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West Europe Report

SCIENCE AND TECHNOLOGY

(FOUO 6/81)

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CONTENTS

INDUSTRIAL TECHNOLOGY

USE OF CAD/CAM REPORTED AT INTERNATIONAL CONGRESS

Paris AIR & COSMOS in French 18 Apr 81 pp 20-21

[Article: "Extraordinary Development of CFAO"]

[Excerpt] The annual international congress of CAM-I (Computer Aided Manufacturing International, Inc) was held this year from 7 to 9 April in Cannes, France; the organization's name reflects its concern with CFAO [Computer-Assisted Design and Fabrication] techniques.

Although it did not contribute anything very new to the field, this congress unquestionably attested to the importance being gained by CFAO in several industrial sectors, foremost among which appear to be automobiles, aerospace, and electronics.

During three days, about 200 people heard some twenty presentations of high technical caliber, among which about ten, or roughly half, concerned the aerospace field to a greater or lesser extent. In addition to many industrialists, the participants included ADEPA [Agency for the Development of Automated Production], CFAO systems manufacturers, academics, and members of research institutes. While the principal aim of the congress was to assess the progress of CFAO among a certain number of American, Japanese, and European enterprises, there was noticeable concern on the part of several participants regarding personnel training and upgrading, as well as the changes in organization which are inevitable due to the development of CFAO. Others also raised the question of discontinuity which sometimes appears to exist between the design of a product and its actual computer-assisted fabrication.

The companies most advanced in terms of CFAO all began to get equipped in the 1970's and to apply this technique to fields of their choosing. It became clear that after several years of experiments, which were successful in most cases, the companies are now convinced that CFAO is profitable, at least in technical terms, and they are preparing to expand its field of activity. The two improvements most often mentioned concern the technical quality of products and the time required for their design.

CAM-I, which organized the event, is a non-profit Texas company which in fact belongs to an international association aiming to pool resources and coordinate efforts for CFAO development. Established in 1972, CAM-I now has 80 member organizations from various sectors, including about 30 from Europe and six from Japan. In aeronautics, the main American manufacturers are naturally included: Boeing, Lockhheed, and McDonnell Douglas. So are the European ones: Aerospatiale, MBB, Rolls-Royce, Saab-Scania, and Valmet Oy (Dassault-Breguet is not yet a member of CAM-I). Its activities, regulated by an elected administrative board, fall in three categories, each corresponding to a special function: technology, standardization, and training. A company may be admitted if it is accepted by the directors and if it subscribes 7000 dollars annually.

The papers read at the congress fell in four main categories:

Assistance at the national level for CFAO development; notable were the United States Air Force and the ADEPA presentations;

Industrial experience (MBB, SNIAS [National Industrial Aerospace Company], Boeing, Ferranti);

Industry and education (University of Bordeaux, British institute of Cranfield);

Examples of applications in Japan and the United States (General Dynamics).

We of course cannot describe all the presentations here, but we have singled out three of them for their exclusively aeronautic content: those of the SNIAS Helicopter Division, of MBB, and of Boeing.

CAO in Marignane/SNIAS

In 1972 the SNIAS organization in Marignane began a serious study of CAO/FAO techniques on two fundamental premises: continuity between design and manufacture, which is the essential condition for the success of the system; and a strict definition of human and machine functions, in terms of their respective potential. The SNIAS Helicopter Division then proceeded to apply these techniques to three situations: design and drawing of transmissions; then, of simple structures; and finally, of three-dimensional complex structures.

In the first instance, the division noted a considerable reduction in the time elapsed for each project, as well as in costs (up to seven times less).

Applied CAO for simple elements uses the CADAM system (Computer Graphics-Augmented Design and Manufacturing) developed by Lockheed and marketed by IBM. After starting in 1979 with one console, the Marignane establishment now has eighteen of them. Two weeks are needed to train an operator who becomes fully operational within three months.

CFAO applied to complex shapes uses the Systrid 1 system which SNIAS has been improving since 1978 in collaboration with the Battelle Institute of Geneva. This system is actually used for external helicopter parts made of composite materials (blades, air intakes, fairings, and so on), as well as their molds. The system has been operational since 1976 and makes it possible to perform several modifications during the design phase. SNIAS emphasizes the fact that these complex shapes can now be classified according to their equations, thanks to this type of system.

Among the SNIAS projects is the extension of CAO to the development of electrical circuits (this project has in fact been instituted at the Toulouse Airplane Division), and the establishment of a central data bank.

MBB

For its part, MBB has also begun to use CFAO techniques in 1970 in the following fields: aerodynamics, structural analysis, diagrams and estimates, and numerical control machines. In 1978 the German firm felt a need to acquire a general interactive graphic system: once again, the CADAM system was the one chosen. After two years, there are 60 screens being used by 400 people. Productivity rate increase has been evaluated at 4.8 percent and the system makes it possible to transfer data among various groups: studies, design, manufacturing shops, and finished component inspection.

11,023
CSO: 3102/259

INDUSTRIAL TECHNOLOGY

GROWING USE OF FORGED COMPONENTS IN AERONAUTICS

Paris AIR & COSMOS in French 18 Apr 81 pp 23-24

[Article by Gerard Collin]

[Text] The aerospace industry is known for the shavings it makes: it is not unusual to remove 90 percent of a sheet of metal through machining in order to reach the dimensions of the wanted part. Faced with a technique which may be considered wasteful as well as costly, forging is making progress. It provides a more direct approach to the final outlines of the part and also preserves the metal's natural grain.

Alignment "Ingrained" in Forgers

In very simple terms, it can be said that a forged part is "aligned" in a preferred direction, along which the bonds between atoms are stronger. The material then has superior mechanical characteristics along this axis. In order to take advantage of this, plane designers specify an alignment orientation so that during tooling or forging, this optimum orientation will be aligned with maximum stresses. Forging or stamping operations establish the grain of the part and orient it according to the shape of the part. Forgers thus feel they endow the aeronautical parts with mechanical characteristics which are superior to those of tooled pieces of equal mass, to the extent that tooling breaks the grain lines.

