Dornier DO-228-200
commuter transport prototype
Europe Shows Strength in Missile Field

Paris—A vast array of multipurpose missiles displayed here during the 34th Paris air show characterized new developments and growing European industry technological advances challenging U.S. world market dominance.

U.S. industry and Defense officials here said that within the past few years European companies, banding together, have closed the technology gap with the U.S. in the development of missile components and subsystems, demonstrating in some cases surprising advances. They believe that unless U.S. industry and the Defense Dept. increase research and development funding for missile systems, Europe could take the lead in missile and drone development.

Missile systems took on an added importance here as new fighter aircraft were absent from the flying demonstrations. There is a consensus that it will be several years before fighters beyond the present generation of General Dynamics F-16, McDonnell Douglas/ Northrop F-18, Panavia Tornado and Dassault Mirage 2000/4000 enter development in the West. Until that time, product improvement in both aircraft and in weapons systems will continue.

Underscoring European missile system development programs are a number of new weapons that were displayed at the air show. While the U.S. is producing the General Dynamics ground-launched cruise missile for USAF deployment in Europe, countries here already are developing designs and the required technology for a tactical ground-launched cruise missile.

British Aerospace Dynamics Group is moving toward a 500-km tactical cruise missile for use against airfield targets. The weapon would be armed with a conventional submunitions warhead and use scene matching guidance along the general conceptual lines of the guidance system in the General Dynamics Tomahawk cruise missile.

The British are considering the Sea Eagle, a new generation air-launched sea-skimming anti-ship missile. The Sea Eagle was displayed here on a weapons pylon beneath an aircraft wing in the static display area.

Italy’s Meteor Mirch 100 remotely piloted vehicle was displayed with a new automatic navigation system developed by Pacific Aerosystem, Inc. It has the capability to be adapted for use as a tactical cruise missile system, and Italy may propose Mirch for that mission and possibly export sales.

Both the Mirch 100 and the new Sirah navigation system were displayed here, and Meteor also displayed a helicopter scale model equipped with the Mirch 100.

Agusta is in initial flight tests with the Mirch 100 mounted on an A-109A helicopter. The Mirch drone, equipped with the new navigation system, can be programmed to loiter over the battlefield for surveillance. The navigation system will be tested with the drone in Italy starting in September.

The Mirch 100 has a 900-km, one-way penetration range and a speed of 540 mph. It can be used for battlefield surveillance, penetration reconnaissance, target acquisition and electronic countermeasures, as well as for attack on naval and ground targets.

The Mirch 100 is operational now without the auto-
USAF/Fairchild Industries A-10 close support aircraft displayed on the Le Bourget flight line at the 34th Paris air show is armed with the Thomson-Brandt BAT 120, a 120-mm. retarded bomb designed to destroy armored targets such as tanks. A parachute retarder deploys to place the bomb in a nearly vertical position above the tank target before detonation. At detonation, 800 calibrated fragments are dispersed over the target, with each fragment designed to penetrate 7-mm.-thick armor at 20 meters from the impact point.

It became obvious to U.S. industry officials here that Europe is involved in substantial exploratory research and advanced development programs in missile systems, according to a high-level Pentagon official attending the air show. A

U.S. aerospace company official said: “In many cases it is without commitment to full-scale development or production,” while European governments are funding development programs along with industry.

An example of a development program is in the advanced short range air-to-air missile (ASRAAM) program with British Aerospace and Germany’s Bodenseewerk Geraetetechnik working on a highly maneuverable small missile to give the pilot a multiple shot capability. Feasibility studies have been funded for the missile program.

Antitank Missile Studied

A consortium known as EMDG (Euromissile Dynamics Group), which includes Messerschmitt-Boelkow-Blohm, Aerospatiale and British Aerospace Dynamics Group, is involved in studies of the next or third-generation antitank missile system designed to replace the Hughes wire-guided TOW, the French-German HOT and Milan, and the Dragon. Such guidance systems as thermal imaging, millimeter wave and laser beam rider are under consideration for use with the missile, designed to destroy the latest in Soviet armor.

“The trend in European missile technology is quite clear,” a top-level U.S. industry official said. “It is toward end-game performance in the weapon, with sophistication and accuracy with better warheads, guidance and propellant.”

He cited as an example of technology advances the display here for the first time of the French Matra short-range surface-to-air missile, scheduled for deployment in 1986. The passive infrared-guided missile is for use against low-flying subsonic aircraft and is shoulder-fired. It uses a laser fuzing system and, U.S. officials believe its capability is close to the Stinger missile.

Matra won a competition and has been awarded a $40-million contract for development. The company also expects to use the missile on helicopters for air-to-air missions against Soviet helicopters such as the Hind D.

Additional Developments

Other European missile and ordnance developments include:

- France’s Thomson-Brandt Bat 120, which was displayed on the weapons pylon of the USAF/Fairchild Industries A-10 close support aircraft on the flight line. The Bat 120 is a low-altitude retarded bomb for use against targets such as air defense radars, convoys, armored vehicles and parked aircraft. It impacts at a nearly vertical angle, scattering 800 calibrated fragments capable of penetrating 7-mm.-thick armor.

- French nuclear armed medium-range submarine-launched ballistic missile, known as the M4. It was displayed in model form in the French defense pavilion.

**Air Show Coverage**

This week’s coverage of the 34th Paris air show, which concluded at Le Bourget Airport June 14, was provided by an AVIATION WEEK & SPACE TECHNOLOGY team headed by Editor-in-Chief William H. Gregory. The team included Robert R. Popelewski, Los Angeles bureau chief, Jeffrey M. Lencovitz, Paris bureau chief, David A. Brown, London bureau chief, Eugene Kozicharov, Brussels bureau chief, Clarence A. Robinson, Jr., senior military editor, David M. North, business flying editor and Michael Feazel, transport editor.

The photography was by Robin Adshead and Steven Murez.
Deployment is expected in 1985 on the French submarine Inflexible. The M4 follows the M3, and earlier M1 and M2 models, but is a 4,000-km. range weapon. The Inflexible will be armed with 16 of the missiles, which are launched from the submerged vessel using a real-time fully automated fire control system.

- France's SSBS-3, an improved version of the two-stage nuclear-armed surface-to-surface ballistic missile. France has had the ballistic missile operational in silos since 1971, but the improved missile is hardened against nuclear effects and has improved accuracy and range.

- France's Pluton nuclear-armed battlefield support missile fired from a tracked vehicle also is being upgraded, and France has tested in the Pacific an enhanced radiation warhead that may be deployed on the missile. A model of the surface-to-surface ballistic missile was on display in the French defense pavilion.

- France's Thomson-CSF Sica family of missiles derived from the Crotale line with modifications and improvements. The Sica system is an all-weather surface-to-air missile system designed to counter aircraft operating from 200-20,000-ft. altitude. It has a range of approximately 12 km. The system can be mounted on tracked vehicles and armored vehicles.

The Shahine, developed for Saudi Arabia, is an example. The radar for surveillance, detection and tracking is carried in one vehicle, and the missile launcher with six missiles is carried in another. A microwave data transmission system links the separate components of the system, and it can handle 12 targets simultaneously.

An electro-optical sensor is used separately from the radar to monitor targets and provide surveillance, and the missile is acquired in initial flight by an infrared receiver sensitive to the booster's wavelength. Each radar surveillance unit can be linked to four firing units. Ten army and navy units in several nations are armed with the Crotale family, including the naval Crotale.

