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# INTEGRATED CAE-APPLICATION OF A CAD/CAM SYSTEM THROUGH THE EXTENSIVE USE OF INTERFACES

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## Abstract

The most important point in introducing complex CAD/CAM systems is their integration in the existing infrastructure of a company.
Dornier, a German aerospace company, has been using an interactive CAD/CAM system since 1980. Originally, the system was introduced in the design office. In the past years the applications of the system was extendet to almost all divisions. It was, however, necessary to extend CADAM for the various departments. This was achieved by making extensive use of batch and interactive interfaces.

Only if the data transfer between the participating departements is transparent and fluent can the application of a complex CAD/CAM system be successful.

## I. Introduction

In 1980 we started to use an interactive CAD/CAM system (CADAM) for design tasks as a pure 2D-system. The release current at that time had many restrictions. We still had to use our existing batch system for the more complex tasks (NC, 3D). This led to ever increasing interface problems: we often had to change programming systems within one task. Why couldn't and why cannot one CAD/CAM system completely solve the existing tasks? This is probably a company-specific problem. Every company has special applications, infrastructures and procedures to which a generally applicable CAD/CAM system cannot react.

Several possibilities exist for solving the problem:

1. You wait until the CAD/CAM system offers the desired capabilities.

2. You buy a second or third CAD/CAM system which may cover these capabilities. This creates, of course further interface problems.

3. You program the tasks yourselves and add them via the existing interfaces.

The utilization of this 3rd capability allowed us to use CADAM as the central system and, through consequent utilization of the interfaces, to integrate all areas within the company and to achieve a continuous data flow.



## II. Application of MACROs and Interfaces

Figure 1 shows the various applications in our company with CADAM as central system. All applications use special MACROs or are coupled via the batch interface. Let's have a closer look at the data flow and applications within a project:

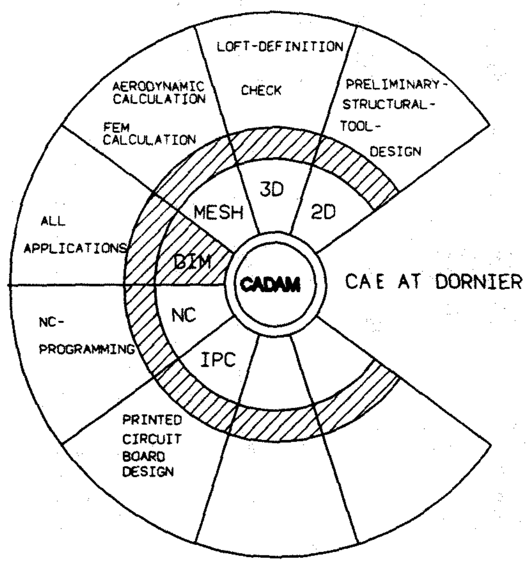


Figure 1

### 1. Preliminary Design

The aircraft design is carried out by the design division. The main dimensions are determined and calculations and configuration analyses performed. The result is a 2D-drawing of views which is stored in the data base for all departments involved (figure 2).

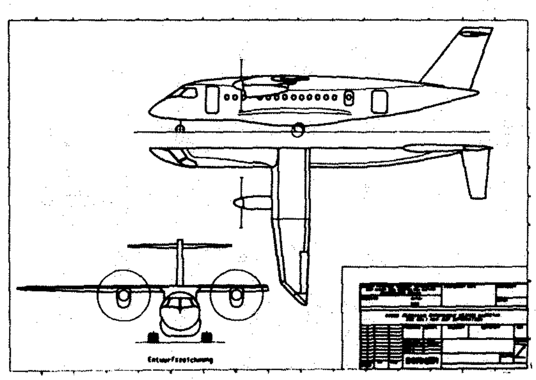

Figure 2

2. Lines Definition

On the basis of this data the surface is structured threedimensionally. Unfortunately, the standard system does not offer sufficient capabilities in this area, so that interactive MACROs which are programmed in-house are used. However, the standard capabilities, as for example WINDOW and SURFACE, are fully utilized.

The following MACROs are available, among others:

SPLINE manipulations:

- o Connection of several splines
- o New distribution of points
- o Comparison of two splines
- o Investigation of angle of vision
- o Addition of and difference between two splines
- o Display of tangents and coordinates of the definition points
- o Smoothing of 2D- and 3D-splines.

SURFACE definition:

- o Surface definition with 3D-splines
  The result is a wire frame model with splines of the third degree or bicubic patches.
- o Modification of the above mentioned surfaces
- o Computing of offset surfaces of the above mentioned surfaces
- o Field of vision computing.

The result is a smooth, three-dimensionally defined body. The model is the basis for all further applications. Via a MACRO, the body can be transferred to an E & S screen and represented as "shaded model". Surface unevenness can be determined through appropriate illumination effects (figure 3).