Very Large Investments

But it is also true that forging requires very large investments because of the press itself, foundation structures, tooling dies, and preheating ovens. Moreover, the forging or stamping operation is fully profitable only if the part produced is very close to the final dimensions. Otherwise, machining remains significant. Generally, the stamping seems fully justified for mass production, when it becomes "precision stamping" with ratios of delivered to machined weight ranging from 1.2 to 1.5. It then requires even larger investments but these can be justified provided the numbers produced become significantly large. This is indeed the present case, with the Airbus family and the CFM-56, and it has been the case for a long time at Boeing which strongly believes in forging.

French Aeronautic Forging: in Second Place

In this context, forgers currently are in a favorable period; they are increasingly in demand; they can depend on programs (Airbus, CFM-56) with fast production rates; and they have access to large machines, including the 65,000 ton press at Issoire (the United States has "only" 50.000 ton forges). By way of example, Forgeal was furnishing 11 tons of rough parts for the A 300 and 20 tons for the A 310!

This accounts for this growing role on the French aerospace market, then on the European market, and even the American one, notably Boeing and General Electric. According to statistics we have seen, the world market (excluding the Eastern block) for aluminum and light alloys is estimated at 85,000 tons, of which 60,000 tons in the United States. Of this 85,000 ton total, aeronautics accounts for two-thirds: aluminum forging has in fact developed along with aeronautics.

After the United States comes Germany with a tonnage of 13,000 t, of which only about 1200 t is for aeronautics.

French forging amounts to over 4500 t (SNECMA [National Aircraft Engine Study and Manufacturing] is not known and thus not included here), of which over 50 percent is for aeronautics. This percentage is increasing, as a matter of fact, thus placing French forgers easily in second place in the worldwide aerospace field.

Great Britain seems to be receding (2000 t total). Italy is another country which is even more out of the picture.

In terms of corporations, the aeronautic forging market (still for light alloys) is dominated by the American biggies: Wyman Gordon, Alcoa, Kaiser, Martin Marietta. Then comes Forgeal (PUK [Pechiney-Ugine-Kuhlman Company] group) with 2200 t, producing about half the light alloy tonnage in France. Next in France are Creusot Loire (1200 t), Forges de Bologne (600 t), then in no specific order Tuillier Minel, Bar Lorforge, Forgeavia, Forges Stephanoises, and Forges de Bourthe, to which, for the sake of completeness, we should add SNECMA and Aubert et Duval, the latter being more specialized in steel or even titanium. Mention should also be made of companies such as Creuzet in Marmande, specializing in precision stamping.

Forgeal and Creusot Loire

Forgeal and Creusot Loire thus provide the bulk of French light alloy aeronautic production, which often puts them in competition--and also in association--through the intermediary of Interforge, for the Issoire 65,000 t press (as well as with SNECMA and Aubert et Duval), in addition to GIE Air Forge (see AIR & COSMOS No 840, p 50).

Forgeal exports about 50 percent of its production, first to Great Britain (25 percent), then to FRG (6 percent) and the United States (3 to 5 percent). Forgeal's main customers, listed in no special order, are British Aerospace, Dassault, Rolls Royce, SEP [European Propellant Co.], SNIAS [National Industrial Aerospace Company], Turbomeca. In the United States, Forgeal has been a supplier for General Electric for 5 years, and more recently for Boeing. For the B 767, Forgeal sells directly to Boeing through GIE Air Forge, or else indirectly via Aeritalia and Dowty.

Creusot Loire uses the same approach, notably supplying half of GE's requirements for gas turbines, also Boeing.

This attack on the North American market is based both on national capabilities and industrial means, and also, it must be said, on the American suppliers' saturation risks, leading the United States industry to diversify its sources and logically doing this in France first. For Forgeal, this 50 percent exportation not only does not hurt French or European programs, as can be seen from the fact that Forgeal--like Creusot Loire--is already on a production schedule of 6 to 8 Airbuses per month. In addition, the bulk of the exportation goes to cooperation programs. Finally, this exporting makes it possible, according to the spokesmen of these companies, to enhance their expertise by a direct onslaught on the American market which is a source of competitiveness.

The French forging industry thus has the Issoire 65,000 t press, a 20,000 t press at Creusot Loire (Pamiers), and a second one at Forgeal (Issoire); these three presses are commercially used for light alloys and titanium by Air Forge (in connection with the aeronautical stamping only).

Forgeal will soon acquire a new 20,000 t press to be placed in operation in 1981. At Creusot Loire it is also expected that increased demand for aeronautic forging will lead not so much to high power as to medium power linked with advanced processes (such as higher temperatures).

PUK and Aeronautics

The Pechiney Ugine Kuhlman group in 1980 reached a consolidated volume of business of about 38 billion francs. The share of activity devoted to the aerospace sector is estimated at about 5 percent or over two billion francs in 1980, placing PUK at the very forefront of French aerospace suppliers (not including equipment suppliers).

However, this share is fairly difficult to specify because there are no less than about 30 companies in the PUK group which are supplying the aerospace industry.

The first among these is well known: it is Howmet (HTC = Hownet Turbine Components), a 100 percent American affiliate of PUK, doing a business volume of nearly one billion francs. They are the foremost world specialists (along with TRW) for super-alloy turbine blades, and in this capacity they equip most of civilian and military aircraft. The group's second aerospace company is Cegedur Pechiney, with 6000 employees and a share of 8 to 10 percent of activity in aeronautics, or about 300 to 400 million francs per year. Next is Forgeal with 175 million francs business volume for 1980 (for 500 people), producing aluminum and titanium alloy parts, of which 80 percent for aeronautics and the rest for weapons (20 percent of this total is sold through GIE Air Forge).

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TRANSPORTATION

CASA, NURTANIO ANNOUNCE CHARACTERISTICS OF CN-235

Paris AIR & COSMOS in French 16 May 81 pp 15-17

[Article by Jacques Morisset: "CASA and Nurtanio Announced the Characteristics and Performance of the CN-235 at Madrid on 7 May"]

[Text] At last, on Thursday, 7 May, CASA and the Indonesian firm, Nurtanio, held a press conference (announced last March: see AIR & COSMOS No 853) related to the future CN-235 twin turboprop principally intended for regional airlines and which is being developed by a joint subsidiary, Airtech.

