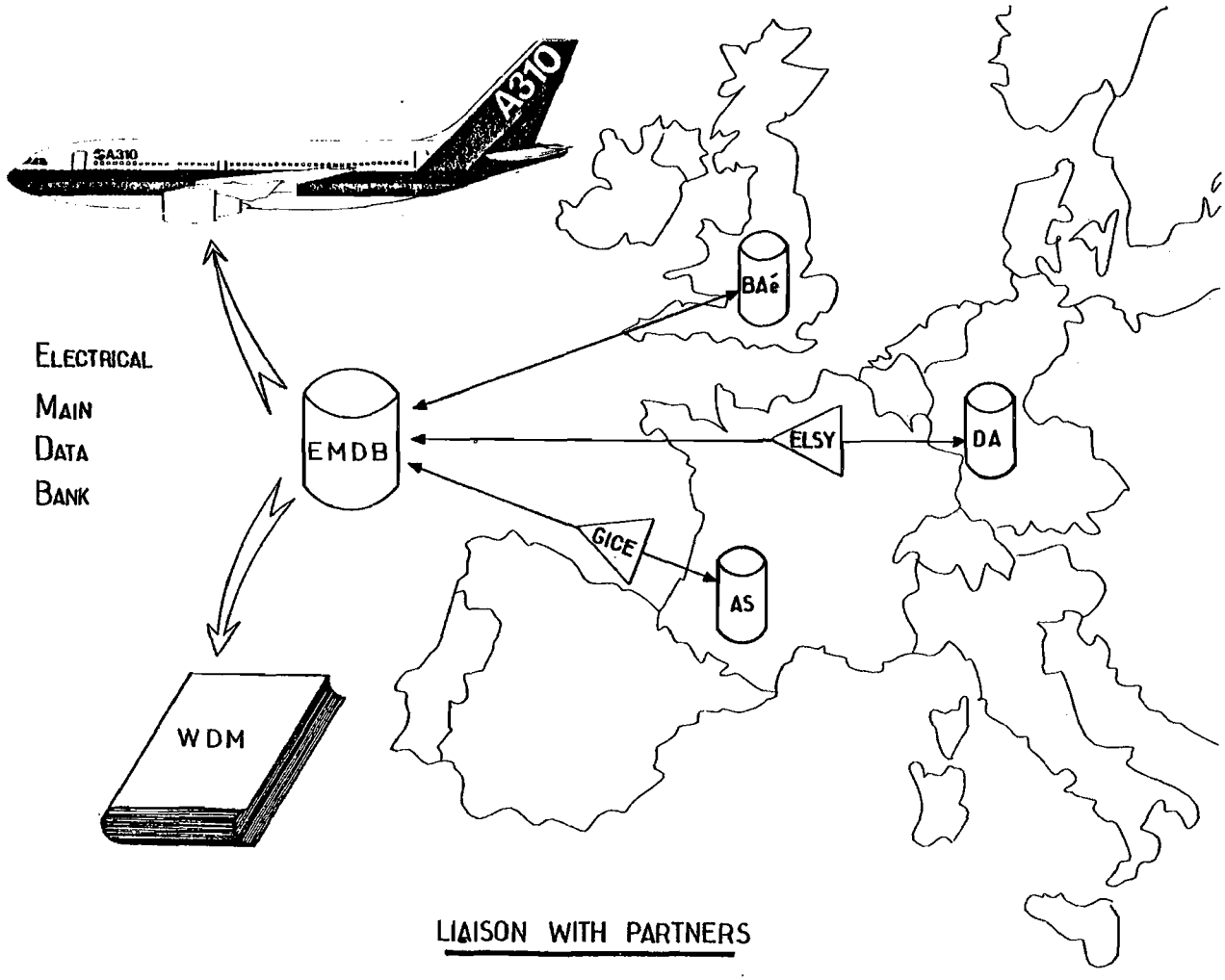


Figure 2

The ever-increasing use of data banks allows access to data which was previously impossible to acquire efficiently.

We can thus see that there will be more and more interaction between fields which were previously quite separate. For example, as far as electrics are concerned, one could envisage using the "shape" bank which defines the aircraft structure, to draw the electrical wiring looms in perspective and, by interaction with the schematic diagrams to obtain either an aid for direct compilation of the wiring diagram or, automatically, the list of cables without having to go through the "wiring diagram" phase.

See figure 3 on the following page

5.2 - Adaptation of the data processing tool

Technological developments in the field of graphic consoles allow us to hope that there will no longer be any serious problems once an overall compilation method has been established.

At the present time, graphic consoles raise two problems :

a) the screens are too small,

b) the quality of the picture is relatively bad.