- Italy's SNIA showed models of and
provided information on several rocket systems and on rocket-assisted artillery rounds. One of the systems is the Firoz 25 field rocket system for saturation fire pow-
er at ranges from 10-25 km., and a war-
head selection from 17-39 kg. However, an
aerodynamic brake also can be used with
the rocket and it can be armed with anti-
tank submunitions.
A smaller Firoz 6 field rocket system
uses a 2-in. dia. rocket and is operated with
40-50 rockets per launcher, depend-
ing on the vehicle installation. SINA also
is developing a 105-mm. rocket capable of
performing three missions—electronic prote-
ction through chaff dispensing along with
infrared signatures, illumination and
bombardment.
A 2-in. air-to-surface rocket system also
has been developed for use on fixed-wing and
helicopter aircraft, and a high degree of
accuracy has been demonstrated by the
Italian air force, according to SINA offi-
cials.
Franco’s Thomson-Brandt also has
developed and displayed a family of rock-
ets and bombs, including Lance 60-mm.
rackets for both fixed and rotary-winged
aircraft using several variations of rocket
pods. There also was displayed a larger
100-mm. rocket system known as Zebulon,
or “Z” rockets, used in three-round
launchers for the Gaetole helicopter. The
rocket is designed for antitank and is
parachute retarded so it strikes tank tar-
gs when almost vertical, spraying high-
powered calibered fragments. The company
has developed and tested with
Mirage aircraft the BAP 100 low-altitude
runway penetrator bomb. The weapon is
parachute-cradled and is just above the
target. At point a rocket ignites to
punch through concrete 40 cm. thick
to explode under the runway.

Extensive Soviet participation in this year’s
Paris air show included a new Soviet version
as well as an aircraft display featuring
the latest Soviet transport aircraft. The static
aircraft display included, from left, the Mil
Mi-17 and Mi-26 helicopters—both of which

Another 125 kg. bomb has been devel-
oped by the company with a sensitive drug
impact fuse. One of the 100-mm. rockets
displayed in the Allis pod was equipped with
a laser sensor to home on designated
targets.
British Aerospace showed at Le Bourget the Swiftpulse antimissile missile with a
combined visual/thermal infrared sight,
which enables use at night and in all
weather. It also makes the weapon effec-
tive against armor even when operating in
early morning or energy-generated fog,
according to company officials. The Brit-
ish army will be equipped with the new
sight in two versions, one for direct fire
mounted on vehicles, and the other on
trips. The infrared sensor can be used for
general battlefield surveillance.
The company is developing a new Mk. 2
warhead effective against laminated So-
viet armor through the 1980s, officials
here said. British Aerospace is upgrading
the Rapier/Blindfire low-altitude air de-
fense missile system, which was displayed
on the flight line here. Improvements are
in the areas of microprocessing and infr-
red passive surveillance and tracking

Advanced Missile System

France’s Luchaire has made improve-
ments to the Striim 89-mm. antitank rock-
et launcher by developing a night sight,
and by adding antipersonnel, smoke and
incendiary rocket capability. A new anti-
armor warhead will be exhibited this week
at Satory, France, with the capability to
penetrate 460 mm. of armor plate through
a new shaped charge and fuse. It has a
range of 400 meters against tanks, and an
antipersonnel/antiarmor round with a
shallow-holed charge warhead to pene-
trate armored personnel carriers has a
range of 600-1,000 meters.
A low-light-level night sight also has
been developed. The older version of the
Striim weapon is in service in 20 countries.
Luchaire also displayed its 250-kw. low
drag bomb retarded by a valve permitting
low level surprise attack. The bomb has
options allowing use with caninical and
mechanical fuse/electrical fuse.
Italy’s Selenia displayed the Aspide
multipurpose missile in various configura-
tions, and the company is developing
improvements for the weapon in the late
1980s, such as an active terminal phase
guidance system. Aspide is in operation in
10 countries. A recent order was placed by
a Mediterranean nation, with another
pending from a Middle Eastern nation,
according to company officials here.
The company is developing a vertical
launcher system for the naval application
of Aspide, with proposals for armored air
defense version mounted on tracked vehi-
cles using a Contraves fire control system.
Oto Melara would install the system in
tanks. Selenia believes it could become a
competitor to Roland or to the French
Saca weapons family. The mobile air
defense version would be packaged in two
vehicles, with one carrying the surveillance
and tracking radar, and the other the fire
control and launcher containing six mis-
siles. The semi-active seeker would provide
a high kill probability, estimated by the
company at 80%, with a range to 12 km.
Aspide also is armed with a new fragmen-
tation warhead.
Aspide is deployed on high-performance
fighter aircraft, with surface-to-air de-
defense systems such as the Spada, and
Contraves Skyguard integrated with 35
mm. air defence gun system, as well as
the Albatros shipboard point defense system.
In the vertical launcher Aspide will be
become a competitor for Raytheon AIM-7M
Improved or Advanced Sea Sparrow. Sele-
nia already is developing a modification kit for deployment of Aspide in existing
NATO Sea Sparrow launchers.
In some ways, according to U.S. Defense
Dept. officials visiting Le Bour-
get, Selenia and Italian companies in gen-
eral are typical of the surge in European
technology, especially in the areas of sen-
sors and ordnance.
Selenia, as an example, provided equip-
ment from three company divisions for the
display with two new radar system anten-
ae: one the RAI 31S, a three dimensional
S-band air surveillance system; the other,
the Plato, designed for tracking airborne
targets at very low altitudes and for use in
coastal surveillance. Plato also operates in
S-band.
Competitors Assess 150-Seat Transport

Paris—Expenditures approaching $10 billion to develop a new generation of 150-passenger aircraft could result in "industrial suicide" for the U.S. and European commercial aircraft industry if three manufacturers compete, according to industry officials here.

At minimum, a three-way competition among airframe manufacturers could cripple the ability of at least one competitor to continue as a viable force in the commercial market, they believe.

Airbus Industrie, which claimed during the Paris air show it had already "launched" its A320 150-passenger aircraft, said it hoped for launch orders by September and plans for first delivery as early as late 1985.

The consortium of McDonnell Douglas and Fokker unveiled the MDF 100 and expects to be near a decision by the end of the year on whether to go ahead with the project. First deliveries could be in the first quarter of 1986.

Boeing plans to wait before making a production decision, but unveiled a scale model of its 7-7 and said it would not be shut out of the market.

Industry skeptics, including the manufacturers themselves, do not believe that financially depressed world airlines will have the financial resources to buy enough of the new-generation aircraft to support all three airframe manufacturers and three engine manufacturers.

The airframe manufacturers are uniformly predicting a worldwide market for about 2,500 of the aircraft through the end of the century, a level that could theoretically support three airframe manufacturers and three engine manufacturers profitably, based on estimated breakeven levels of 600-700 sales each.

But even the optimists believe that if the market is 2,500 aircraft, at least one manufacturer is likely to lose a large amount of money, and possibly even fail, because it is unlikely the market will be evenly divided.

Pessimists believe the 2,500 figure is optimistic in an environment in which only a handful of airlines are profitable, and in which profit levels sufficient to provide capital for new aircraft needs have been met only once in the past decade.

Developing the new aircraft is expected to cost up to $2 billion per airframe manufacturer, and up to $1 billion per engine manufacturer.