Airtech, whose headquarters are in Madrid, is thus a company organized under Spanish law; it is the instrument chosen to control development and fabrication, on a 50-50 basis, of the CN-235. The investment required is estimated at about $80 million. Equality of the two companies is being maintained to a very high degree since two assembly lines are planned, one at Getafe (the Madrid area establishment of CASA) and the other at Bandoung, third largest city in the Republic of Indonesia, located south of the capital, Djakarta. Two flight prototypes will be assembled simultaneously in those two establishments and will fly on the same day (supposedly in October 1983). As for single-source studies and fabrications, they will indeed be equally divided between the two companies, CASA being responsible for the central fuselage, the central portion of the wing, and the cockpit while Nurtanio will devote itself to the wing tips, the rear portion of the fuselage, and stabilizers.

There is no doubt at all of the two manufacturers' determination: the success of the CASA-212 "Aviocar" (see AIR & COSMOS No 853), of which 256 models, also manufactured by Nurtanio under license, have already been sold, the excellent cooperation existing between the two companies, the obvious worldwide need for an airplane of 30 to 40 seats, and the knowledge of the marketplace which they now possess can only incite CASA and Nurtanio to push their cooperation further forward and to develop jointly a new airplane adapted to their manufacturing capabilities. Airtech was established by virtue of a basic agreement signed in October 1979 and from all evidence the two manufacturers are resolved to go forward.

The new project, now very much advanced, was presented on the Spanish side by Enrique de Guzman, president of CASA, Carlos Marin, executive vice president of CASA and vice president of Airtech, Pablo de Bergia, sales director, Jose Luis Lopez-Ruiz, technical director, and Alberto Elvira, program director; on the

Indonesian side by Sutadi Suparlan, production manager, and Prof O. Diran, project director. Last, the presence of a General Electric representative, James Neye, was noted; it must be remembered that the airplane is to be equipped with two Model CT7-7 turbine engines of 1,700 shaft horsepower.

The characteristics chosen for the CN-235 result obviously from both the existence of the CASA-212 (20 to 26 seats), with which it is not a question of competing, but rather a question of backing it up with a natural extension, and from market studies which allow forecasts of a worldwide civil market, over 10 years, of about 1,800 airplanes, to which must be added 600 military transport aircraft. Airtech believes that it can sell about 600 CN-235 airplanes, 300 of them for civil uses, which is an extremely reasonable ambition.

The CN-235 specifications were established last year and constitute a compromise among the various requirements for an airplane which is to be capable of use everywhere: simplicity, ruggedness, adaptation to highly varied uses (passenger and/or cargo transport); capability of operation from improvised airports on the one hand, and economy of operation, good efficiency, and comfort on the other hand. With this backdrop, a selling price now estimated at $100,000 per seat, or more precisely, $3.85 million (1981).

Like De Havilland for its future "Dash 8" and Aerospatiale/Aeritalia for their ATR-42 project, CASA and Nurtanio have chosen the four abreast seat arrangement, a solution which provides two advantages: increased comfort (height below the ceiling and baggage rack volume) and the possibility of going to 40 to 50 seats with a lengthened fuselage; moreover, Airtech has not only not excluded that eventuality but is expressly predicting it with future CT7 engines capable of delivering up to 2,400 shaft horsepower. The payload (cargo) now fixed at 4.5 tons will then certainly exceed 5 tons.

For the rest the airplane is highly conventional, it being understood, however, that:

It is a good bet that advanced techniques will be used whenever it seems reasonable; such could be the case, for example, with secondary structures (rudders and flaps) constructed of composite materials: CASA has already gained some experience in this area and Boeing has not hesitated to assign to it the fabrication of external flaps of carbon fibers for the B-757;

the cabin is pressurized but to a moderate level: 3.58 psi [pounds per square inch] or 0.25 kg/cm^2 [kilograms per square centimeter]; this pressure differential corresponds to establishing cabin altitude of 8,000 feet (2,400 meters) for an airplane flying at 18,000 feet (5,500 meters). The advantage of moderate pressurization: structural weight saving; the disadvantage: it poorly adapts cruising flight altitude greater than 18,000 feet to desirable passenger comfort. But does a commuter airplane need to fly at a higher altitude?

the aft part of the fuselage is designed, a priori, to house an axial loading ramp: the same basic structure will therefore be used for the "passenger" and "cargo" (civil or military) versions. In principle this deliberate choice, easily understandable for manufacturing reasons, penalizes the "passenger" version for a structure of this type is a little heavier since it must transmit the torsion stresses induced by the stabilizers through a smaller fuselage section, but specifically, the choice of a moderate pressurization level more or less compensates this disadvantage by virtue of the weight saving it confers;

the fuselage cross section adopted is practically the same as that of the ATR-42 and also similar in shape (flat bottom); it is, in contrast, somewhat greater than that of the DHC-8; particular pains have been devoted to the possibility of rapid changeover to the cargo configuration and vice versa; and

the landing gear will permit the use of makeshift airfields; its general design is CASA's but the manufacturer has not yet been selected from among the companies solicited (including Messier-Hispano-Bugatti).

Schedule

The development schedule announced for the CN-235 is as follows:

1980--general studies, project definition, fixing the main characteristics;

1981--detail studies, tests corresponding to the development phase;

May 1982--manufacture begins;

March-April 1983--assembly of fuselages;

July 1983--final assembly;

1 September 1983--off the line

September 1983--functional tests of systems;

October 1983--first flight of the two prototypes;

Second quarter of 1984--delivery of model certificate (FAR Part 25 and Part 36, ICAO Supplement 16)

In the meantime two airframes will have been built and used for static tests (in Spain) and fatigue tests (in Indonesia). The airframe is being studied for a service life of 50,000 hours.

The first deliveries will be made in the end of 1984 when airworthiness certificates are obtained; marketing of the CN-235 will be done in accordance with a regional plan which has already assigned Asia to Nurtanio and Europe and America (through the American distributor, American Casa Distributor, Inc.) to CASA. The planned production rate is eight airplanes per month (four in Spain and four in Indonesia). A system of financial aid to purchasers will in the meantime have been instituted.

