Reaching for the Skies

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Preparing for Vega...

Editorial

Coming back after fifteen years to take charge of the Directorate of Launchers makes me feel rather like a latter-day Ulysses. Like him, I am struck by the magnitude of the changes that have taken place. I remembered Launchers as an engineers' paradise, but find myself in a hard-nosed business world.

There have been some revolutionary changes. Firstly, we've had a commercial revolution, the signal for which, in Europe, was given with the creation of Arianespace. Secondly, there is structural revolution, with vertical industry consolidation in the USA and Europe. At the same time, a far-reaching cultural revolution has taken place. Just try to imagine fifteen years ago someone suggesting that Russian rocket engines might be used in US Air Force launchers!

Amidst all these changes, things have been remarkably quiet on one front: most of the technology we use today dates back fifteen years. This is a challenge that has yet to be faced.

Ariane is a paragon of excellence in Europe. If we are going to consolidate and build on it, the launcher sector must adapt to the larger world around us. We need to broaden the role played by governments, including strategic investment and market intervention. We need to open the sector to international cooperation, while strengthening European solidarity. Finally, we must greatly accelerate the development of new technologies. ■

Jean-Jacques Dordain
Director of Launchers

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Reaching for the Skies
Contributions (in English or French) should be sent to the coordinator:
Philippe Willekens, ESA - D/Launchers
8-10, rue Mario-Nikis, F-75738 Paris
Phone: (33)1 5369 7388
Fax: (33)1 5369 7678
E-mail: Philippe.Willekens@esa.int

Writing: Michel Guyon
Editors: Bruce Battrick & Huguette Sawaya
Layout: Eva Ekstrand
Illustrations : Richard Roussel
Photos: ESA-CNES-Arianespace-Service optique CSG, Air Liquide, Cyospace, Snecma Moteurs
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Major firsts for Envisat

The Envisat campaign was ushered in on 26 March with the arrival in French Guiana, on container ship "Le Toucan", of various items of ground equipment. More followed as air cargo on 9 and 16 May. Envisat itself arrived on an Antonov aircraft in two parts: the Service Module, responsible for keeping the satellite operational, and the Payload Module housing the actual mission instruments. Measuring some ten metres high once assembled, Envisat will call for a large fairing. This is going to be a first, as is the use of the brand-new EPCU payload preparation complex (see facing page). Only two of the three rooms will be used: ES5-C for satellite integration/verification and ES5-A for filling with propellants. The campaign continued through to 14 July with a break until mid-August; the launch is scheduled for the end of the year.

MORE on the WEB

Busy schedule leading up to Ministerial Council

Business scheduled for the November Ministerial meeting of the ESA Council includes many decisions awaited regarding launchers: Ariane-5 Plus development, funding to meet the fixed costs of the CSG and the Ariane launch sites, the Ariane Research and Technology Accompaniment programme and the reusable launcher issue, plus the response to Russia's request to launch Soyuz from Kourou. In the meantime, attention is focussing on preparing for these decisions, at two levels. To deal with matters specific to launchers, the Ariane Launcher Programme Board will be meeting monthly. In parallel, a Council Working Group - likewise meeting monthly but addressing the broader agenda - will integrate "launcher" business with that relating to the "Space Station", "Applications" and "Science".

Kourou gets boost from EPCU-S5

With the opening of the EPCU-S5 in Kourou, things will never quite be the same again. Inaugurated only recently, the new payload preparation complex - cofunded by ESA (30%) and Arianespace (70%) - will radically alter how things are done at Europe's Space Port.

Until now, satellites were accommodated in the first instance in a building reserved for non-hazardous operations. There, the customers would check out their hardware. The payload would then be transferred by lorry to an area a safe distance away from office buildings for fuelling. "In each case, precious time was wasted on packing and unpacking," explains Philippe Rolland, Arianespace mission manager. The operation was then repeated for the journey to the final assembly building.

But from now on, while the trip goes via the BAF, all preparatory operations can be conducted simultaneously at the EPCU. Its great asset is its air-cushioned payload transit passages between the three main clean rooms. And while the satellite constellations that this configuration was designed to handle are now on hold, the EPCU, with its 3000 m^2 of clean rooms and 20 metre high ceiling, will not be lying idle. "With the larger spacecraft now on the way, this is no luxury," says Philippe Rolland. Especially as the complex will also have to accommodate the nine Automated Transfer Vehicles (ATVs) intended for servicing the International Space Station.