"Our customers cannot hope to support with purchases aircraft and engine investments like that and the consequent competitions that follow," Robert J. Carlson, executive vice president of United Technologies Corp. and president of the Pratt & Whitney Aircraft Group, said.

"Competition is wonderful," he said, "but masochistic industrial self-destruction is quite another thing, and from my perspective, this industry may be posing itself to do just that if it convinces itself the 150-seat chocolate cake provides adequate sustenance for all."

The airframe manufacturers, meanwhile, are pinning their hopes on the possibility that at least one of the airframe manufacturers will drop out of the competition — and that no new ones will enter.

Most industry officials here believe all the competitors are in place. Lockheed-California President Edgar Cortright said that Lockheed is actively exploring the possibility of a venture on similar aircraft, but will keep its plans private until the venture is firm.

Both Airbus Industrie and the McDonnell Douglas/Fokker consortium were trying last week to focus attention on Boeing as the airframe manufacturer most likely to withdraw from the competition.

Boeing said its entry is likely to be delayed until the 1987-88 time frame, two years behind the announced delivery date of the other two competitors — and behind the timetable set by Delta and American airlines, the most likely U.S. launching customers. Boeing said the delay is necessary because it would take that long for acceptable new engines to become available, and that the advantages of the new engines would outstrip the advantages of its competitors' early delivery dates.

The company first into the market is most likely to be successful, according to Frans Swartouw, president of Fokker. And the last one in is least likely to succeed.

Top officials at both Airbus Industrie and McDonnell Douglas/Fokker said repeatedly they believe Boeing is using the engine question as a smokescreen to cover an inability to produce a new-generation aircraft on the same timetable as the others. They push the theory that Boeing is too busy with other projects to be able to devote the management or engineering talent, or the financial resources, to produce another new aircraft by 1986.

They point to Boeing's apparently increased interest in producing a reengined 727-200 as proof that Boeing may be hedging its bets on the 7-7, or at least providing itself with a bridge aircraft to keep customers satisfied until the 7-7 can be available later in the decade.

Airbus Industrie and McDonnell Douglas/Fokker believe they have the clout to push the engine manufacturers into developing an all-new engine on their timetable.
They are convinced the huge Boeing Commercial Aircraft Co. could if it chose to.

"If the airlines sign on the dotted line by the end of the year, the engines will be there on schedule," Dan Krook, senior vice president and marketing director of Fokker, said.

George A. Warde, senior vice president-commercial of Airbus Industrie, agreed. "Advances in technology come about as a result of need," he said. "If we delayed our timetable until 1988-90 nothing would happen with the engines until it was necessary to meet that lead time."

Even if the all-new engines are not ready in time for the 1986 introduction, both Airbus Industrie and McDonnell Douglas/Fokker plan to introduce the aircraft with derivative engines because they believe the timing is so important. They and their customers then would absorb the cost of switching to new-technology engines when they became available.

Both manufacturers believe the derivatives that are likely to be available will be adequate to meet the fuel efficiency requirements set out by Delta and others.

Boeing, however, said the derivatives will not be fuel efficient enough, and that the airlines will not be willing to bear the cost of buying the derivatives as well as all-new engines. "We do not want to start a program with a new aircraft and a derivative engine, then have to replace the engines in a few years," Joseph Sutter, vice president-commercial at Boeing, said. "The airlines cannot afford to have engines that are only half-developed. That would just cost everyone a lot of money."

Persons not yet directly involved in the competition who have studied the engine question closely agree with Boeing that it is unlikely a derivative engine would be able to meet the fuel efficiency standards demanded by the airlines.

Airbus Industrie's Warde said Boeing may be focusing on the wrong issue by relying strictly on fuel efficiency. Introducing an all-new engine could add so much to maintenance and initial cost that the aircraft could become uneconomical despite its fuel efficiency, he said.

Boeing officials emphasized the amount of money already spent and the number of people, "100 of our best engineers," who are working on the project as proof of the company's commitment to the 7-7.

The manufacturer also said it easily has the capacity to add the 7-7 to its product line because major work on most of its largest current projects is winding down and it is facing the near-term possibility of having surplus engineering and management capacity.

"We will not allow them to take a significant portion of our market away," Sutter said. "If the engines will support a 1986 delivery, we will deliver in 1986. In fact, we could probably beat our competition time-wise."

Sutter, however, believes either Boeing's competitors' timetables will slip, or they will be forced to offer a relatively inferior product that will not threaten Boeing's primary market.

"We are committed to building an aircraft that will be profitable over the long-term," Sutter said. "If we have to give up some short-term sales to do that, we will, but if it looks like we will lose customers, we will move."

In the end, the number of manufacturers who enter the 150-pasenger market will depend on how committed the individual manufacturers are to the market, and their ability to obtain financing.

In both cases, the McDonnell Doug-

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**CASA/Nurtanio Cite CT7 Advantage**

Paris—Consortium of CASA and Nurtanio is counting on a new, more powerful version of the General Electric CT7 engine to give its new CN-235 aircraft an edge in the crowded 30-40 passenger aircraft market (AWST June 8, p. 203).

The new engine, designated the CT7-7, is a further modification of the CT7-5, which powers the Saab-Fairchild 340.

The new engine provides a larger airflow, increasing horsepower more than 100 shp over the CT7-5, to 1,750 shp. General Electric said the engine will provide 10-20% lower fuel burn than current engines.

The engine is built on the standard CT7 core, and includes a single-spool gas generator consisting of a five-stage axial, single-stage centrifugal flow compressor, and a two-stage axial flow gas generator turbine. The engine continues the modular maintenance capabilities of earlier CT7s.

The aircraft will be offered in an all-cargo version that can carry 9,920 lb. of cargo in five L-2 containers, four LD-3s or two 88-in. cargo pallets. A rear ramp/cargo door will be offered, and a movable cabin bulkhead will make the aircraft quickly convertible between passenger and cargo configurations.

*Aviation Week & Space Technology, June 15, 1981*
Orders Placed for British 146-200 Aircraft

Hatfield, England—Westair Holding, Inc., owner of Pacific Express Airlines, has ordered six British Aerospace 146-200 aircraft and has taken eight options. Total value of the 14 aircraft is $250 million (Avst June 8, p. 217).

British Aerospace had hoped to announce the orders when the aircraft was rolled out (Avst May 25, p. 26), but was unable to reach an agreement with the new airline until the Paris air show. The $250-million price assumes a 10% inflation rate until delivery in 1984, and spare parts valued at about 12% of total cost.

British Air Ferries also said during the show that it planned to acquire at least 10 of the 146s, though a contract has not been negotiated. The airline also has not decided how the order will be divided between 146-100 and -200 aircraft.

British Aerospace now has firm orders for 22 of the four-engine aircraft and 13 options, excluding British Air Ferries. The firm orders are from four airlines: Pacific Express, Air Wisconsin and two unnamed airlines, including one in the U.S.

Westair plans to begin operations with new BAC 111 aircraft leased through British Aerospace, then replace the fleet as the 146s become available.

Financing details for the 146 have not been worked out, but British Aerospace officials said they would be similar to the 8.75% interest rate and the down payment provisions provided for Air Wisconsin.

Initial Pacific Express operations will be financed through a private stock offering in Westair Holding, Inc., managed by Citicorp Venture Capital, Ltd. The private offering is to be followed within 60 days by a public stock offering.