CASA estimates the break-even point of the operation will have been reached at about the 350th airplane. Although the development of the CN-235 is in a civil context the Spanish air force is being "kept up to date." As a matter of fact CASA indeed hopes that the latter, which has already formally contributed to the start up of the C-212 program, will also purchase CN-235 airplanes. The same reasoning applies equally well in Indonesia.

The principal competitors of the future airplane will obviously be the Shorts 360, the DHC-8, and the ATR-42, if it gets underway. CASA (with Nurtanio) is counting upon its experience, the excellent adaptation of the product to the market, and the synergy which will result from the association of the two countries to penetrate the market vigorously, including North America (where the C-212 has achieved a remarkable penetration); the success of the "Aviocar" makes the CN-235 operation completely credible.

Let us add that, quite like Aerospatiale and Aeritalia with the ATR-42, Airtech is in fact aiming at the still larger market for airplanes of 30 to 50 seats, thanks to the future lengthened version of the CN-235, which will provide up to 50 seats, a market which is also that of the British Aerospace 748, DHC-7, and Fokker-27 "Friendship." In adopting a fuselage wide enough to accommodate four passengers abreast Airtech certainly made the right move.

The CN-235 at a Glance

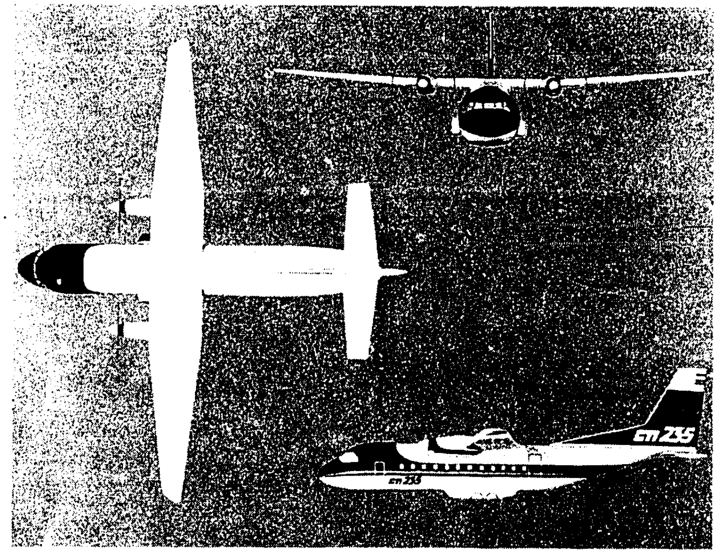
Span: 25.8 meters; overall length; 21.3 meters; wing surface: 54 square meters; overall height: 7.9 meters; interior fuselage width: 2.7 meters; floor width: 2.36 meters; cabin volume: 42 cubic meters; landing gear track: 3.5 meters; transport capacity: 30 passengers (spaced 38 inches apart) or 34 passengers (spaced 32 inches apart), or four LD-3 containers, or five LD-2 containers; maximum weight at take-off: 13,000 kg; maximum weight at landing: 12,800 kg; zero fuel weight: 11,809 kg; maximum payload (cargo): 4,500 kg; fuel weight (maximum): 4,000 kg.

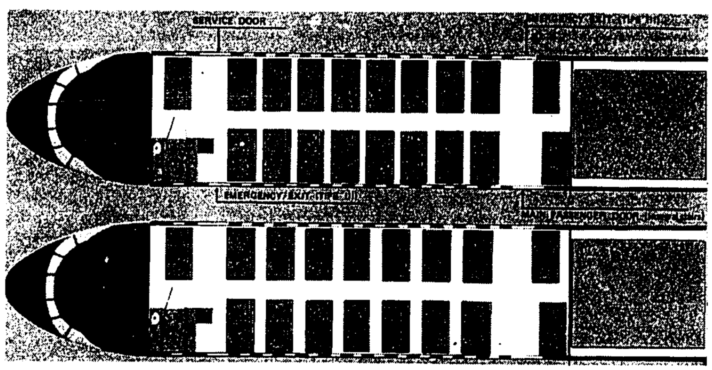
Calculated performance at maximum weight with two General Electric CT7-7 turbine engines of 1,700 shaft horsepower up to 30°C driving four-blade propellers at 1,384 revolutions per minute: take-off distance with 35-foot obstacle clearance: 900 meters; landing distance after 50-foot obstacle clearance: 600 meters; initial rate of climb: 11 meters per second with two engines, 3.2 meters per second with one engine; service ceiling under ISA conditions: 29,000 feet (8,850 meters) or 13,000 feet (3,965 meters) on one engine; maximum cruising speed: 250 knots (469 km per hour).

The CN-235, with reserves for 45 minutes of flight and diversion of 160 km can fly, cruising at 20,000 feet: about 1,000 km with 38 passengers (38 x 90 kg), 1,450 km with 34 passengers, and 3,700 km with reduced payload of 1.3 tons.

