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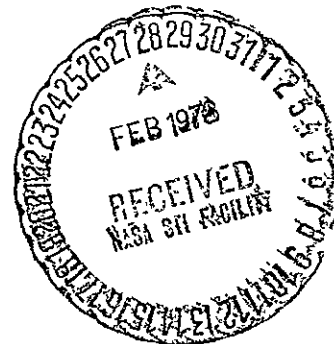
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A NEW HELICOSTAT FROM SNIAS HELICOPTER DIVISION

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16 Abstract

The Helicostat can be viewed as a helicopter in which the vehicle weight is nullified by two balloons arranged in a catamaran fashion. Development of such a vehicle, the prototype of which could fly in two years, would involve a very low technological risk since a market has already been identified.

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HELICOSTAT FROM SNIAS HELICOPTER DIVISION

History, it is said, is an eternal new beginning, a new illustra- tion of this adage has just been given by Aerospatiale through its Helicostat project, a hybrid machine - half balloon, half helicopter - which was recently the object of a press conference at the Bois Technical Center[1].

The new machine is in reality the distant son of the helicostat of Etienne Oehmichen, a French engineer born in Chalons-sur-Marne in 1884 and who remains for historians of aeronautics the first to have succeeded on May 4, 1924 - more than 52 years ago - in making a stable helicopter fly over a one-kilometer closed circuit in Valentigney, in the Doubs Department. The machine used, the second built by the French pioneer, weighed 1100 kilograms. It was equipped with a 180 HP rotary engine driving twelve propellers or rotors designed to insure sustentation, translation, and direction.

The First Helicostat

But Œhmichen, a tenacious engineer and a first-class theorist, was a born researcher, his tests had convinced him that it was difficult to stabilize a helicopter without using complex methods.(his No. 2 helicopter owed part of its stability to an actual gyroscopic flywheel provided by the rotary engine that was used.) Therefore, he built a theory on the stability of machines with rotating airfoils that was remarkable for that time in history. While the Marquis Pateras Pescara was able to make fly[+], with difficulty, the first helicopter with counter-rotating rotors equipped with two control devices that

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*Numbers in margin indicate pagination in foreign text.

[1]See _Air et Cosmos_, issue #650.

[+]in 1923 and 1924 at Issy-les-Moulineaux.

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were universally adopted later.
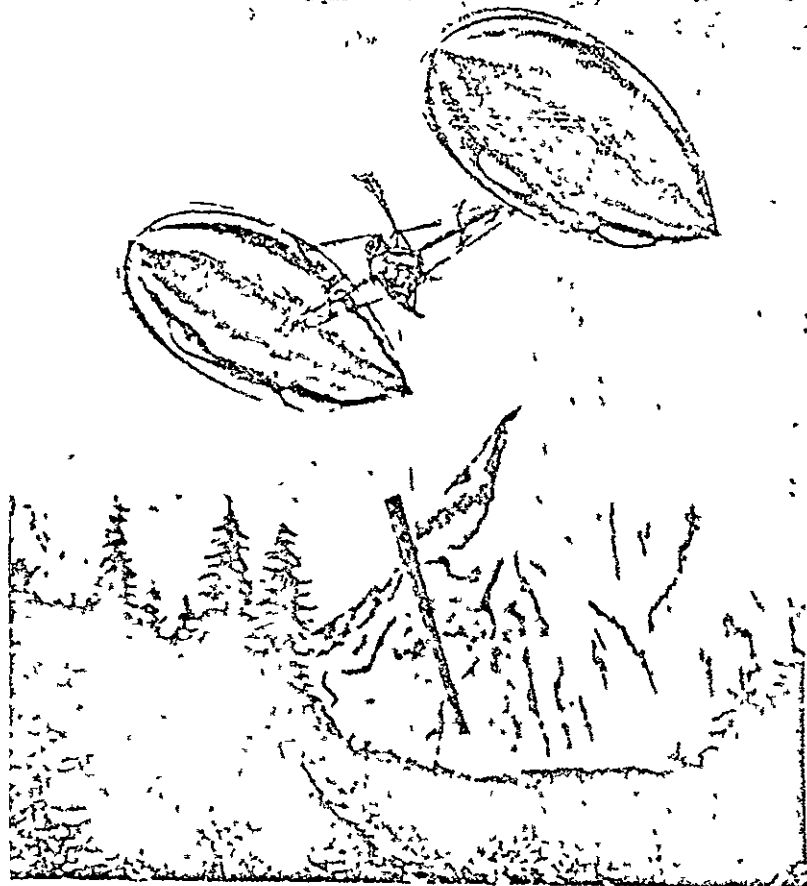
Œhmichen was attempting to show that there was a simple means of auto-
matically stabilizing the helicopter, raise its center of gravity and
its center of pressure ("bound volume" effect) by equipping it with a
balloon inflated with air and placed above the rotors.