"We would never have been able to prepare ATVs in the old rooms. While four-to-five tonne satellites can be handled using standard gantries, things are quite different when you're manoeuvring gigantic hardware weighing over 20 tonnes," explains Rolland.

Thanks to these unique assets, EPCU-S5 should make it possible in the short term to increase turnaround rates, now that Kourou has four filling rooms instead of just one.

MORE on the WEB

Beluga delivers choice caviar!

Munich airport, 28 February. Rather like an Ariane-5 whose fairing parts to release its payload, the "Beluga" Airbus half opens to deliver its cargo. The comparison is apt enough, as the cargo in question is none other than the dynamic model of the ESC-A cryogenic upper stage – the upgrade soon to be fitted to Ariane-5. It will have taken Astrium five months to complete its integration, in Bremen (D). What is more, a new multi-purpose integration stand was also inaugurated and validated in the process. Next stop for the ESC-A: a campaign of tests at IABG in Ottobrunn (D).

Interview with **the new Director of Launchers** *Jean-Jacques Dordain*

Last February Jean-Jacques Dordain replaced Frederick Engström at ESA's Directorate of Launchers. In an interview with RFS he talks about his first impressions and his personal management style, gives his take on the current market, and outlines his strategy.

Tell us a bit about your first few months on the job.

I'm still in the learning stage. The important thing for me is to establish a close relationship with my new colleagues. I'm someone who prefers talking to people around a table, rather than on the phone or by e-mail. So I don't even have a computer in my office! I'm trying to apply what I learned in the Directorate of Strategy (from 1993 to 2001). My belief is that the best way to motivate a team of people, especially a small group like this Directorate, is to involve them fully in what's going on. So I hold weekly meetings with all the staff, reviewing what was discussed the previous week, the results, and the prospects for the upcoming week. I hope that it helps them in their work.

And outside the Directorate?

I thoroughly enjoyed the conceptual work that I did in the Strategy Directorate, but it's worlds apart from working with a roaring engine on a launcher. I spent fifteen years of my life in research, so it's in my blood: I need to know what's happening at the coal-face, in the industry. But right now there's no time for visiting our industrial partners, and I devote a considerable amount of attention to the Delegations. This type of contact is a crucial part of the preparations for a Ministerial Council. Delegations need to understand the logic behind our proposals, and we need to understand what they expect from the launcher programmes.

Vega – your first major task?

This programme was decided just two months before I arrived, so it was my predecessor who should be credited with rallying the support needed to initiate this programme. Now we have to start constructional work, looking ahead to 2005 and the first launch. This will be the first time that ESA will be managing the technical side of the development of a launcher, so it is a real challenge. I have already detected a lot of enthusiasm, among the ESA teams as well as in industry.

Looking further ahead, what is your assessment of the global market for launchers?

The market is changing very rapidly. Today it consists mainly of large geostationary communications satellites. But parallel to this coveted segment, there is also a smaller, much more diverse institutional market that includes scientific satellites and interplanetary probes, but also the ATV for the International Space Station. We have to examine our strategy for coping with this diversity, so a range of competitive launchers will be needed. Maintaining our own access to space and reducing costs are the two most important factors for Europe; naturally, this does not rule out international cooperation.

But international cooperation is already a reality in Europe, isn't it?

Of course. The thing to remember is that the process of globalisation is driven by markets, and so creates strains and stresses within Europe, while our governments have a mandate to strengthen the fabric of European cooperation. Just look at the existing areas of cooperation with non-European partners: it takes place in a national, not European framework, with German-Russian companies like Rokot, and Franco-Russian ones like Starsem, the Soyuz operator. Or look at European industry, where you have Switzerland's Contraves and Sweden's Saab-Eriksson working on the American Atlas-5 programme. What's holding us back is the fact that there isn't a unified policy behind European cooperation. We need to define a single European policy that will encompass all the stakeholders. Once that is done we should discuss the roles that can be played by governments, space agencies and commercial firms in this cooperation. The important thing is to maintain consistency among ourselves, so that collaboration on international projects is not perceived as harming European solidarity.

Is this the only European weak spot?