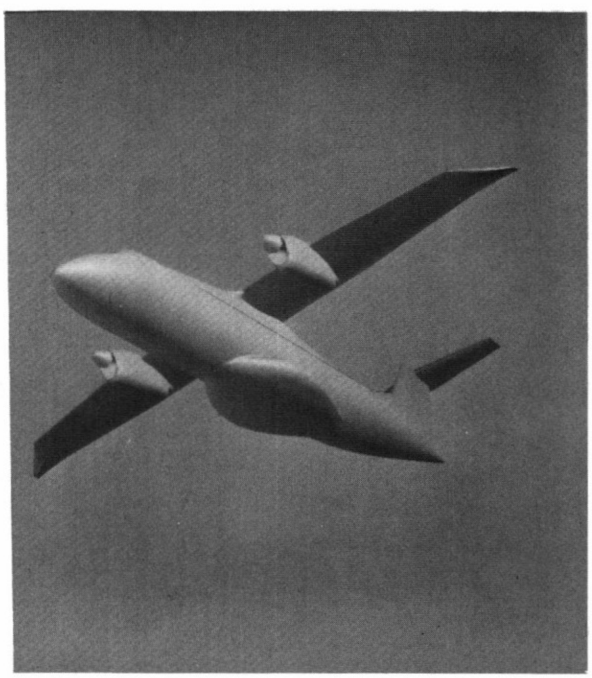

Figure 3

3. Aerodynamik

This 3D-model is divided into MESH elements using the "Panel" MACRO. This is performed automatically through definition of the longitudinal and cross section. The elements need no longer be structured individually. The result is an idealized structure of the surface. Via the batch interface, these MESH elements make up the input for an aerodynamics calculation program, which does not run under CADAM control. This program is very CPU-intensive and calculates the aerodynamik quality of the body. The result influences again, among others, the 3D-definition, so that the optimum shape is determined iteratively (figure 4).

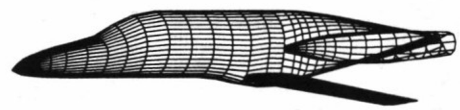

Figure 4

4. FEM Calculations

As in aerodynamics an idealized structure is processed from the 3D-model under FEM aspects. The actual CPU-intensive calculation is performed via the batch interface again in a special FEM calculation program.

5. Design

For loft-dependent parts, the design takes over the contour as intersection in 2-dimensional form and creates the design drawing. In the Airbus A320 project all drawings are created with the CAD/CAM system (mechanic, electric and hydraulic drawings).
The full standard library helps to save time. The normal access method via part number, find number and detail number requires, however, an extra catalog and is therefore troublesome. We use a Macro for searching for standard parts, the macro operates in conversational mode and leads to the searched for part via graphic and numeric search arguments. The parts themselves are stored in the normal STDLIB, so that both systems can be used in parallel. Fillling in the parts list is still a tedious problem for the designer. The input with the IMS system used by us is very laborious. Presently we are experimenting with a Macro-controlled CADAM-input list in which cross references to the standard library and attributes are allocated. This list is passed to the IMS parts list system via an interface.

The release of computer-generated drawings represents a further problem. Because only one original exists for conventional paper drawings, the data models can be copied and plotted at will, unless restrictions are incorporated. During the transition from the information status to released status several modifications of the model must be performed: modify status, set pass words, modify frame and title block, update change note, position signatures. When performed manually on the screen, up to 15 minutes per drawing were required for these steps. Through the use of a macro it was possible to reduce this time to 3 minutes. At the same time, errors are avoided and the signatures checked for acceptability.

## 6. Tool Design

The tool drawing is directly derived with the same system from the drawing. This results in a high degree of rationalization. Otherwise the same applies as for the generation of the design drawings.

## 7. NC Programming

With the current NC function two to two and a half dimensional parts can be developed directly from the design drawing. In order to program complex surfaces, we developed a special NC macro which also allows to machine five axes of the surfaces with the face of the milling cutter. Various types of milling cutters are also admissible here (figure 5).

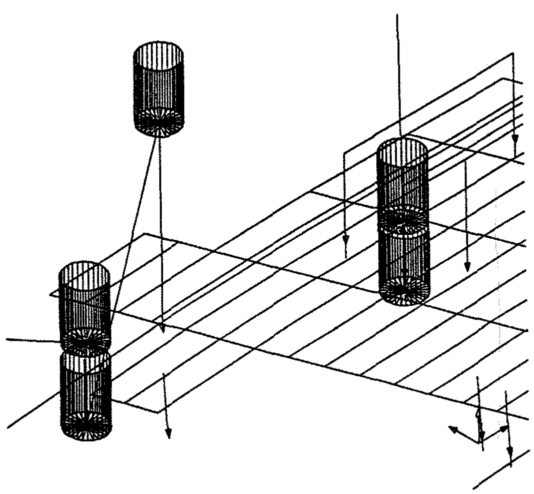

Figure 5

In parallel, the NC system APT 140, which is a follow-on of the known APT by British Aerospace, is utilized for complex parts. The connection is performed via the APT-NC interface.

## 8. Check

Numerically controlled measuring machines require 3D-points with normal vectors for checking 3D-contours. A macro generates this data automatically from selected points and starts jobs which transfer this data to the NC-controlled measuring machine. Prerequisite is, of course, the original CAD/CAM 3D-model.