British Aerospace said it plans to use composite propellers with 6-8 blades on its proposed reengined, stretched version of its 748 aircraft. The new version would increase in capacity from 50 to 60 passengers, and the speed would increase about 50 kt. to 290-300 kt.

The manufacturer is considering a number of engine options, including engines in the 3,000-hp. range manufactured by General Electric, Rolls-Royce and Pratt & Whitney. British Aerospace said there “is every reason to believe” the engines will be ready in time for mid-1980s delivery of the new version.

Final decision on whether to go ahead with the derivative, which would provide about 30% more fuel efficiency per seat, will be made by the end of the year, according to Eric Johnson, marketing manager for the 748.
Fuel Savings Stressed by Engine Manufacturers

Paris—Civil turbfan engine manufacturers are looking for substantial decreases in fuel consumption and for firm financial commitments as they position themselves for another round of stiff competition to satisfy engine requirements for a 150-passenger transport.

Although it is too early to determine whether there will be more than two entrants in the new transport class, engine manufacturers are lining up their preliminary technical data and possible production partners and testing the political winds to see whether they will join the competition to develop a new 29,000-lb.-thrust class of engines.

Further complicating the engine development program is the lack of definition of the new 150-passenger transport by some aircraft manufacturers and lack of a launching customer for proposed models. The third ingredient needed for a go-ahead of an engine development program that could cost in excess of $500 million—top management approval—also is lacking.

The Airbus Industrie A320 and the partnership of McDonnell Douglas and Fokker for the MDF 100 are two of the 150-seat transport programs. Boeing’s 7-7 is a possible contender.

To meet the challenge of a new development program for an engine in the 25,000-lb.-thrust class, Pratt & Whitney, General Electric/Sneca, Rolls-Royce and a consortium of Japanese manufacturers are doing preliminary design and financial studies. The 25,000-lb.-thrust class engine would be used for the 150-seat transport and as a candidate for reengining older transports.

More than one engine company official here for the Paris air show said a decision on a new engine has not been made, and would not be made until there was more direction from the airframe manufacturers and the airlines.

There also is doubt whether the market for a new 150-seat transport would support more than two aircraft designs or more than two engine manufacturers. Many of the discussions on the potential engine programs centered on whether one or more of the engine manufacturers would drop its development program.

Officials said the increase in fuel costs has made the sizing of transport aircraft more important, and no longer can an airline pay the penalty of flying an aircraft that is too large for the route segment.

Pratt & Whitney has not made a decision about entering the competition to develop a 25,000-lb. class engine. If it does, the engine most likely would be a scaled-down version of its PW2037 turbfan, designated the PW2025. Study of the 37,000-lb.-thrust PW2037 engine began in 1971, and full-scale development was started in 1979. Federal Aviation Administration certification of the engine is scheduled for December, 1983.

Further complicating the engine manufacturers’ decisions on the new class of engine is whether Boeing will propose the reengining of its 727s with two advanced turbfans. Pratt & Whitney sees its basic PW2037 as properly sized for the reengined 727, which will carry more than the 150-passenger transport.

Rolls-Royce and the Japanese consortium making up Rolls-Japanese Aero Engine, Ltd., have agreed to target the development of their RJ500 engine for the 24,000-27,000-lb.-thrust range, rather than the 20,000-lb.-thrust class as earlier favored by the Japanese.

The lower thrust engine has been sized for an aircraft in the 120-130-seat category, but now the partnership views the 150-seat aircraft as the prime market.

Rolls-Royce will develop and manufacture the core of the new engine while the Japanese consortium will develop the low-pressure turbine and some of the engine accessories and the external sections. The combined company is committed to produce two engines, with the first scheduled to run for the first time early next year. The Rolls-Japanese group projects the engine available for service in 1986.

General Electric expects its engine candidate for the 150-seat transport—the CFM56-2000—to be ready in 1985, but with better economy available in the 1987 period. The CFM56-2000 would be a derivative of the 24,000-lb.-thrust CFM56-2.

The CFM56-2 is being used to reengine McDonnell Douglas DC-8-60 aircraft and the Air Force/Boeing KC-135 tanker.

General Electric officials believe they can increase the thrust rating of the CFM56-2 from 24,000 to 25,000 lb. by increasing the rotor speed and temperature without other changes. General Electric and Sneca are conducting a study to see what modifications would be required to the basic engine to reach higher thrust levels, if dictated by the aircraft manufacturers and launching airline.

Although General Electric officials see a CFM56-2000 available by the time the first 150-passenger aircraft is available, they believe that given more time they can increase the fuel efficiency of the derivative engine. One General Electric official said the partnership could produce a 5% improvement in specific fuel consumption over the next four to five years, but if given more time, up to a 13-14% increase in fuel efficiency should be attainable from the basic CFM56.
Air France Signs for A320 Transports

Air France—Airbus Industrie’s A320 short-to-moderate range transport moved one step closer to production go-ahead with Air France’s preliminary contract for 25 aircraft and options for 25 more. The French flag carrier’s A320 order is conditional upon the formal agreement for launch commitment by the multinational Airbus Industrie European consortium. The Air France contract states that such a decision must be made by Mar. 31, 1983, in order for the purchase to be valid.

Airbus Industrie has proposed the single-aisle A320 as its entry into the growing competition for new-generation short-to-medium-seat-category aircraft, and the sale has completed its basic design and definition work on the twin-engine aircraft.

Air France President Pierre Giraudet said the carrier has placed total deposits of $1.7 million for the aircraft. Of the total of 50 aircraft, 34 are anticipated to be 160-seat A320-200 version and the remainder the smaller A320-100 which seats approximately 120 passengers.

Program scheduling calls for the initial Air France A320 to be delivered in 1986, officials said.

The Air France order adds momentum to the A320 program, but Airbus consortium officials point out that the decision does not signal a formal production launch. Members of the European air-

Astra Orders

Paris—Israel Aircraft Industries expects to begin accepting orders for its new Model 1125 Astra business jet aircraft in mid-1985, after production guarantees for the aircraft have been firmly established, Gabriel Gold, IAI president, said last week at the Paris air show.

The aircraft now is under development at IAI’s facility near Lod, Israel, where, the wing of the engineering mockup recently was mated to the fuselage.

Sales of the Model 1724 Westwind 2 continue strong, he said, with an order backlog of about 70 aircraft. Production has been increased to five per month.

Soviets Develop Turboshaft Powerplant for Transports

Paris—Soviet Union has developed a new turboshift engine designated the D-36, a low-fuel-consumption, lightweight powerplant designed for new economical passenger and cargo aircraft. The MIL Mi-26, the world’s biggest rotary-wing aircraft, is to be powered by the D-36 engine.

A free-turbo turbine derivative of the Lotarev D-36 turboshaft, the D-36 has a maximum thrust rating of 38,000 lb, an engine dry weight of 2,000 lb. The engine was shown for the first time in the Soviet air show at Paris air show. The Mi-26 helicopter was on display on the flight line.

The specific fuel consumption (SPC) of the engine is 0.035, and its management plans off power, the Soviets said. Compressor combustor casings are the same as in the D-36, and the engine has variable incidence variable guide vanes in the compressor.

The Soviets said the new engine uses high-strength materials and advanced technology, according to United Press International.

Soviet efforts to develop low specific fuel consumption for the engine indicate that the USSR is anticipating a fuel trend in the future, he said. Fuel price increases are leading the Soviets to build more efficient engines, not only for operations in the USSR but also for customers abroad.