Evidently, such a balloon did not take part in sustentation and
therefore only had a stabilizing effect. In reality, the first craft,
tested on January 15, 1921, actually had a 100 m^3 lifting balloon
built by Zodiac and designed to lighten the entire assembly by 70 kg,
as the Dutheil-Chalmers 25 HP engine was inadequate to lift Œhmichen's
No. 1 helicopter which weighed 370 kg. Three of the later craft (Œh-
michen built at least a total of seven) were true "Helicostat" in the
sense intended by their creator; that is, craft rising thanks to lif-
ting rotors but lightened by a balloon inflated with hydrogen.

As early as 1931, Œhmichen had mastered the problem perfectly,
his fourth machine, topped with a spindle-shaped 550 m^3 envelope built
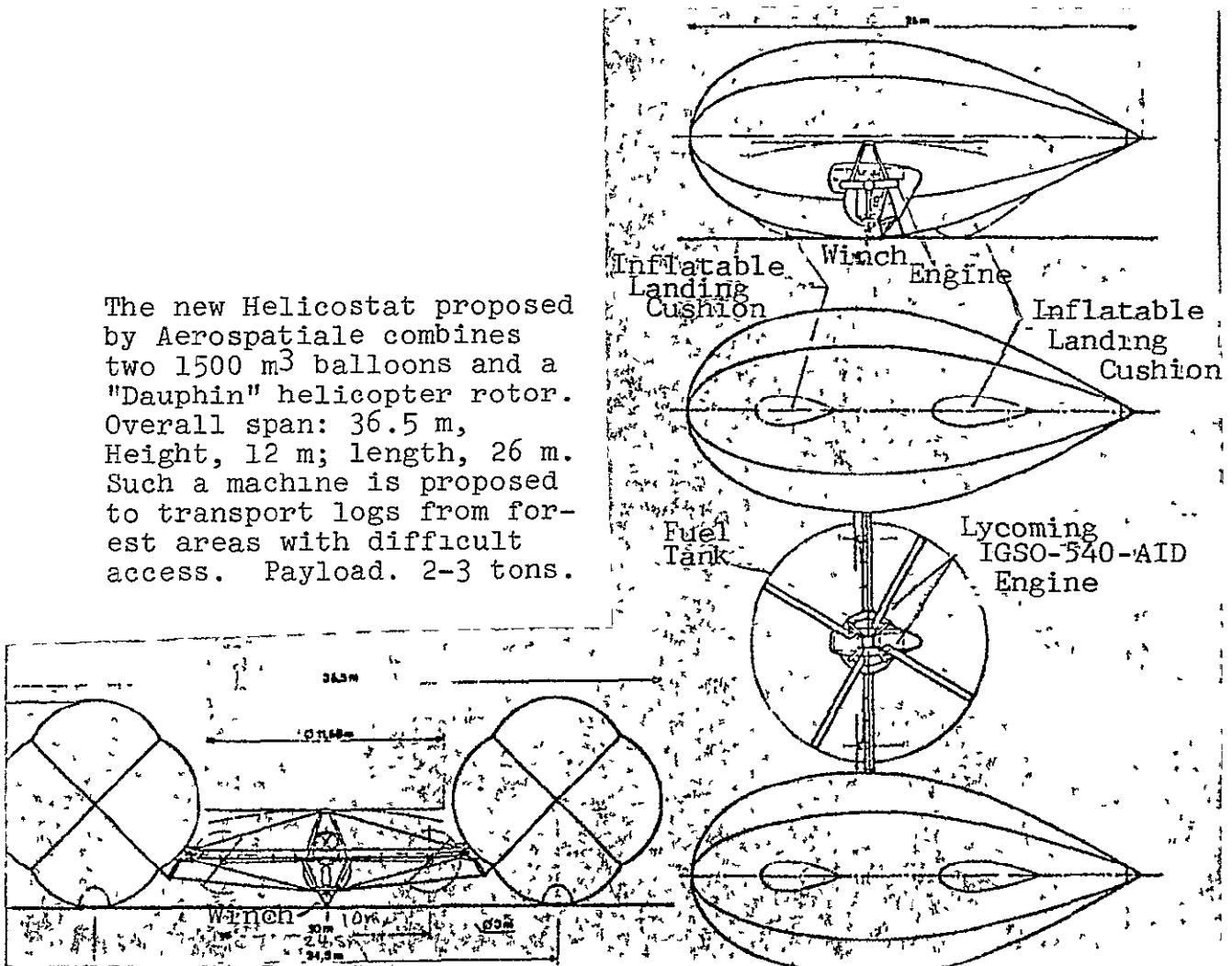by Zodiac, flew at Orly, demonstrating total maneuverability, a key to