We don't do enough technology development here. Naturally, governments fund the development of programmes, and Europe spends a lot of money on the overhead costs for the Kourou Space Centre and launch complexes, to ensure a level playing field for Arianespace. But there isn't enough funding for advanced technology. This is true for conventional launchers, but even more so for reusable launchers, where efforts are fragmented, to the detriment of overall effectiveness. And yet this is precisely where we can expect a technology revolution that will open up space to a larger body of users.

Is November's Council meeting likely to move things along?

I don't think that this Council will completely adjust the balance of investments, or set up any important new schemes for international cooperation. However, it may indicate the direction in which the launcher sector should be moving in the years to come, including the organisation of the public sector and its relations with industry. ■

Shooting for the stars

1969. Engineering degree
"What I liked most about my studies? Finishing them! My graduation coincided with the first human landing on the Moon. That left a lasting impression."

1976-1991. Lecturer at the Ecole Polytechnique (Department of Mechanical Engineering)
"Teaching is the most important profession I ever practised. For me it was a valuable and richly rewarding experience."

1977. Selected as one of the first five CNES astronaut candidates
"It was the first selection of this type in France. It was an exciting time and taught me a great deal about myself, physically and psychologically. I was appointed to head ESA's astronaut office (from 1986 to 1993), but I never got an opportunity to fly. And 20 million dollars is still a lot of money..."

1977-1982. Coordinator for space activities at ONERA (Office Nationale d'Etudes Aérospatiales)
"This was my first real job, and it profoundly shaped me. I learned an enormous amount, working in different posts. ONERA teems with high-powered engineers from all disciplines."

1985. Edmond Brun Award from the French Academy of Sciences
"Among the prizes I have been awarded, this is the one that touched me the most. It was the first time it had been awarded, but more importantly, Edmond Brun had been my professor, and I learned so much from him."

1990. Chairman of the Board of Enquiry into the failure of the first MAXUS launch (sounding rocket for microgravity research)
"A board of enquiry is expected to carry out a meticulous search for clues and then to reconstruct exactly what happened, all in the space of a few weeks. It's a gruelling experience, especially as it takes place in the emotionally charged atmosphere created by a failure. Working at Kiruna, Sweden, 100 km north of the Arctic circle, was a magical experience. There was the feeling that we were walking on completely untouched land. Not quite the Moon, but almost!"

1997. Executive Secretary of NASDA's Evaluation Committee (Japan)
"I've worked in Europe and in the USA, but Japan was really special. It is a different world. And the Japanese really appreciated the efforts I made to understand their point of view."

Preparing for Vega...

The solid boosters for the Ariane-5 launcher are processed in the heart of Fiatavio's Colleferro complex not far from Rome, home to some of the finest technology know-how in Italy. The smoothly functioning machinery is now being geared up to produce components for Vega, on the same assembly lines and using the same tooling. In the meantime, the plant is anything but idle.

The first thing that strikes a visitor to Colleferro is the line-up of containers in the yard. They bear the ESA logo and are waiting for the ship that will take them to Kourou. The containers are the 'outer shell' for the cylindrical segments of booster case for the Ariane-5 launcher. Inside, the segments are already covered with a high-performance protective liner. Behind them lie weeks of painstaking treatment in Fiatavio's Colleferro plant near Rome, an indispensable stage on the path to success for the Ariane-5 booster – and tomorrow, for Vega.

The launcher components are brought from Augsburg by a special train, then transferred to trucks for the trip to the production plant. On the way, they traverse the ten hectares of the plant site. Old factory rail lines and a row of dilapidated buildings near the entrance are mute witnesses to a hundred years of history, relics of the industry as it appeared in 1913.

Ideal situation

That was the year it all began for Colleferro, against the sombre background of a Europe that had itself become a powder-keg and was poised for war. From that grim beginning, the site has steadily evolved, as illustrated by the historical maps displayed at the plant's entrance. The demand for powder rose continuously, for military applications but also the mining industry. The location was found to be perfect for delicate work with explosive substances: an ideal

Focus

on Francesco Depascuale

Head of production and development of new technologies at Colleferro

Aged 46, this aerospace engineer has spent half his life in the business. A graduate of Milan's Scuola Politecnica, he has performed research on Ariane-5 solid-propellant motors, before being appointed head of engineering by Fiatavio. He spent four years in Paris as the head of the solid booster stage programme for Europropulsion. He is a permanent member of the Comité Technique of Arianespace.

level of atmospheric humidity, the coast situated nearby, a protective circle of hills to discourage low-flying air attacks, and the absence of any major settlements. It was not until 1935 that Colleferro came into existence, and not until the 1950s that it developed into a full-sized town with its own social infrastructure.