## 9. Parametric Design

The PARAMETRIC DESIGN macro was created in order to create graphically interactive parameterized drawings. Programming knowledge is not necessary.

# III. Interfaces between several CAD/CAM systems

Unfortunately, our system is not the only CAD/CAM system on the market. But we have any cooperation in numerous international programs and any companies has different systems. This results in considerable interface problems. Now any thoughts about interfaces.

## 1. Fundamental possibilities

### 1.1 Direct Interface of System A to System B

This programs are specially tailored to the two systems.

Advantages:
- easy to handle
- maximum transfer
- tailored
- fewer error sources

Disadvantages:
- many interfaces for more systems
- possibly, the interface must be generated first of all (not available)

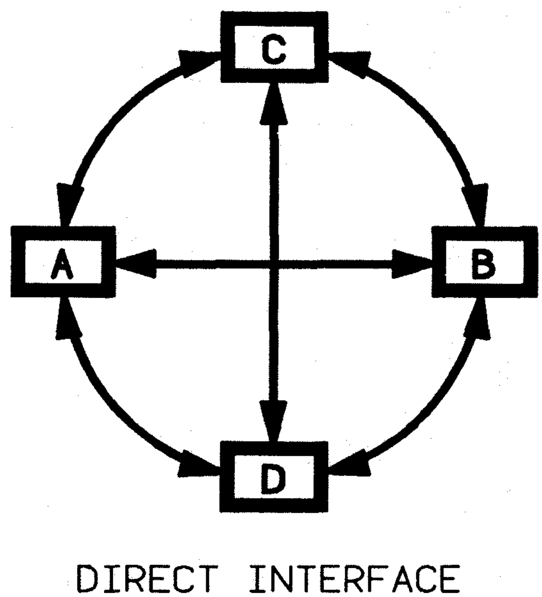


Figure 6. Direct interface

### 1.2. Systems-Neutral Interface

A neutral format will be defined here which must be generated and/or taken over by the system producers via so-called preprocessors and post-processors.

Examples: VDAFS, IGES, SET

Advantages:
- small number of interfaces
- one interface will be probably available for the introduced systems
- it is not necessary to install the second system

Disadvantages:
- only defined elements can be transferred
- rigid data format
- few intervention possibilities
- high calculating times and high storage requirements
- many error sources

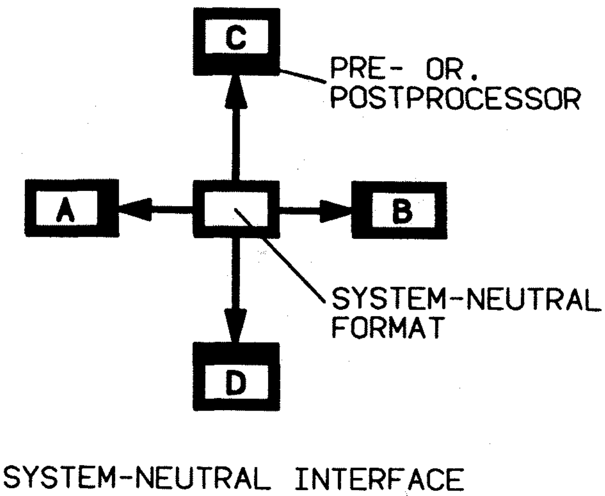


Figure 7. System-Neutral Interface

There will allways be a certain data loss for all these possibilities.
For this reason it is necessary to install both systems or to submit the paper drawings in addition.

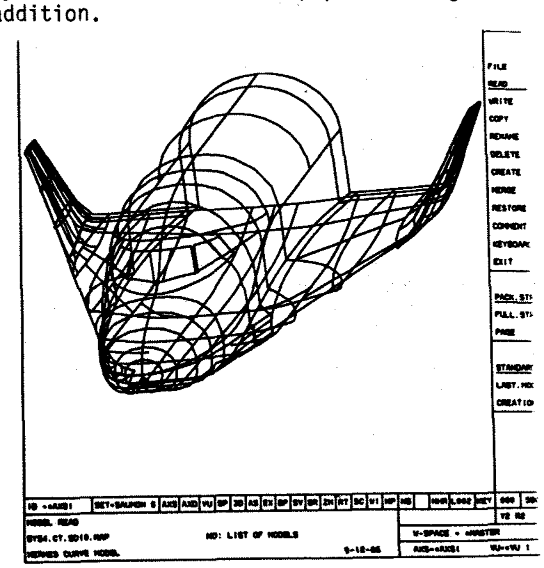

Figure 8. Example for VDAFS

## IV. Summary

Within one company one should avoid, if possible, the use of several CAD/CAM systems. However, this is only possible if the system can be tailored to company-specific requirements and all applications integrated. This requires some prerequisites: a uniform programming language (FORTRAN in this case), a computer network, no isolated solutions and the will of all participants to accept disadvantages in comparison to a customized isolated solution if a generally better data flow provides advantages for the whole company.