The new aircraft is expected to meet present and projected requirements of U.S. Federal Aviation Regulations and the British Civil Aircraft Regulations.

The official added that while it is unusual that the Soviets are planning to introduce a new family of engines, the previous Soviet engines were technologically behind others and, therefore, they could not meet the stringent certification requirements. “We see now not only a new generation of engines, but also a new generation of engines looking very much out of date,” he said.

The official said the D-30’s low weight is due to the use of high-strength materials and modern manufacturing processes.

The official said a new type of combustion chamber has been developed that cuts exhaust pollution. Modular type of the engine facilitates engine changes and offers the possibility of expanding the propulsion plant.

The engine is fitted with universal mounts, allowing it to be installed in a pod under an aircraft’s wing or in a pod on a fuselage or on the fuselage sides. The official said a thrust reverser can be fitted on the engine.

The Soviets also displayed the older Soloviev D-30, a turbojet engine, which has a takeoff thrust rating of 20,000 lb. The engine powers the Ilyushin IL-62M.
Paris—"Big-wing" version of the Northrop F-5G, redesignated the F-5S, has been proposed as a low-cost contender for the Swedish air force's JAS fighter/attack aircraft in a tightly scheduled competition. The Swedish Military Command's recommendation is due Oct. 1.

A new version of the F-5 is one of five aircraft competing for the fighter selection. They are:
- Saab-Scania 2105, which is being proposed by Industry Group JAS, a consortium of five Swedish aerospace firms.
- General Dynamics F-16, modified in accordance with the Multinational Staged Improvement Program (MSIP) now under way in the U.S. and the four NATO nations that have selected the aircraft. In effect, the aircraft being offered to Sweden by General Dynamics is the same as will be delivered to USAF in 1985.
- McDonnell Douglas F-18, essentially unchanged from the one that will be produced in the mid-1980s for the U.S. Navy, but with the addition of a land-based, mobile landing arrester system that uses twin drag chutes to stop the aircraft once it has touched down.
- Northrop F-18L, with weaponry modified to meet Swedish requirements.

This includes provision for a 25-mm. or 30-mm. gun, low-drag, quick-turnaround bomb racks and provision for carrying such missiles as the Swedish-developed RBS.15 antiship missile.

The F-SS version of the Northrop F-5G will have a wing 25-30% larger than the wing on the F-5G and will have modified flaps.

The changes are designed to improve the F-SS's landing characteristics to enable it to land in 1,500 ft. and meet Swedish requirements for operations from dispersed small airfields and road sections.

The new wing design also would likely improve some flight performance, but officials said the primary goal was to shorten the landing distance.

The F-SS also would have its armaments capability modified to meet Swedish needs, including provision for the larger gun and the RBS.15 missile.

All the aircraft in the competition are expected to have avionic suits substantially different from those planned for the standard versions.

In the case of the Saab-Scania 2105, the only aircraft designed specifically for the competition, a new triple mode radar is being designed by L.M. Ericsson that is expected to be capable of providing air-to-air, air-to-ground and air-to-sea functions (AWAST June 8, p. 222). The aircraft also will have an L.M. Ericsson-developed forward-looking infrared camera system.

The aircraft will have a new standard computer, designated the SDS80 and developed by the team of L.M. Ericsson, SRA Communications and Dataaab.

Cockpit of the Saab-Scania aircraft will have only four conventional circular dial instruments, and these will be used only as backup. Replacing the analog gauges will be three cathode ray tube displays and a holographic head-up display with a wide field of view.

All of the cockpit displays are to be produced by SRA Communications, one of the five corporate members of Industry Group JAS, a consortium of Swedish companies formed to design and develop a competitor in the JAS program. The other members are Saab-Scania, L.M. Ericsson, Volvo Flygmotor, and FFV, a government-owned company that recently joined the consortium to handle such requirements as maintenance and test equipment needs.

Industry Group JAS has several contracts with other aerospace companies to provide technical assistance. Companies in the group include Rockwell International, for assistance in composite materials structures and possibly some data from the HiMAT aircraft maneuverability studies; and Messerschmitt-Boelkow-Blohm, for studies of calculation methods, control modes and structural materials.

The Saab-Scania 2105 will be 30% composite structure as a means of saving weight.
French Evaluate Grumman E-2C

Paris—French air force has completed a second flight trial of the Grumman E-2C Hawkeye, an evaluation of the aircraft for the country's military early warning requirements.

The latest test series was requested by France because electromagnetic interference had been encountered during an initial evaluation last year, and some of the data gathered during the first flight series was not sufficient for the French evaluation. France is considering purchase of the twin-engine turboprop Hawkeye to improve its early warning detection and monitoring capabilities.

The second evaluation phase was conducted from the Mont de Marsan test center in April and involved 19 flights for approximately 72 flight hours. The aircraft used for these evaluations was a U.S. Navy E-2C which had been accepted by the Navy but which had not yet been delivered by Grumman. This arrangement allowed the French to utilize one of the most recent aircraft off the Grumman E-2 production line, a company official here said.

When the electromagnetic interference was encountered during the first flight trials in June, 1980, Grumman had made some modifications to the aircraft systems while the E-2C was still in France, but additional work was performed after the tests were completed and the aircraft had returned to the U.S. The modifications helped to adapt the E-2C systems for French land operations, which provide conditions different from those normally encountered by U.S. Navy E-2Cs on their overwater duties, the official said.

"Our system changes were more of a 'customizing job,' and the modifications were minor in relation to the overall complexity of the E-2C's systems," the official said. "The French air force is a high technology organization and it has conducted a very precise, comprehensive and extensive evaluation of the aircraft."

French air force personnel are completing a report on the latest tests and the study could be finished by the end of this month. However, additional action by France probably will not occur until the end of summer because of several factors. These include establishment of a new French government under Francois Mitterrand, the related election of a new national assembly, and the traditional European summer work slowdown.

According to the Grumman official, systems modification work accomplished on the E-2C for the French evaluation involved less than 5% of the aircraft's total avionics. The officials said the U.S. Navy potentially could be interested in adopting similar changes to its aircraft as the result of the experience gained during the French evaluations.

Paris Air Show

Boeing Will Present Proposals For Reengining 727-200 Aircraft

Paris—Boeing Commercial Aircraft Co. expects to present formal proposals for a reengining program for 727-200 aircraft, designated 727-200RE, to potential airline customers this month.

The formal proposal will include a range of prices, depending on the number of aircraft likely to be reengined. Boeing is not disclosing the range, but confirmed that a $12-million price tag per aircraft is possible.

Three engines are available for the program to convert the 727 trijet to a twinjet. The Rolls-Royce RB.211-535C engine would be available first and be the least expensive of the alternatives, but would provide the least fuel savings. A version of the RB.211, as well as the Pratt & Whitney PW2037, would be available later and be more expensive, but would provide better fuel efficiency.

Boeing said the decision on whether to go ahead with the reengining program will depend on airline response. Airlines such as American Airlines have been pressuring Boeing to go ahead with the program. American is interested in reengining about 80 of its 727s.

The airlines have considered Boeing reluctant to go ahead with the reengining program in the past because the aircraft would compete with the new 757 and 767 aircraft. Boeing indicated last week, however, it may be more interested in the program.

"If enough airlines want this and the engine manufacturers are responsive in helping bear the burden, then this airplane will happen," Joseph Sutter, Boeing vice president-commercial development, said.