Up to 30 thousand employees worked here at the height of the Second World War. Today the workforce is down to 700 employees, and 80% of the work is done for the space industry. Sheep graze obliviously among the high-tech facilities, beneath a maze of pipes and conduits suspended six feet off the ground. Our transporter follows the line of piping to reach the building in which the booster segments are going to be treated: first-class treatment from the moment they are unloaded (see photo 1).

Scrubbed and powdered

"Our main job here is to apply the thermal insulating liner to the steel parts that make up the booster casing, to shield them from the 3000° temperatures that are developed during the launch," explains Francesco Depascuale, responsible for advanced technologies at Colleferro. The first step is to clean the surface of the segments. To do this, the cylindrical segments are placed upright in a giant vat filled with solvent, to loosen any residual grease and other contaminants remaining from the fabrication process. At the same time, a dense spray of plastic particles is applied to the inside walls of the cylinder at high pressure, giving the surface the required roughness before the thermal protection is applied.

The scrubbing is *a must* for all parts that end up in the clean room. The air in the clean room is constantly being

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circulated through filters, and anyone entering the room must wear special shoes, coats and bonnets. Up to 48 segments per year can be treated in this cavernous hall, whose ceiling is dominated by hoists that silently rove back and forth, moving the various parts of the booster casing in a precisely choreographed sequence. Next comes the crucial step of applying the insulating primer.

5 to 90 mm of rubber

The rubber insulation is deposited directly on the surface of the cylinder in layers that are one, two, three or four millimetres thick. This makes it possible to vary the final insulation thickness for different conditions of combustion, because some parts of the booster casing need more protection than others. The actual thickness varies between 5 mm and 90 mm, the thickest being reserved for the base of the casing, exposed to the full brunt of combustion gases flowing towards the booster nozzle. The made-to-

Your papers, please ....and your cigarette lighter!

Safety is not a joking matter at Colleferro. Visitors are made to understand this at the gate: among other things, they are required to hand over their automobile cigarette lighters! This is only the visible part of a vast safety organisation. Paolo Bellomi, the head of solid propulsion for Fiatavio, explains that many of the traditional safety rules now play a largely symbolic function, however.

Still, it's better to err on the side of caution. Once solid propellant ignites, there is no stopping it. Bellomi recalls an occasion during the early phase of the development of Ariane when a defective charged booster segment had to be destroyed. Since there was no way of doing this on the test stand, it was decided to prop up the segment horizontally on a wooden pyre, covered by a corrugated metal roof. "It took ten minutes to burn out," recounts Bellomi, "and when we went to inspect it, there was nothing left: the segment had consumed even the metallic parts, there was not even a trace of the roof remaining." No wonder that special precautions are taken in the more sensitive areas. Special anti-static shoes are required, to avoid the risk of static build-up, particularly when the air is very dry. Lighters and cigarettes are routinely banned, of course, but so are battery-powered watches that could induce a discharge around the propellant. Mobile phones are another no-no: Paolo Bellomi assures us that propellant powder and electromagnetic waves don't mix!

In addition to the ubiquitous Faraday cage, each building is constructed with a pre-weakened wall. In the event of runaway propellant combustion, the wall is designed to yield readily, thereby avoiding a dangerous build-up of pressure that could lead to a catastrophic rupture of the building, with flying debris and all the attendant destruction.

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measure coat of thermal insulation, made more complicated by spherical portions of the casing, is tailored by a powerful computer that contains geometrical profile information for each segment and monitors the correct profile, like a potter working by touch (see photo 2).

Biggest autoclave in Europe

When it is first deposited the rubber is soft, which ensures good adhesion. It then needs to be vulcanised to give a permanent bond. To do this the technicians wrap the segment in a giant plastic bag, which is then evacuated to eliminate any air pockets or bubbles that might have formed between successive applications of the rubber insulation.