very good safety. It was equipped with a 40 HP Salmson engine driving two tractive propellers with variable and reversible pitch, and two propellers with slanted shafts. Two hundred hours of flying were completed in that fashion in all types of weather. Fifty percent of the lift was obtained thanks to 400 m^3 of hydrogen.

In 1932 the second Helicostat by Œhmichen appeared, built with the assistance of the aeronautical equipment company, "Claude et Hatton". We can ask ourselves, 45 years later, why the formula was never adopted. Potential users, the army primarily, undoubtedly had their attention monopolized by the large dirigibles and by the first promising tests of autogyros by Juan de la Cierva. Thus, the first generation helicostat disappeared, even though it was the simplest rotary wing aircraft. It could have led to the creation of a family of mixed "balloon-helicopter" craft offering numerous possible combinations of lift distributions between the rotors and Archimedes' principle and much easier to use than classical "dirigibles". The reappearance of the balloon + rotor combination in the shape of the new Aérospatiale Helicostat (let us mention that Aérospatiale makes reference to Œhmichen's work) is the indirect consequence of the movement toward lighter-than-air craft that has been taking place over the last years. In France, this has materialized with the creation of the "Association d'Etude et de Recherche sur les 'Aeronefs Allégés'"* or Aérall. The November 1973 symposium organized in Paris by Aerall was the point of departure of a "high interest movement". In 1975, ONERA and Aerospatiale released information on the Obelix" project[2], a multiballoon craft equipped with eight helicopters rotors ("Super Frelon") and capable of lifting 500 tons. E.D.F., we remember, was studying the problem of transporting and installing large tanks for its future nuclear power plants.
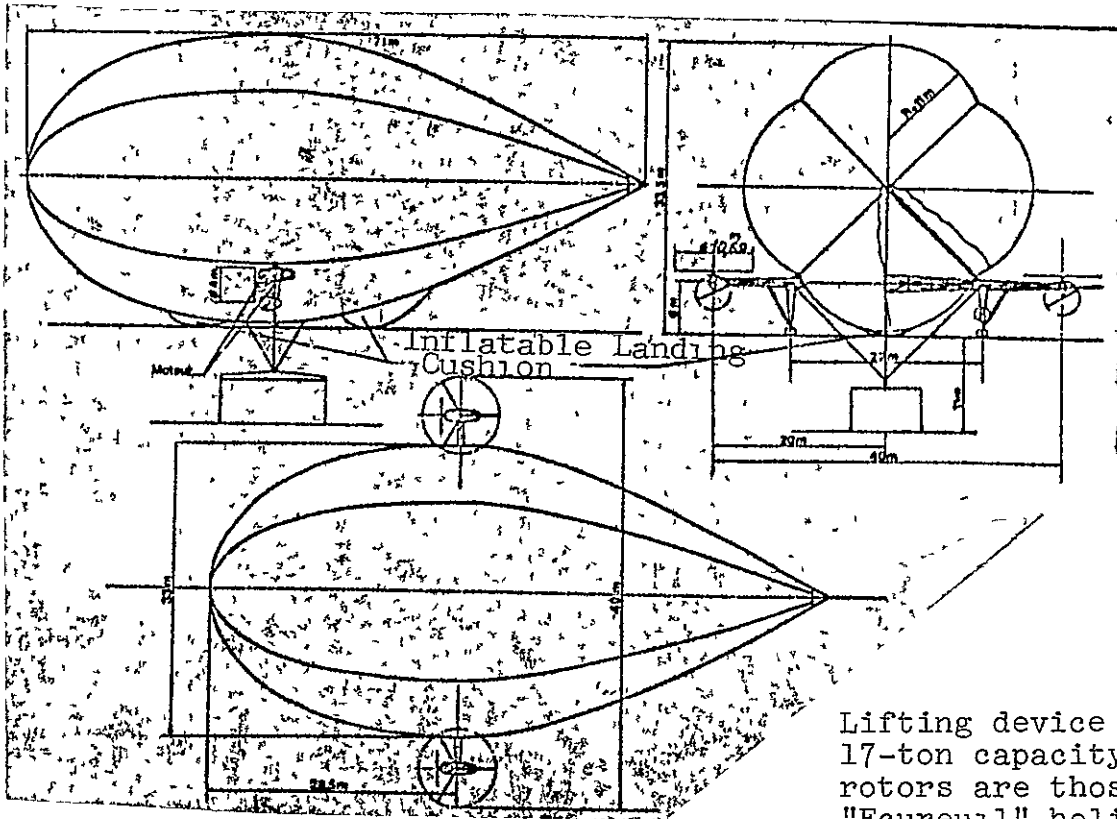
The "Obelix", like other projects (let us mention in particular the lenticular dirigible "Titan" by M. Balaskovic) sinned, however, in one direction: gigantism. The necessary funding was large, risks were not negligible and E.D.F..was in a hurry. Therefore, we no longer talk, temporarily perhaps, of the "Obelix" project, but the idea has been launched and the small working groups formed around these projects