Sutter estimated as many as 800 currently operating Boeing 727s could be candidates for the reengining, which could extend their useful life 15 years at a price approximately one-half that of replacing the aircraft with new-generation 150-passenger aircraft. The reengined aircraft also could serve as a bridge until new technology aircraft are available and would have higher resale value.

Boeing, however, would receive relatively little benefit from the program, since most of the cost is in the new engines. "Shouldn't the engine manufacturers pick up a lot of the investment?" Sutter asked. "If they do, this could be very painless for Boeing."

A program that could provide as many potential engine orders as this is going to provoke the wildest cat and dog fight you have ever seen among the engine manufacturers," Sutter said.

Boeing estimates the reengining program would provide a saving of about 26% in fuel burn per seat mile.

Model of Boeing 727-200RE reengined with representative high bypass engines is shown.
**Paris in Retrospect**

Paris every other June becomes a kaleidoscopic montage of technical trends in the aerospace industry. Now, with the chalet walls dismantled and the crowded ramp emptied at Le Bourget Airport, here are some of facets reflecting the spectrum at the 1981 Paris air show:

- **Military fighters.** Most of the high-performance fighters flying at Paris were making at least their second visit. Only the McDonnell Douglas F-18 debuted at Paris this year, and it had flown at the Farnborough air show in 1980. A full-size mockup of the Northrop F-5G fighter, a privately funded development, was new in the static display in its own domed enclosure where the F-18L mockup resided in 1979. A model of a proposed fighter to meet the Swedish JAS requirement was in an exhibit hall. Not much else in the fighter line was brand new, and the show accurately reflects a trend. There are not going to be many new fighters in the 1980s. Both the U.S. and Europe developed a stable of fighters and strike fighters in the 1970s: the American F-14, F-15, F-16, F-18 series, the French Mirage family, the tripartite Tornado. Costs of fielding those aircraft in the 1980s are chewing up huge chunks of defense budgets, and the next development slate is not likely to come before the 1990s, and possibly after the turn of the century.

- **Missiles.** Air-to-air, ground attack and air defense missiles proliferated this year. Raytheon's Patriot air defense missile for the U.S. Army was on display with its supporting radar vehicles and the General Dynamics ground-launched cruise missile intended for European nuclear deployment was also. Missile activity was the other half of the aircraft picture. A family of high-performance aircraft delivery platforms is going into service, and the cost of gaining a few tenths of a Mach number or a little more range or maneuverability will discourage development of new ones. Instead, the funds will go into more effective missiles to arm these existing platforms, or into the array of avionic black boxes lining the show exhibit halls that will offer more cockpit automation, better fire control or better electronic countermeasures for survival.

- **Commuter transports.** With the Dornier 228-100 flying at Paris, the Short 360 on static display and the Aerospatiale/Aeritalia ATR 42 full-size fuselage mockup also on the ramp, it was clear that Europe has the next generation of commuter aircraft in being or close to it. American manufacturers have not yet placed their bets in this competition, and Europe is off to a lead in dominating this market.

- **One-hundred-fifty seat transport.** This gestating aircraft was the most discussed subject at the show. Airbus Industrie with its A320 and Fokker in a joint venture with McDonnell Douglas for the MDF 100 are eager to roll, but Boeing has its plate full with the 767, 757 and 737-300 development programs. Boeing's reengined 727 is a sleeper in this market. There are plenty of airlines whose balance sheets can't finance a new 150-passenger transport, but which could manage a reengined 727. The latter could siphon off enough orders to slim down the 150-passenger transport market.

- **Soviet development.** The Russians manage to average about one new aircraft per Paris air show, and the heavy lift Mi-26 helicopter was this year's. Development costs, particularly in the civil aircraft field, are straining the Soviets as they are the West. They talk about 10-billion ruble development costs the way U.S. companies speak with consternation of $2-billion commercial transport investment, and the Soviets are floating the idea of market specialization by their country, Europe and the U.S. to share the load and split the overall transport market.

- **European tier.** Continuing the trend obvious at the last Paris air show in 1979, Europe keeps on expanding its subcontractor and supplier network. Technically, the challenge to the dominance of the U.S. industry continues to grow. Italy is coming on strong with a cadre of U.S. experienced engineers as a seasoning. One Boeing engineer said the first Aeritalia components for the 767 have been delivered to Seattle, and the workmanship was stellar.

The show itself has reached a critical mass from the standpoint of physical size. There is not much prospect for any further real estate expansion on the Le Bourget ramp, but an additional road is planned in 1983 in the chalet area to unload some of the vehicle and pedestrian congestion on the single artery existing this year. It is crowded even though it has been blocked off from the static display ramp in a good move to separate industry and public show crowds. Paris dominates international air shows because of this large and steadily evolving infrastructure.

Overall there was a subdued air about the show this year that was difficult to diagnose. One reason was the lack of new airplanes in the flying display, but this is a fact of life. Development programs take 10 years, and that cuts down the crop for an air show every two years. Another reason was the French electoral sweep leftward that turned the usually ebullient French industry noncommittal. The new French president, Francois Mitterand, brought the French air force precision flying team back to the show this year for the first time in a decade, but he also asked for removal of all weapons from aircraft he reviewed during his official show visit. It left the French wondering whether they had inherited a reincarnated Jimmy Carter to disorganize a smooth French aerospace export machine.

—William H. Gregory
Paris Air Show

Aircraft
In Flying Display

High-performance military aircraft dominated the daily flight presentations at the Paris air show. In its first appearance at Le Bourget, a U.S. Navy/McDonnell Douglas F/A-18 (left) executes at the bottom of a square loop maneuver with swirling condensation marking the vortex pattern over the aircraft's highly swept leading edge extension. McDonnell Douglas test pilot Pete Pichler flew a demonstration profile that emphasized the F/A-18's acceleration and vertical maneuvering performance. Dassault-Breguet Mirage 4000, flown by Dassault test pilot Jean-Marie Saget, was among the highest performance aircraft at the show. The Mirage 4000 is shown below left with landing gear and speed brakes extended as it approaches for landing. Dassault-Breguet Mirage 2000B, the first two-seat prototype in this new fighter series, approaches for landing (below right) at the end of one of its daily flight demonstrations. The Mirage 2000B, making its first appearance at the Paris air show, was flown by Guy Mitoux-Maurouard, a Dassault-Breguet test pilot. Danish air force/General Dynamics F-16, built in Belgium and flown alternately by General Dynamics F-16 test pilots Neil Anderson and James McSweeney, pulls up for a vertical climb (right) following a low pass over the runway. Wriggling smoke generators mark its path.
Two trainers making their first appearances at the Paris air show were the Aerospatiale Epsilon piston engine trainer (above) and the Siai Marchetti S.211 turbofan trainer (below). The Epsilon, flown by French air force Capt. Marc Yoh, demonstrated impressive vertical maneuvering capabilities. The S.211, shown making a low-level pass during its demonstration, was flown by Siai Marchetti test pilot Alessandro Ghisleni. It is one of many trainers vying for a growing international market.

Flying Display

By Robert R. Ropelewski

Paris—Poor weather, strict enforcement of flying rules, and an absence of new high performance aircraft at this year's Paris air show resulted in a generally restrained flying program, underscoring the business atmosphere of the exhibition and de-emphasizing aerial circus aspects.

A Franco-German C-160 Transall military cargo transport made a gear-up landing following one of its daily flight presentations, and a parachutist was killed in the closing days of the show when his parachute failed to open fully after a low-altitude para-drop, marring an otherwise accident-free program.