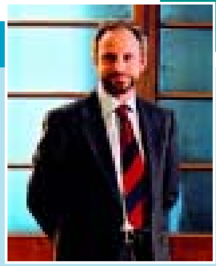
We watch from a distance as the gaping maw of the autoclave, measuring over three metres in diameter, is readied for the largest of the segments. The outsize oven is the largest autoclave in Europe (see photo 3). It will keep the insulated cylinder at ten times atmospheric pressure and 180°C for more than twenty-four hours, secure behind two inch-thick steel doors.

In order to verify that the vulcanisation process has functioned correctly, the segment is hoisted into a stand for ultrasound inspection. A metallic boom with the ultrasound probe on the end is extended into the cylinder to measure the thickness of the protective coating one minute portion at a time (see photos 4 and 5). A small stream of water ensures good probe contact so that the ultrasound signal goes straight to where it's needed. To completely inspect an eleven metre-long segment takes more than three days. Throughout, engineers keep a critical eye on the proceedings: "For all of our high-precision machinery, people remain the heart of Fiatavio," emphasises Francesco Depascuale. This becomes clear when watching Giacomi Santucci perform the delicate task of trimming by hand the edges of a segment's protective coat using a simple utility knife (see photo 6). Pearls of perspiration glisten on his brow as the expert technician carefully outlines the precise contours of the segment. Any error could jeopardise the fit when the segments are transported to Kourou for assembly.

Focus

on Paolo Bellomi

Head of solid propulsion at Fiatavio



Holder of a degree in Mechanical Engineering from the University of Rome, Paolo Bellomi has been working at Fiatavio for sixteen years. Following a specialised course in aerodynamics in Belgium, he spent a period of time doing combustion research at the University of California. Since returning to Italy he has been working on solid propulsion. Since 1991 he has been working continuously on the Ariane programme, on military programmes and Zefiro. The 42-year old has one dream: to watch Vega rise from its launch pad, four years from now.

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Another of the tasks at Colleferro is to prepare the housing that receives the booster igniter, which will be shipped to the Space Centre in a separate container. The 1.2 metre-long igniter will be fitted into the booster, along with a metallic tube into which a specialised combustible will be cast. The fast-burning material is designed to react fully in three-eighths of a second, creating a pressure and heat wave that will ignite the propellant evenly along the entire length of its hollow star-shaped interior.

Once its protective sheath is ready, the segment takes its place in the yard, joining others already there. Another four to five weeks, and they will be unloaded at Kourou to be taken to the booster integration building. This is the culmination of a tightly coordinated programme. As Francesco Depascuale remarks, it is a graphic illustration of what the somewhat abstract notion of European cooperation is all about. And now the way is prepared for the coming of Vega. ■

Solid propellant, solid experience

by Paolo Bellomi

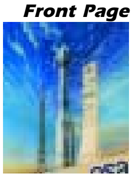
Head of Solid Propulsion at Colleferro

Solid propellant has a venerable history, going back much further than liquid propellant. This explains many of the differences, such as its ease of handling and comparatively low cost. In performance terms it is less attractive for upper-stage propulsion, but it remains a useful alternative.

The practice world-wide is to use solid propellants if possible during an initial 'boost' phase, reserving the more costly liquid fuels for the upper stages. This is because solid propellants provide high thrust, but their rapid combustion rate limits them to the first few minutes after lift-off. Most solid-propellant boosters work for around two minutes, compared with ten minutes for the Vulcain engine, for example.

The Ariane-4 is a good example. It exists in a solid and liquid booster configuration, the former producing much higher thrust levels than the latter. A modern liquid-propellant engine such as Ariane-5's Vulcain produces a respectable 100 tonnes of thrust, but each of the two solid boosters develops over six times as much, enough to raise a naval frigate into the air! The combination gives an ideal profile for the flight trajectory.

The solid's other major advantages are its ease of storage, low maintenance and simple ignition. Italy has a considerable amount of expertise in the area, thanks to the early interest in gunpowder in this country. Thus, pyrotechnic rockets began to be studied in the 16th century. After examining fireworks imported from China, Italians produced the first learned treatises on solid-rocket propulsion. Solid propellant continues to be the workhorse of rockets, particularly as pressure to cut costs grows. Of course, solid boosters do not lend themselves to re-utilisation as readily as liquid engines do. But they could be ideal for powering future reusable launchers during the rapid boost phase.