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[2]Air et Cosmos, nos. 563 and 564.

The new Helicostat proposed
by Aerospatiale combines
two 1500 m³ balloons and a
"Dauphin" helicopter rotor.
Overall span: 36.5 m,
Height, 12 m; length, 26 m.
Such a machine is proposed
to transport logs from for-
est areas with difficult
access. Payload. 2-3 tons.

Inflatable Landing Cushion

Winch

Engine

Inflatable Landing Cushion

Fuel Tank

Lycoming IGSO-540-AID Engine

Winch

Lifting device with a
17-ton capacity; the
rotors are those of the
"Ecureuil" helicopter.
Total weight: 30 tons.
Span, 40 m. Height, 33.5
m. Length: 71 m.

have had the merit of clearing up the problems.

A Need. Removing Logs from Forest Areas

Meanwhile, (in June, 1975) experimental flights performed in the Isere Department with a "Lama" crane-helicopter belonging to Aerospatiale had shown the advantage of using helicopters to clear logs; that is, to transport felled trees (in areas difficult to reach) to /21 the road network. For a lack of cablemen, cable systems used to carry logs over forests were gradually disappearing, particularly since their cost of operation was too high.
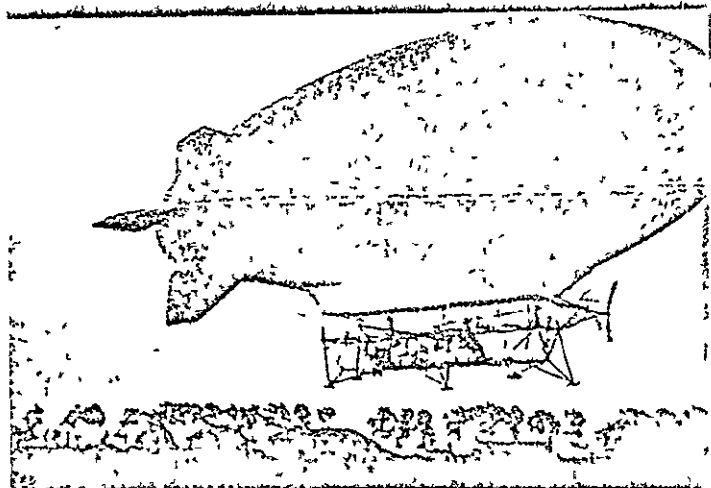
The number Four craft by Etienne Œhmichen was the first to bear the name of "Helicostat". Between 1929 and 1931 it completed 200 flying hours, including a 30 minute demonstration hovering at an altitude of 300 meters, no-power landings and stable flights with the control stick released. Fifty percent of the lift was provided by two tiltable rotors driven by only a 40 HP engine. The other half of the lift was provided by 400 cubic meters of hydrogen.

350,000 Tons Per Year

Now, large quantities of timber are available from mountain forests (at least 350,000 usable tons annually). This timber is left in the forest when forestry preservation (timber that is not removed rots and the forest degenerates) and our balance of payments should induce us to exploit all forest areas. By recovering each year 350,-000 additional tons of lumber, we would save 0.35 billion francs, or nearly 50% of imported fir and pine lumber.