In the same way as the draftsman works at his drawing board today, using documents arranged behind him on his desk, one can imagine that this data appears on one or more screens, and that there is an interactive link with a main file which would

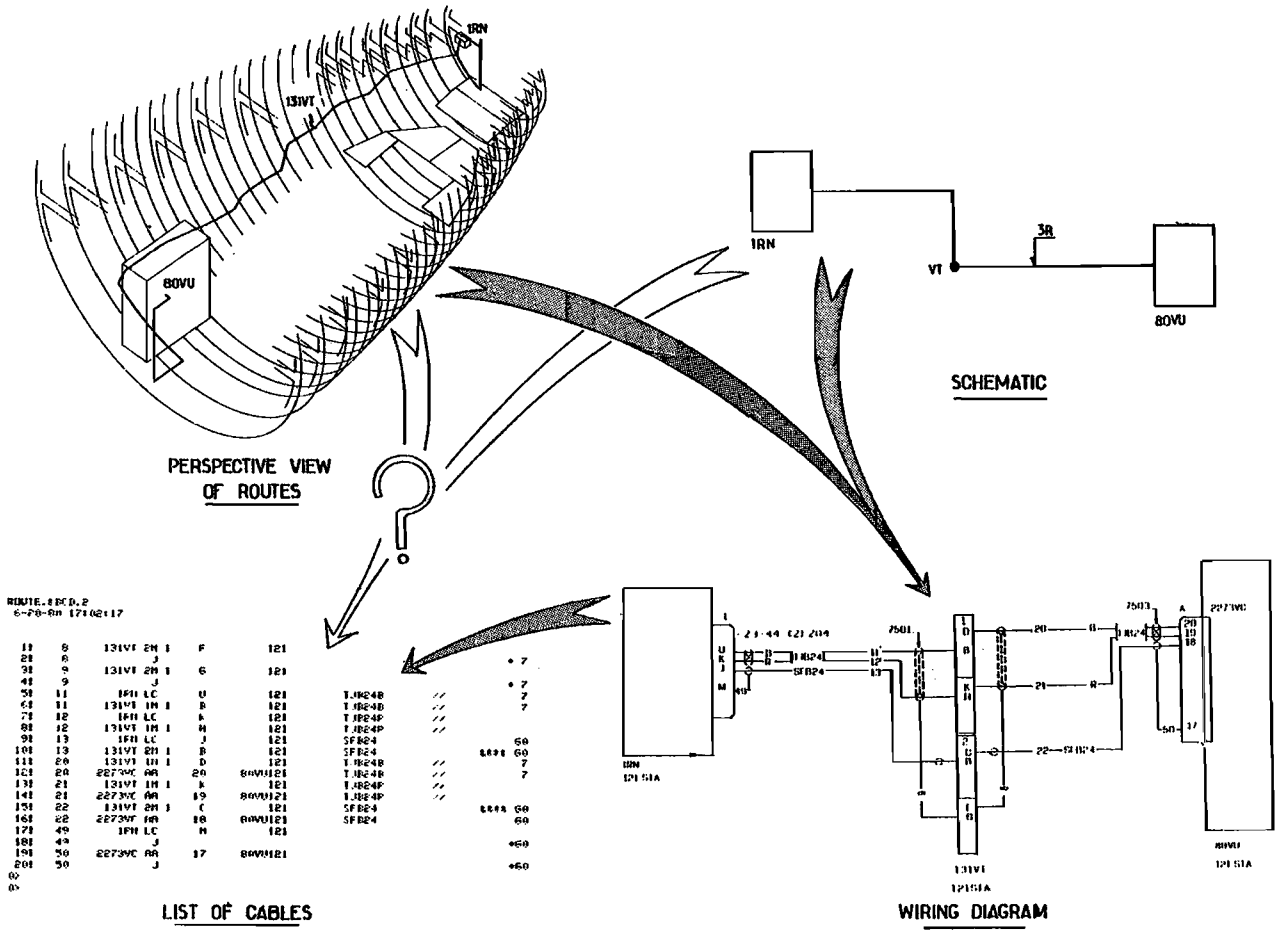


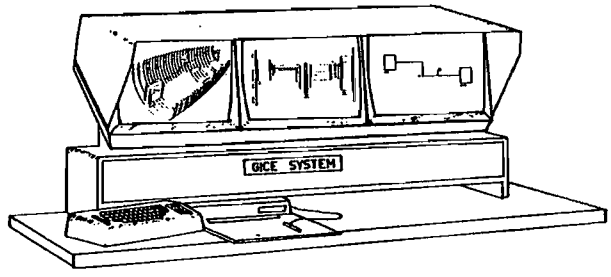
Figure 3

allow him to work globally on an "additional working screen".

The future working station could thus be 2 or 3 screens installed side by side, or only one large screen with several working "windows". The alphanumerical data could be listed at the bottom of the graphic screen or on a special terminal reserved for this purpose.

See figure 4

After being limited to a separate world reserved for the initiates, the data processing tool is therefore now becoming more and more integrated in the design stage, thus allowing optimum use of its possibilities.



Could the future working station look like this ?

Figure 4