Demonstration pilots gathered on two separate occasions to discuss show flying rules and agreed to submit several recommendations that could influence flying displays at future Paris salons.

With some exceptions, high-performance military aircraft continued to be the main attraction in the Paris show's daily flying displays. Except for the U.S. Navy/McDonnell Douglas F/A-18, which was appearing at Paris for the first time, most of the military aircraft performing here were either Paris veterans or variations of aircraft that had been flown here in previous shows.

Daily F-18 displays were flown by McDonnell Douglas test pilot Pete Pilcher, whose flight profile attempted to show the acceleration and vertical maneuvering capabilities of the aircraft. A short takeoff with afterburner was followed by a vertical climb to a half Cuban eight reversal at an altitude of approximately 3,000 ft.

With a speed of about 300 kt. at the
Restraint Under More Restricted Rules

bottom of the half Cuban eight, Pilcher did a four-point aileron roll as he passed along the runway in the opposite direction from takeoff. At the end of the pass, he used a 6-g chandelle reversal to slow the F-18 for a high-angle-of-attack 270-deg. turn at a speed of 185 kt. and an angle-of-attack of approximately 30 deg.

The 270-deg. turn headed the F-18 toward the spectator area, and to avoid overflying the area, Pilcher used an Immellmann maneuver with a left turn at the top to begin repositioning the aircraft for the following maneuver. The Immellmann reversal was accomplished with a gain of only about 1,500 ft. in altitude and ended with an airspeed of about 115 kt.

A descending, high-angle-of-attack left 180-deg. turn brought the F-18 down for a slow pass along the runway at 115 kt. and an angle-of-attack of 23-24 deg. Power required to hold the aircraft at this speed and attitude appeared minimal, and the F-18 appeared to be exceptionally steady at this low speed.

High Speed Pass

Pilcher used an accelerating chandelle to reverse the aircraft's direction and bring it down the runway for a high-speed pass with ailerons rolled left and right before pulling the nose straight up to begin a square loop. The upper leg of the loop was flown at an altitude of about 4,000 ft., and the descending leg included several seconds with the aircraft stabilized in a 90-deg. nose-down attitude.

At least one veteran demonstration pilot expressed some discomfort in watching such a maneuver at such a low altitude for this type of aircraft, but he conceded that the safe recovery from this maneuver after day tended to underscore the maneuvering capabilities of the F-18.

Recovery from the square loop was followed immediately by a smooth pullup to a barrel roll entry to the landing pattern for a final approach and landing. Observers who had seen the F-18 flying display at last year's Farnborough air show said that its Paris display represented a considerable improvement over the earlier show, and established the F-18's place—in terms of acceleration and vertical performance—among the new generation of fighter aircraft such as the USAF/McDonnell Douglas F-15, the General Dynamics F-16, and the Dassault-Breguet Mirage 2000 and 4000, all of which performed at this as well as previous Paris shows.

Mirage 2000 flying display at this year's Paris exhibition was shared by two aircraft. The first, a two-seat Mirage 2000B prototype, flown by Dassault-Breguet test pilot Guy Mitaux-Mauquard, performed a series of high-g, high-acceleration maneuvers to show the aircraft's maneuvering and climbing capabilities. He also illustrated the aircraft's low-speed capabilities with a near-zero-airspeed maneuver not generally seen at such low altitudes.

The maneuver was begun at the end of a high-g, low-altitude turn and consisted of a pull-up to an 80-deg. nose-high altitude, which Mitaux-Mauquard then held until the Mirage 2000's fly-by-wire flight control system commanded an automatic pitch down. This occurred at an altitude of about 3000 ft. with an airspeed of near 0.

The pitchover appeared relatively smooth, and the aircraft ended up in an approximately 60-deg. nose-down attitude from which a recovery was made with considerable altitude to spare.

The maneuver was included in the show flying display to underscore that the Mirage 2000 has been cleared for flight with no angle-of-attack or airspeed limits from zero to 6000 ft., with load factors allowable up to 9.

Mitaux-Mauquard said that in flight testing the Mirage 2000, the aircraft nose was raised to 90 deg. and maximum lateral stick displacement was applied and held throughout the maneuver with no loss of control.

A second Mirage 2000, the third prototype of the series, was demonstrated in the flying displays with a mottled-blue camouflage paint scheme and an underwing payload of four Matra R.550 Magic air-to-air missiles. This aircraft, flown by Dassault-Breguet test pilot Michel Porta, did not perform the steep climb/low airspeed maneuver.

Air defense variant of the Panavia Tornado variable-geometry fighter also made its first appearance in flying displays at the Paris salon this year. Flown by British Aerospace test pilot David Eagles and navigator Roy Kenward, the aircraft was displayed in heavy combat configuration with four British Aerospace Skyflash and two Sidewinder air-to-air missiles and two external fuel drop tanks. Despite the additional load, the aircraft's vertical maneuvering capabilities showed continued improvement over previous public demonstrations of the Tornado, underscoring the steady increase in thrust coming from the Turbo-Union RB.199 engines powering the aircraft.

Italian Demonstration

Maneuvering capabilities with external payloads were also stressed in flight demonstrations of the Aeronautica Macchi MB.339K Veltro 2, the close-air-support version of its MB.339 trainer. Daily flying presentation of the Veltro 2 by Aeronautica Macchi test pilot Riccardo Durone showed that the MB.339 maintained a comparatively good climb/maneuvering capability even with a heavy external load.

The McDonnell Douglas F-15 flown by McDonnell Douglas test pilot Pat Henry, the General Dynamics F-16 flown by company test pilots Neil Anderson and James McKinney and the twin-engine Mirage 4000 flown by Dassault-Breguet test pilot Jean-Marie Saget continued to provide the spirited performances that have made them the superstars of the European air show circuit in recent years.

Fixed-wing vertical takeoff and landing aircraft have been major attention-getters at European shows for many years, and the appearance of Bell Helicopter Textron's XV-15 tilt-rotor research aircraft at this year's Paris exhibition drew similarly intense interest in its daily flying display. Flown alternately by Bell test pilots Ron Erhart and Dorman Cannon, with NASA Transatlantic Race

Paris—Two French airline pilots were missing and presumed lost during the recent Transatlantic air race for light aircraft.

The two, Jacques Masserot, 55, and Olivier Reclou, 31, were last heard from over the Atlantic bound for Paris from New York on the afternoon of June 10. They were flying a Piper PA-24-250 Commanche and had completed the first leg of the race from Paris to New York.

Winners in the race, held concurrently with the Paris air show, included:

- Twin-engine class—Boyd Munro and Russ Hancock of Australia, flying a Piper PA-31 Navajo, with a elapsed time of 29 hr 43 min. and a compensated time of 28 hr. 13 min.
- Single-engine class—Robert Mortari of Perkasie, Pa., and Thomas Danaher of Wichita Falls, Tex., on a Beech E-35 Bonanza, with an elapsed time of 38 hr. 29 min. Patrick Fourtick and Bernard Lamy, both of Paris, flying a Piper PA-32 Saratoga, had the best compensated time of 42 hr. 4 min.