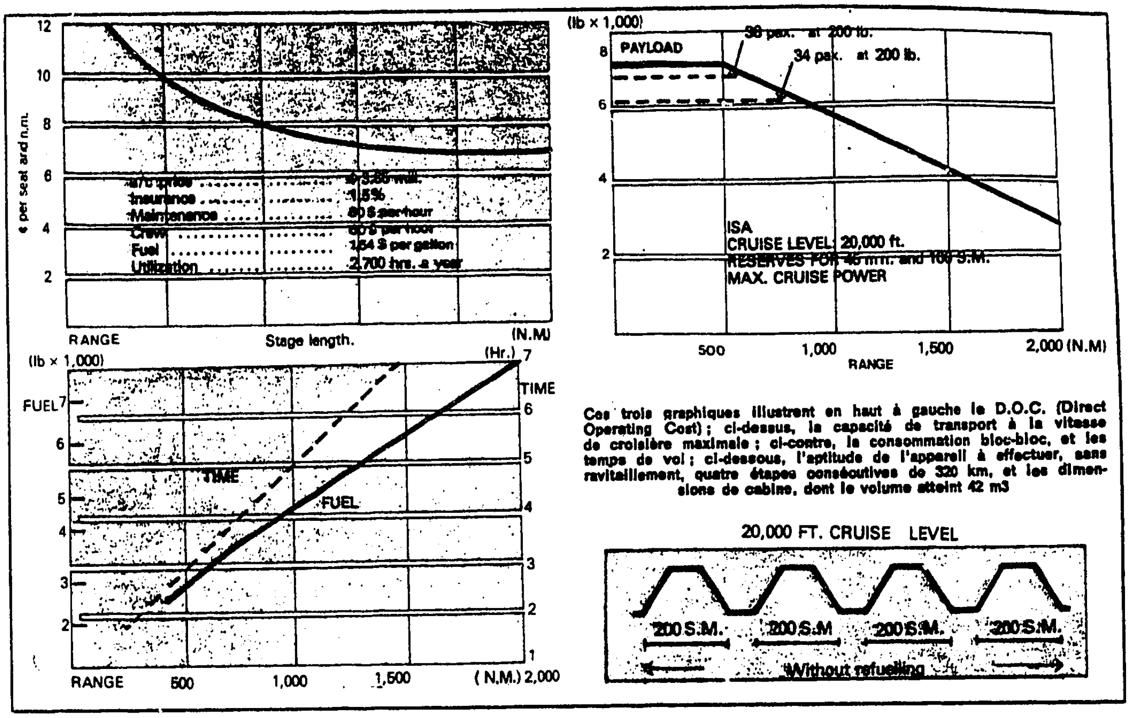
Nurtanio Expanding

The Nurtanio company, the majority of whose stock is owned by the Indonesian state, is assembling BO-105 and SA-330 "Puma" helicopters and manufacturing the C-212 "Aviocar" under license from CASA; 68 aircraft of this model have gone into production, 34 of which have been delivered.

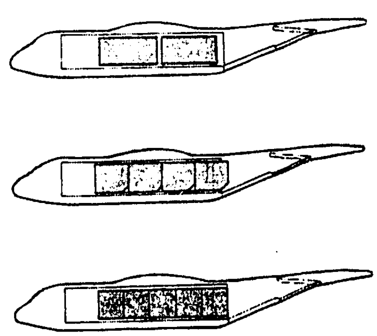




Proposed arrangements of 38 passengers (spaced 30 inches apart) and of 34 passengers (spaced 32 inches apart). The height of the center aisle is 1.90 meters: the aft compartment provides volume of 7 cubic meters.



These three graphs show: upper left, the DOC (direct operating cost); above, transport capacity at maximum cruising speed; and opposite, the total fuel consumption and flight time. Below, the capability of the airplane to fly four consecutive legs of 320 km without refueling, and capacity of the cabin whose volume is 42 cubic meters.



The CN-235 will be capable of transporting two 2.23-meter palettes, or four LD-3 containers, or five LD-2 containers.

The company is in full bloom: its employees now number 3,400; the number should reach 10,000 during the second half of this decade.

The test and research installations are also growing very rapidly. In particular, a fatigue test shop and wind tunnel have been started.

The president of Nurtanio is Prof B. J. Habibie, who is also Indonesian Minister of Research. Cooperation with CASA began in 1975.

The CASA-212 "Aviocar"

The CASA-212 "Aviocar" is continuing its career with vigor; at the beginning of May 256 airplanes of this model have been on firm order by 24 countries, to which must be added 25 to 30 options. More than 180 airplanes have come off the assembly line in Seville, the production rate now being 4 airplanes per month (it is going to increase to 5) at Seville and 2 at Bandoung. Selling price: 2.1 to 2.2 million dollars. The airplanes being manufactured at present are C-212-200, equipped with Garrett TPE-10-501C turbine engines of 900 shaft horsepower. The next airplane to be delivered to the United States is the C-212-200 No 181, which will reach America by the northern route; to accomplish this it is temporarily fitted with two supplementary cabin tanks with capacity of 2 x 750 liters; the capability of the airplane thus attains 10 hours of flight.

Notable is the penetration of the "Aviocar" in North America: more than 30 have been placed there in 18 months by American Casa Distributor, Inc.

The break-even point of this program is estimated at 360 airplanes.

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TRANSPORTATION

FINDINGS OF TESTS ON PORSCHE M-15 FUELED ENGINES

Stuttgart MTZ MOTORTECHNISCHE ZEITSCHRIFT in German Apr 81 pp 133-137

[Article by Dusan O. Gruden and Guenther Hoechsmann: "Operational Characteristics of the Thermodynamically Optimized Porsche (TOP) 924 Engine Using M-15 Fuel"]

[Excerpts] Under the research program funded by the BMFT [Ministry for Research and Technology] "Alternative Energies for Transportation" Porsche built 10 924 cars equipped with 4-cylinder TOP engines (thermodynamically optimized Porsche engine), which are designed to run on M-15 fuel. In order to be able to run the engine on premium gasoline if need be, a second ignition timing characteristic is stored in the fully electronic ignition system. Legal requirements for exhaust gas emissions are met with both types of fuel, while retaining good driveability and fuel economy.

1. Introduction

Under the research program supported by the BMFT "Alternative Energies for Transportation" (1) the Porsche company is participating in the subprogram "Methanol Fuels" with 10 of its 924 cars, which are designed for operation on M-15 fuel.

The following considerations formed a basis for the selection of the experimental medium: fuels containing alcohol are practically unavailable on the market and will become important only in the future. Therefore it did not seem sensible to test traditional engines, which are designed for conventional fuels, with fuels of the future. All over the world a new generation of engines is being built, which are being designed for the stricter requirements of the future. Porsche is also working intensively on the continued development of the piston engine (2-6). One of these developments is represented by the thermodynamically optimized Porsche engine (TOP), which can show a clear reduction in fuel consumption, compared with conventional engines, and also an improvement in the quality of the exhaust gases (6). This variation on the gasoline engine is seen as a true alternative for the future. The decision was therefore made to integrate the new future-oriented engine with the new fuel of the future and to test it in the current large-scale BMFT research program.