The situation is the same in many countries: Switzerland 240,-000 to 1,000,000 tons per year; Austria, 280,000 tons per year; Norway, 1.6 million tons per year, etc. Experiments conducted with the "Lama" have shown that the latter was superior to cable systems in spite of the handicap of the relatively small load sling-lifted (900 kilograms). At the end of 1976, more than 6,000 tons of timber had been removed in that fashion in the province of Haute-Savoie, then in the province of the Pyrenees Atlantiques, but the situation would be even better if the cost of lumber removal by air could be reduced and if cutting large logs into smaller sections could be avoided (need for a higher load-carrying capacity).

From this came the idea to apply the work performed by the "Aerospatiale study group for aerostatic machines" to build a light-weight machine capable of lifting 2 to 3 tons. By seeking to optimize the "balloon + rotors" combination, engineers finally arrived at a hybrid machine that we can consider as a dirigible with lift and maneuverability characteristics greatly increased by a helicopter rotor, or as a helicopter with its own weight counterbalanced by balloons which would evidently make it possible to increase the lift capacity by that amount.

New Formula

Correctly named "Helicostat" (even if its definition does not exactly match Œhmichen's concept) the machine proposed by Aerospatiale would be even easier and more economical to build as we have made an effort to use a maximum number of low-cost and existing components. The technological risk appears to be virtually nil and so does the industrial risk, since the demand - which already exists - has been identified; only the building of a prototype that could fly in two years remains. Government agencies, moreover, seem to be sold on the Helicostat idea and could participate in the financing of its development.

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Description of the New Helicostat

The formula that has been adopted is that of the "catamaran", two 1500 m^3 keels connected by a transversal beam supporting the engines, propellers, rotor, cockpit, and winch. To park, the craft lands on small reinforced balloons located on the bottom portion of the keels. These include an external envelope pressurized with air, internal small balloons inflated with helium, and a beam and stiffeners providing rigidity and transferring forces.

This piston engines would be Lycoming IGSO 540 AID engines, each furnishing, at continuous maximum power, 360 HP between 0 and 3200 meters of altitude and driving;

- two pusher-type variable pitch propellers, 3 meters in diameter, providing also yaw control and playing an anticoupling role;
- one rotor, 11.68 meters in diameter. In fact, it is the rotor used in the SA 365 "Dauphin" equipped with a "Starflex" hub assembly The rotor driving assembly is also that of the SA 365.

The computed weight budget is the following:

- Empty weight, fully equipped: 2428 kg (567 kg for the keels, 639 kg for the structure, 975 kg for propulsion, 247 for the pilot and equipment),
  - Fuel, 407 kg,
  - Weight when ready for use, 2835 kg.

The Empty weight being counterbalanced by the small balloons filled with helium, the maximum payload (load plus fuel) is then equal to the rotor lift force, or:
- with two engines: 3000 kg at ground level, 2400 kg at 2000 m. with standard atmospheric conditions plus 20 (22°C)
- with one engine: 2100 kg at ground level, 1600 kg at 2000 m, and 22°C.

Maximum speeds remain relatively high. with two engines, 90 km/h empty, 86 km/h loaded; with one engine, 61 and 54 km/h, at 2000 m and

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22°C; 104 km/h empty and 93 km/h loaded (76 and 68 km/h with one engine). These speeds are in any case very adequate for the type of applications planned.

Maximum Safety

The total mass can therefore reach about 5400 kg. However, the weight does not exceed that of the payload. This explains the very high safety factor that this formula brings; in case of failure of one engine, the craft descends (slowly) only if the payload exceeds 2 tons. In the very improbable case where both engines stop simultaneously, the free-fall velocity with a full load is 15 meters/second. However, if we assume that the sling is 30 meters in length, as soon as the payload touches the ground, the weight becomes nil or very low (that of the fuel) and the fall rate decreases rapidly; at 10 meters it is only 7 meters/second and the Helicostat touches the ground at 4.4 meters/second. The keels inflated at low pressures then act as shock absorbers. The "catamaran" formula has been selected for obvious reasons. twin-engine formula with a single rotor (no separate systems on each side of a single balloon; safety further increased by having the balloons protect the rotor; cockpit in a center location; elimination of the landing gear, and finally, lower manufacturing cost.