French officials said the race would be held again in conjunction with the 1983 Paris air show.
Single-seat and two-place versions of the French Mirage 2000 fighter also performed in daily flight demonstrations at the Paris air show. Single-seat Mirage 2000 prototype (above) in blue camouflage paint scheme makes knife-edge low pass along the Le Bourget runway. The single-engine aircraft carried four Matra RS50 Magic air-to-air missiles beneath its wings. Two-place Mirage 2000B (below) rolls inverted as it passes spectators at Le Bourget. The aircraft performed an unusual zero airspeed maneuver during its flights, demonstrating that it has been cleared for flight with no maneuvering restrictions.

Test pilot Dan Dugan serving as copilot for both, the XV-15 display consisted of a vertical takeoff and hover in front of the spectators, sideward and rearward flight, a transition to conventional fixed-wing flight, and a transition to hovering flight and a vertical landing after a few minutes of fixed-wing flight. The display underscored the aircraft's handling ease in both the helicopter and fixed-wing modes, as well as the relative noisiness of the tilt-rotor concept compared with a normal helicopter. Likewise, the display showed that the aircraft could perform all its functions with little change in fuselage attitude, from slow-speed rearward flight to forward flight at cruise speeds.

After lifting into a hover, with engine nacelles and rotors at 90 deg. from the normal full-forward position, the aircraft flew sideward to the left for several hundred feet, then reversed its direction to right-sideward flight. From this, a transition was made to rearward flight in which the engine nacelles were rotated to 95 deg. to provide rearward thrust. No yaw difficulties were evident despite strong crosswinds on some days.

A conversion was then made to forward flight by slowly rotating the nacelles forward to slow and stop the rearward drift and accelerate forward. The rate of acceleration increased as the nacelles reached the full-forward, conventional aircraft position, with the full conversion taking about 12 sec.

At 130 kt., the crew began a 2g, 60-deg. bank turn to the left and then a 270-deg. turn to the right for a 200-kt. pass down the runway and past the spectators. A 200-kt. maximum speed and 2g maximum load factor have been imposed on the aircraft by NASA until further flight testing establishes that these limits can be increased. Following the 200-kt. pass, the aircraft was gradually decelerated by slowly rotating the engine nacelles (and rotors) aft until the aircraft was on a final steep approach with the nacelles again rotated to 95 deg.

**Trainer Entries**

The trainer field appeared to have more new entries than any other segment of the market in this year's Paris flying displays. Several new trainers, including piston-engine, propeller-driven aircraft, lightweight jet trainers, and a new competitor in the primary jet trainer category made their appearance in the Le Bourget flying displays. Among these were:

- Socata Div. Aerospatiale Epitop primary trainer for the French air force. Powered by a 300-hp. Lycoming AE10540-L1B5D reciprocating engine and flown by French air force captain Marc Yoh, the aircraft exhibited an unrestricted aerobatic capability.

- Embraer EMB-312 turboprop trainer. In a slightly higher performance category than the Epitop, this new Brazilian trainer exhibited excellent vertical maneuvering and aerobatic capabilities. Powered by a single Pratt & Whitney of Canada PT6A-25C turboprop engine, it was flown in the Paris displays by Embraer test pilots Brasileiro Freire Neto and Luiz Fernando Cabral.

- Microturbo Microjet 200 and Caproni Vizzola C22J, both representing a new category of mini-jet trainers being developed privately in France and Italy for possible military market. Both were powered by two Microturbo T518 turbojets of approximately 220 lb. thrust each. Because of the limited thrust, performances of both aircraft were characterized by long acceleration runs prior to starting any vertical maneuvers.

- Siai Marchetti S.211 primary jet trainer, which only began flying a few months ago in Italy. Powered by a single 2,500-lb.-thrust Pratt & Whitney of Canada JT15D-4C turbofan engine, the aircraft was flown by Siai Marchetti test pilot Alessandro Ghisleni in a series of...
relatively conservative maneuvers that reflected the early development stages the aircraft has reached.

Display pilots of all nationalities had fewer complaints this year than at past Paris shows over heavy-handed treatment by the salon’s organizers and flight controllers. All the same, two meetings were held by demonstration pilots during the show to draft a set of recommendations for presentation to the show’s organizers.

Most of the recommendations were aimed at reducing pilot workload both before and during their aerial performances. One recommendation, however, was intended to protect the mandatory preshow orientation flight of air show pilots with designated French test pilots.

Some of the recommendations to the organizers included:
- Closure of the airport to all traffic not associated with the flying demonstration during the portion of the day when high-performance aircraft are flying. During this year’s show, some customer demonstration flights and other departures were allowed from another runway during flying displays over the show runway.
- A separate air show frequency for control of the aircraft flying in the flight displays. The assembled pilots agreed that the French airport controller’s radio procedures were better this year, compared with previous years, but that there was still more radio traffic than necessary.
- Dropping the requirement to file a flight plan prior to each flight, citing the time required to file the plan.
- Easier ground traffic control and better shuttle bus schedules so that pilots would not have to leave for a flight 2 hr. before the flight.
- Establishment of a central location where the pilots and air show personnel could get together and discuss any problems, any changes to schedules or changes in individual flight displays. This recommendation was made in concurrence with the opinion that the air show flight control committee should consist of pilots familiar with aircraft performance, weather and air traffic control procedures.

Orientation Flights

In previous years, new pilots performing at the Le Bourget-based air show could request that a French pilot fly an orientation flight to acquaint the pilot with the area and the procedures used during the show. This year, the Paris air show organizers made the orientation flight mandatory for two-seat aircraft, such as the McDonnell Douglas F/A-18.

As one flight display pilot said: “An orientation flight is one thing, but when the French pilot wants to be briefed on the weapons system, the radar system and other systems on the aircraft, that becomes something else. I would propose we all get our orientation flight prior to the 1983 Paris air show in the Dassault-Breguet Mirage 4000.”

Dornier 228-100 made its first appearance at the Paris air show this year, in both static and flying displays. The 16-passenger aircraft is one of the newest entries in the competitive commuter transport market. It is powered by two Garrett TPE331-5 turboprop engines.

French Ballistic Missile System Tested

Paris—Third test mission for France’s new M-4 submarine-launched ballistic missile ended unsuccessfully when the missile was destroyed in flight. Cause of the test failure is under investigation, but industry officials said the problem may have been due to an error in the missile’s integration prior to launch.

The M-4 is France’s new-generation submarine-deployed missile that is scheduled to become operational in the mid-1980s. It has a range in excess of 3,000 km. (1,863 mi.), and will be capable of carrying six multiple reentry vehicles.

The range capabilities of the three-stage M-4 missile are greater than those of France’s earlier generation of two-stage missiles, which have been deployed both on land and in submarines.

French industry officials said the M-4 test failure apparently did not result from any basic design problem with the missile. The test flight had followed successful M-4 tests in November, 1980, and February, 1981.

Initial M-4 testing is being conducted from the Centre d’Essais des Landes (CEL) in southwest France. Future evaluations will include sea trials on the French test submarine Gymnote.

Operational status for the missile system is anticipated in 1985, when M-4s are to be deployed on France’s sixth nuclear-powered missile-carrying submarine, the Inflexible, which is under construction. It is also planned that other submarines in the French fleet will be adapted to carry the new-generation missiles with modifications to their launch tubes.

Changes for the M-4 from previous French submarine-launched missiles include a wider body diameter, use of a solid-propellant launch-tube ejection method instead of a compressed gas system, and the ignition of the missile’s first stage underwater instead of above the water’s surface. Additionally, France’s aerospace industry experience with advanced materials is being applied to the M-4 through the use of composites on several components.