2. TOP Engine

Increasing the economy of the engine in all phases of operation has become one of the principal goals of engine development. Since the first fuel crisis in 1973 the fuel consumption of European cars has been successfully lowered by about 10 percent, principally through development work in the area of carburation and ignition. These relatively simple measures no longer suffice for the future. A further clear reduction in fuel consumption can only be achieved if the construction of the entire engine is subordinated to the goal of attaining the highest possible degree of economy. This means, for example, that the choice of engine displacement, the number of cylinders, the compression ratio, the stroke-bore ratio, the design of the cooling and lubrication systems, the drive for accessories, etc, must be made with minimal fuel consumption in mind.

Thermodynamic optimization of the engine, using an existing engine construction, represents a first step in this direction. Thermodynamic optimization includes:

--raising the compression ratio to the thermodynamically optimal values of $\varepsilon = 11-13$

--shaping the combustion chambers to give intensive turbulence to the incoming charge

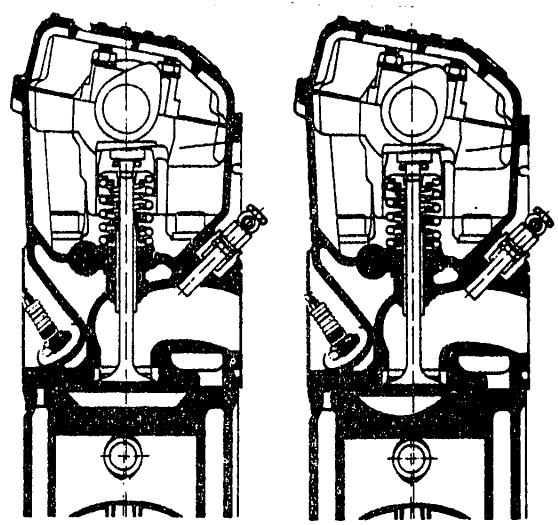
--operating the engine in the part-throttle range with air-fuel ratio numbers of $\lambda \approx 1.2$

--maintaining optimal ignition timing with regard to fuel consumption at all points on the operational curve.

The application of these measures to the Porsche 924 and 928 engines led to the thermodynamically optimized Porsche engines (TOP engines) with a compression ratio of $\varepsilon = 12.5$

Figure 1 shows the combustion chambers of the production 924 engine and the TOP 924 engine.

Fig. 1. Combusion chambers of the production engine (left) and the TOP Porsche engine (right)



One of the problems in developing the TOP engines was to utilize the advantages of thermodynamic optimization under part-throttle conditions without losing maximum engine performance compared with the production engines. By carefully designing the composition of the air-fuel mixture along the full-throttle line and carefully setting the ignition timing in the entire throttle and rev range the requirement could be met.

Principal data for the 924 TOP engine are shown in Table 1.

Table 1. Data for the 924 Porsche TOP Engine

Number of cylinders	i = 4
Total displacement	V_H = 1,984 c^3
Bore	B = 86.5 mm
Stroke	S = 84.4 mm
Stroke-Bore ratio	S/D = 0.98
Compression ratio	= 12.5
Cooling	Liquid cooling
Carburation	K-Jetronic (Bosch)
Ignition	Fully electronic ignition system (VSZ Bosch)

3. Optimizing for Operation on M-15 Fuel

The use of M-15 fuel makes it necessary to replace some production parts in the fuel supply system, such as fuel filters, fuel pumps and the fuel gauge pickup, with methanol resistant materials.

In addition the characteristics of M-15 fuel differ from those of traditional petroleum fuels and require new settings for the carburation and ignition systems, since the engine is to be operated utilizing the fuel's qualities in the best way.

Table 2. Characteristics of Premium Gasoline and M-15 fuel from (9)

Characteristic	Premium Gasoline	M-15
Density at 15°C	g/ml 0.73-0.78	0.75-0.76
ROZ Research Octane Number	98-99.5	101-102
MOZ Motor Octane Number	>88	> 88
Lead content	gram/liter < 0.15	< 0.15
Read vapor pressure	bar 0.45-0.90	0.76-0.96
Stoichiometric volume of air kg/kg	14.5	13.3
Calorific value Megajoules/kg	42.7	39.3
Vaporization heat Kilojoules/kg	419	523

The two most significant differences in the characteristics for gasoline and M-15 are in the calorific value and the stoichiometric volume of air. The lower calorific value of methanol means that a greater amount of fuel has to be supplied to the engine if the same performance is to be achieved as with operation on gasoline. If the setting of the carburation system were left unchanged, the stoichiometric volume of air, which differs from gasoline, would lead to a leaning out of the fuel-air mixture.

Adding 15 percent methanol corresponds to making the mixture about 9 percent leaner. With the carburation system of the TOP engine designed for operation on gasoline, the volume of air for use with M-15 would be $\lambda \gtrsim 1.3$ in the part-throttle range, that is, too lean for good fuel consumption and emissions. For this reason it was necessary to modify the carburation system with respect to the volume of air. Even the handicap with the ignition timing characteristics allowed a new design for optimal operation because of the higher octane rating of M-15 fuel. In full-throttle operation, above all at speeds under 3,000 rpm, a different ignition setting can be selected than for gasoline operation, since the engine knock limit shifts to earlier ignition settings.

The optimization of the fuel-air ratio and ignition timing with respect to minimal fuel consumption was achieved at several part-throttle points. On full-throttle both the fuel-air ratio and ignition timing were set for maximum power in the rev range between 1,000 and 6,000 rpm.

4. Operation on Premium Gasoline

Since there are only a few M-15 filling stations in the FRG, (8) and no M-15 filling stations exist abroad, the cars developed for operation on M-15 were designed in such a way that they can be driven both on M-15 and on premium gasoline without any problems. One goal during development was to satisfy legal requirements for exhaust gas emissions.

Since the vehicles are driven for the bulk of the time using M-15 fuel, the fuel injection system was left just as it was designed for optimal operation with M-15 fuel. This means a 9-percent richer fuel-air ratio with premium gasoline.