Let us mention further that, in the case of small payloads, it would be possible to fly economically with a single engine.   /22

Operational Costs

Operational costs have been analyzed: cost per flying hour would be less than 1500 FF for 1000 hours per year As for productivity, it would be 50% greater than that of the helicopter, the lifting capacity more than compensating for the increase in round-trip time (the helicopter is faster). For example, for respective times of 5 and 3 minutes, productivity is 19.2 tons/hour against 13.6 for the "Lama". Then we have in this particular case (20 trips for the "Lama" 12 for the Helicostat) an average cost per ton of 100 to 120 French

francs for the Helicostat and 175 to 190 French francs for the "Lama"
(125-225 for cable systems). It is not therefore surprising that lum-
ber companies and specialists in this field are interested in this
future machine.

The Aerostat

But Aerospatiale is not only interested in the Helicostat, al-
though this device is the fastest and least expensive to build and also
the one for which an immediate application can be analyzed with great
accuracy, thanks to experience acquired with the "Lama" used for lum-
ber operations by the company "Air-Forêt".

The transportation of heavier loads (internal structural compo-
nents) is still under study, using the "Aerostat Formula", that is to
say, a device with a lift capacity that includes the load provided by
a single aerostatic force, one or more rotors being used only for pro-
pulsion and control. It is the formula used in the "Obelix" but applied
to much lower loads, 15 tons for example. For more than a year, dy-
namic mooring tests applied to such an Aerostat have taken place,
using a small Zodiac balloon of about 10 m^3, equipped with five fixed
pitch propellers driven with electric motors (see our magazine cover);
the whole assembly is controlled about all three axes (one propeller
provides thrust; two propellers control pitch, two others control yaw).
through automatic systems (attitude control systems) devised in coop-
eration with SFENA. Sensors are accelerometers for pitch and a magne-
tometer for yaw. Dynamic mooring, that is, the immobilizing of the
craft relative to the ground, is obtained with a system using photo-
electric cells.

The pilot controls the craft by remote control, using stabili-
zation control systems. This overall system gives good results and
on a real craft it would be possible, in order to position building
structural components, to obtain very accurate positioning relative
to the ground with relatively simple means.

Aerospatiale (Aircraft and Helicopter Divisions) estimates that development with Zodiac and SFENA of a 30,000 m³ Aerostat having an empty weight of 11.5 tons and with a commercial payload reaching 17.5 tons would require 4 years to reach the operational stage. Such a craft, because of the need for ballasting after depositing its payload on the ground, would have low turn-around frequency but would be justified by the nature of the projected function.
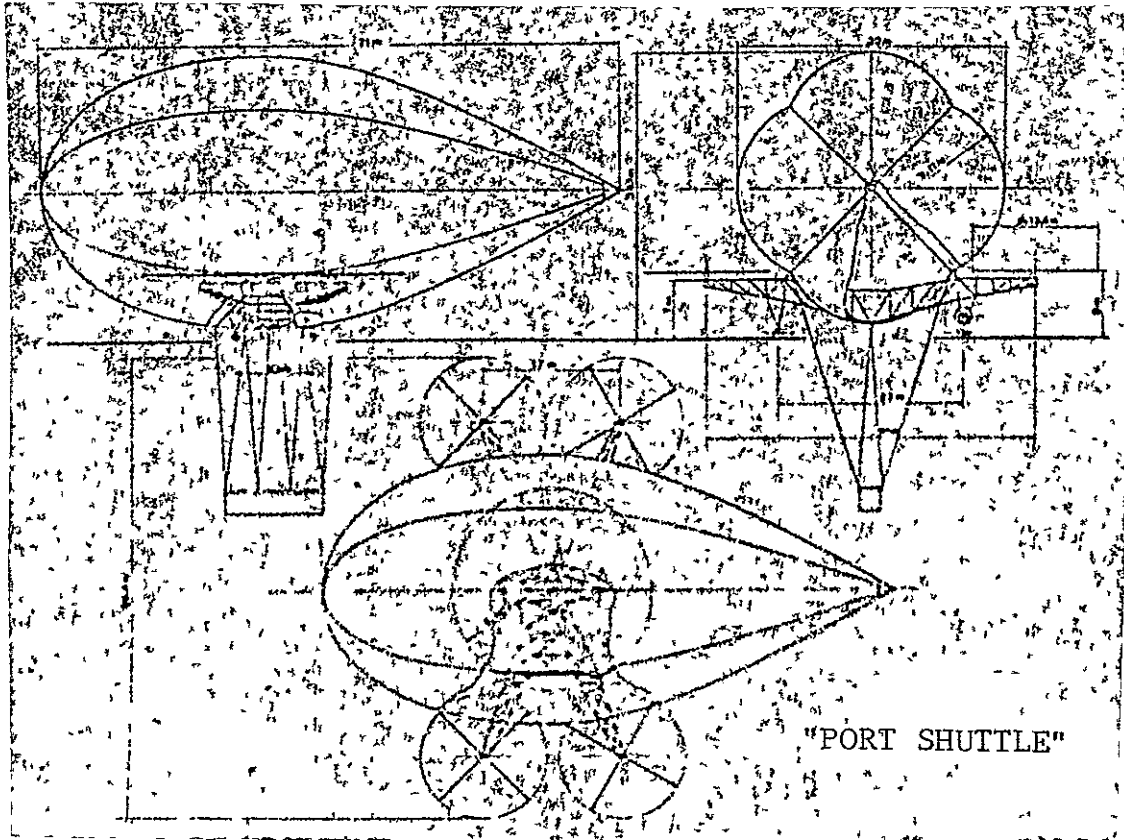