6. Testing

Ten Porsche 924s were equipped with the newly designed TOP engines and are currently being used in normal driving.

6.1 Performance Data

The figures shown in Table 3 were taken while measuring performance characteristics with a test vehicle.

Table 3. Performance Results of the Porsche 924 M-15

Acceleration Time (in secs)	M-15	Premium Gasoline
0 - 100 km/hour	9.2	9.6
0 - 200 km/hour	18.7	18.9
Engine Flexibility in 5th Gear (in secs)		
40 - 100 km/hour	17.3	19.2
40 - 160 km/hour	35.4	37.8
Maximum Speed km/hour	211.8	208.3

6.2 Exhaust Emissions

According to the EEC test procedure (large-bag method) the exhaust emissions of the 10 vehicles (vehicle weight 1,150 kg) are within the limits shown in Table 4.

Table 4. EEC Exhaust Gas Test Results

		M-15	Premium Gasoline	Production Limits
CO	gram/test	20 - 40	50 - 80	104
HC	gram/test	5 - 7	5 - 7	9.2
NO_x	gram/test	6 - 8	7 - 9	12.2

6.3 Fuel Consumption

Table 5 shows the fuel consumption of the experimental vehicles measured according to DIN German Industry Norm 70030 (Part 1) (EEC Recommendation A 70).

Table 5. Fuel Consumption Measured by DIN 70030 (Part 1).

	M-15 liters/100 km	Premium Gasoline liters/100 km
EEC Test	10.6 - 11.7	10.0 - 12.4
90 km/hour	6.0 - 6.5	5.9 - 6.5
120 km/hour	7.3 - 8.2	7.6 - 8.4

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TRANSPORTATION

FRANCO-ITALIAN ATR-42 PROJECT PROCEEDING SMOOTHLY

Paris AIR & COSMOS in French 16 May 81 p 19

[Article: "The ATR-42 Will Carry 42 Passengers 1,400 Km"]

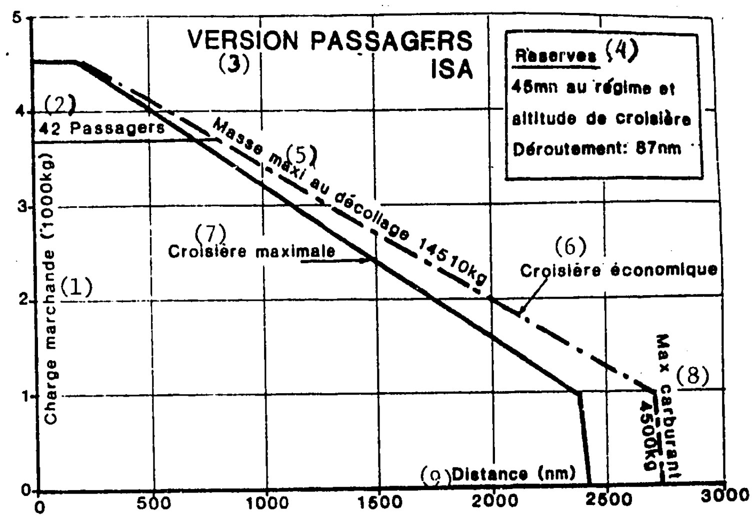
[Excerpt] Although the presentation of the future Spanish-Indonesian CN-235 at Madrid was one of the past week's events, it remains no less true that the studies of the French-Italian ATR-42 are continuing in a climate of excellent cooperation and permit publication of characteristics and performance which are obviously close to those of the definitive project as it will be established by Aerospatiale and Aeritalia.

In comparison with the previously published characteristics (in particular, see AIR & COSMOS No 823 of 30 August 1980) significant differences are to be noted, which is normal since the ATR-42 is in fact the result of merging the AS-35 (Aerospatiale) and AIT 230 (Aeritalia) projects, and optimization effected based on inquiries among potential customers during the last quarter of 1980. This inquiry led to consideration of numerous desires and decision factors, and resulted in an airplane with a somewhat greater initial capacity (42 seats spaced 32 inches apart, 46 spaced 30 inches apart), offering maximum comfort and excellent productivity thanks to the combination of easy maintenance, high availability ratio, and the capability of flying several legs without refueling (high call frequencies). In the final analysis the use of new technologies is essential for improving profitability and study of the airplane must be extremely painstaking; it is, in no way whatever, an easy airplane to make.

The diagrams on this page give a good idea of dimensional characteristics, proposed arrangements, and transport capacity of the ATR-42, the program for which contemplates delivery of the first airplanes in the beginning of 1985. The possible variations of the ATR-42 from the basic model are the ATR-42 "combi," the ATR-42F (cargo), and the ATR-XX, a developed version providing 50 to 60 seats with more powerful engines.

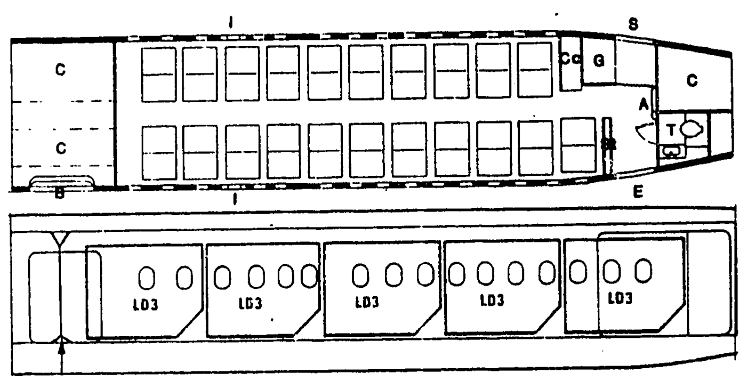
The basic ATR-42 will have a span of 24.37 meters, fuselage length of 21.11 meters, and wing surface of 54 square meters; the cabin (maximum inside width: 2.57 meters, floor width: 2.28 meters, height: 1.90 meters, and length: 13.9 meters) will comfortably accommodate four passengers abreast (width of a F-27; 2.49 meters). The engine selected is the PW 117-2R of Pratt and Whitney, Canada, rated at 1,800 horsepower up to ISA conditions plus 13°C (1,900 horsepower permissible in case of an engine breakdown at take-off). Another possible engine: the General Electric CT7.