The Port Shuttle

For shuttle-type operations applied, for example, to servicing ports (loading and unloading ships) that are inadequately equipped, Aerospatiale returns on the contrary to a formula that is closer to the Helicostat in its "Port Shuttle" project which, for a comparable envelope volume (30,000 m³, 71 meters in length) would be capable of lifting maritime containers 40 feet (12 meters) in length and to set payloads in place accurately in spite of 20 knot winds with 5 meter/second gusts from any direction. High engine power is thus necessary. This has led to a 30-ton payload Helicostat project with four "Super-Puma"-type rotors (with Starflex drive shaft), driven by eight 1800 HP turbines (i.e., a total installed power of 14,400 HP). Such a machine also 71 meters long, would have an empty weight of 20.5 tons, and a take-off load of 54 tons with 3 tons of fuel and 30 tons of merchandise. The four rotors could tilt slightly. Claimed autonomy: 3.5 hours; maximum speed: 125 km/h, distance that can be covered, greater than 300 km.

Such a "Helicostat" would have applications that are important, since the choking of certain seaports is not about to be resolved rapidly.
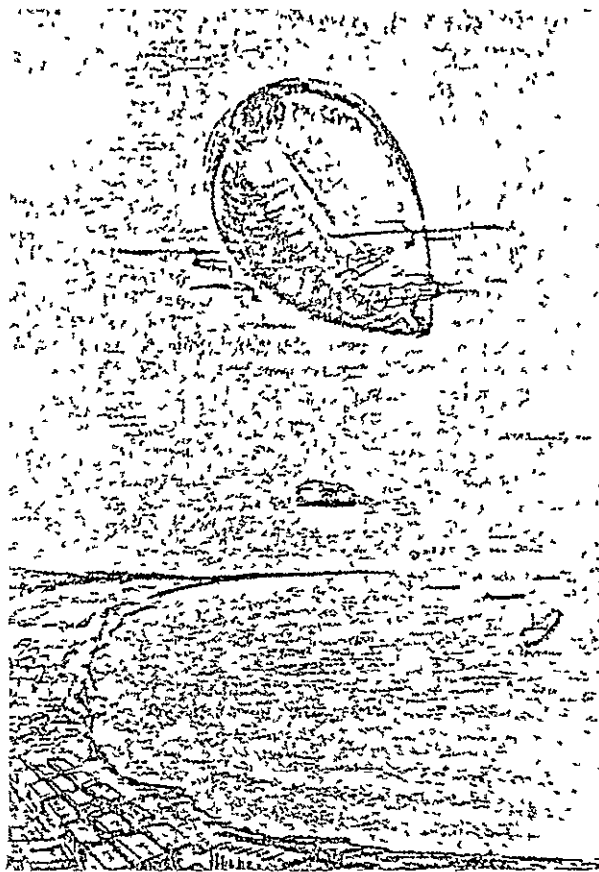
Utilization of a Port Shuttle Capable of loading 30-ton containers.

"PORT SHUTTLE"

Characteristics of the Port Shuttle project. the
four-lobed envelope has a length of 71 meters and
a diameter of 33 meters. The four "Super-Puma"
rotors increase the span to 41 meters.