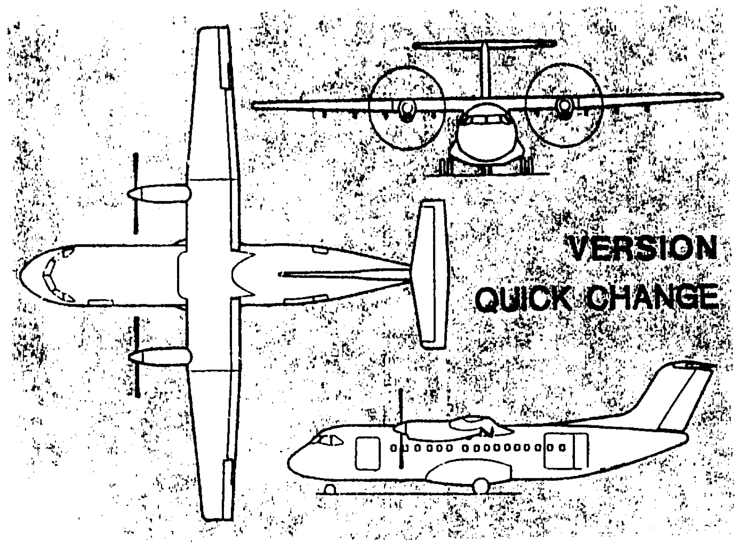
The announced maximum weight at take-off is 14,510 kg, with an empty weight in operational mode of 9,060 kg.



Key:
- (1) commercial load (thousands of kg)
- (2) 42 passengers
- (3) passenger versions
- (4) Reserves: 45 minutes at cruising regime and altitude diversion: 87 nautical miles
- (5) maximum weight at take-off: 14,510 kg
- (6) economical cruising
- (7) maximum cruising
- (8) maximum fuel: 4,500 kg
- (9) distance (nautical miles)

Commercial load as a function of the length of flight leg. Above: arrangement for 42 passengers spaced 32 inches apart ("C" model; forward: freight and baggage compartment, 6 cubic meters volume, with independent access) and an example of utilization in cargo configuration of the QC (Quick change) version which can accommodate 42 to 46 passengers or five type LD-3 containers equall well.





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TRANSPORTATION

FIRST A-310 FUSELAGE SECTION LEAVES ASSEMBLY PLANT

Paris AIR & COSMOS in French 16 May 81 p 23

[Article: "SNIAS [National Aerospace Manufacturing Company]: "First 15/21 Section of the A-310 Comes Off Assembly Line at Saint-Nazaire"]

[Text] A ceremony at which Jacques Mitterrand, president and general manager of Aerospatiale, marked the first 15/21 section of the A-310 coming off the assembly line at Saint-Nazaire on 7 May. Representatives of official French services, of the principal airlines which have ordered the A-310, of manufacturing partners (MBB and British Aerospace), and of course, of Airbus Industrie and Deutsche Airbus were also present at the ceremony arranged by the "Aircraft" division of Aerospatiale. Also noted was the presence of Andre Etesse, director of that division, and Mr Renom, director of the Saint-Nazaire establishment.

Coming off the line on the scheduled date, this first 15/21 section has since been sent to the Toulouse assembly line aboard a "Super Guppy"; it is intended for the first mass produced A-310 which will be Airbus No 162. It is a major component of this airplane, located at the intersection of the wing and fuselage. Despite an evident relationship to the corresponding section of the A-300 (also assembled at Saint-Nazaire) the 15/21 section of the A-310 is in fact appreciably different: even though the diameter (5.64 meters) is obviously the same, the length, in contrast, is distinctly less (6.36 meters versus 7.42) and the total weight has been reduced from 8 to 7.2 tons. The wing, thicker on the A-310, is attached to a central spar (station 21) fabricated at Nantes (Aerospatiale) and then incorporated in the 15/21 assembly, whose other components are being fabricated by MBB (upper bell and emergency exit), by the Meaulte plant of Aerospatiale (forward and aft bulkheads, lower support, lateral elements), at Saint-Nazaire itself (flooring, hatch fairings), and by Hurel-Dubois (Kevlar air conditioning scoops and fillets).

On the A-310 assembly line at Saint-Nazaire there could also be observed the 15/21 sections of the A-310 No 2 (also intended for Swissair) and of the A-310 No 3, or Airbus No 191, (intended for Lufthansa).

The present A-300/A-310 production rate is 4.5 airplanes per month. Taking into account the continual increase in the rate, the Saint-Nazaire plant (which has 2,900 employees) is benefiting from a large investment program. A pilot plant as far as forming large milled fuselage panels, it is going to be equipped with a numerically controlled 600-ton "Loire" press.

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TRANSPORTATION

BRIEFS

DO-228 TEST FLIGHTS--The DO-228 "commuter" airplane, in its 200 version, which came off the line last Wednesday, was to begin its flight tests last Thursday. This airplane, which has 19 seats versus the 15 of the DO-228 in its 100 version, is going to be engaged immediately in a flight test program preceding the joint showing of the two airplanes at the Bourget Salon. The DO-228-100 now has 12 flying hours in 10 flights and has thus reached the initial phase of its tests. These comprise four phases which are to be concluded by the certification, on 17 October, of the DO-228-100 and, on 23 December, of the DO-228-200 after 100 to 120 hours of flight for each of the two airplanes. These tests, which are extremely rapid, are greatly facilitated by those of the experimental TNT (new technology wing) airplane which has undergone no less than 250 flying hours in 230 flights. At the time of the official showing of the DO-228-200 last Tuesday at Oberpfaffenhofen it was stated that deliveries will begin at the end of this year and that production will gradually increase to reach the rate of five airplanes per month. The orders already received, details of which will be announced at the Le Bourget Salon, cover production until the end of 1983. The indicated basic selling price for the DO-228-100/200 is from DM 2.7 to DM 3 million. [Text] [COPYRIGHT: A. & C. 1980] [Paris AIR & COSMOS in French 9 May 81 p 17] 11,706

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