Vega team

For ESA, this is a crucial step, guided by the desire to cover the full range of launch services by building on synergistic effects with Ariane and preparing the way for future projects

Focus

on Stefano Bianchi, ESA

Head of Vega Engineering

Half-German, half-Italian, Stefano Bianchi, 41, has a degree in Nuclear Engineering from the Milan Polytechnic Institute. He started out working for the nuclear industry, in reactor controls, before joining ESTEC in 1987. Subsequently he joined the Ariane-5 programme, where he was in charge of the solid-booster stage. For over ten years he commuted between Paris and Kourou to oversee booster tests and qualification flights. In 1998 his interest was drawn to the nascent Vega launcher.

A new team for a new challenge. Even more than earlier launcher developments, Vega will put the European Space Agency in the front line. The distribution of roles and tasks is going to be tailored for the specific needs of this programme.

One reason for this is the origin of the project. It was initially proposed by Italy, which will be contributing at least 65% to the efforts (with 15% of the tab still to be found). As Stefano Bianchi, Head of Vega Engineering at ESA, reminds us, this situation is different from the successive Ariane programmes in which France, via CNES, always held the dominant share, between 40 and 50%. With Ariane, financial and technical authority alike were delegated: an ESA team oversaw the work done by CNES and reported to Delegations and the Programme Board.

For Vega, an integrated programme team (IPT) has been set up at ESRIN, where it will be deeply involved in operations, with technical support from ESA and the Italian and French space agencies (ASI and CNES) at various levels. Thus, CNES's ground facilities sub-directorate (SDS) and its Evry-based directorate of launchers (DLA) will be involved in the corresponding parts of the new programme.

Bianchi explains that the management structure for Vega will draw heavily on the invaluable experience acquired by CNES. Incidentally, although France decided against financial participation in Vega, it will be directly involved in the P80 programme. This is for the development of Vega's first stage, which will also lead to upgraded future boosters for Ariane-5. A team of four or five managers will work in the DLA's offices at Evry, headed by a CNES project manager who will be responsible for coordinating this work with Ariane-5 technology development. This is part of the strategy of cultivating synergies with Ariane.

Benefits from Ariane

"When Ariane-5 was being developed to replace Ariane-4, we had to change everything," recounts Mauro Balduccini, responsible for Vega programme technology and budgeting in the Fiatavio/ASI joint venture European Launch Vehicle. "With Vega, that won't be necessary." The intention is to make use of what has already been achieved: the technical expertise of DLA in Evry, the know-how and systems of Arianespace for the infrastructure, and the ELV team of Fiatavio for the launcher proper. As for the contract, Stefano Bianchi explains: "The important thing will be to provide at a very early stage all of the technical specifications with the greatest possible level of detail. Then, in

roster completed

making the design choices, we will strive to exploit new technologies where possible, while making the maximum use of existing ones in order to keep costs down." The programme is designed to operate on a lean budget, as the following figures show: 128 MEuro for development of the P80 and 335 MEuro for launcher systems, of which 260 MEuro will be for the launcher itself and 45 MEuro for the ground-based infrastructure, giving a total budget of 463 MEuro. "This is only possible thanks to the synergy effect," admits Bianchi.
Despite its more modest scale, the financial benefits of the programme are tangible, as Balduccini explains: "This is because we can exclude from the budget such things as infrastructure and production, assembly and propellant plants." Thus almost no new construction will be required in Europe, and very little in Kourou: just a new integration building and a special launch table.

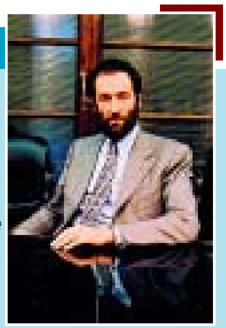
A stage for every need

Despite the modest budget, the project will be a challenge for ESA, notably with the development of three new solid-rocket motors. In addition to guaranteeing access to space for small payloads, Vega could be the stepping-stone to future programmes, in particular for a medium launcher. "What we have in mind is more than a 'family' of launchers," says Balduccini. "The idea is to create a line-up of stages designed with very similar components, to make the most of each development." The objective would be to respond directly to evolving market demand with a fast, flexible modular approach – a build-to-order launcher! ■

Focus

on Mauro Balduccini, ELV

In charge of Vega programme technology and budgeting



A nuclear engineer with a degree from the University of Rome, Mauro Balduccini, 47, first put his training to work at Breda, a member of the Ansaldo group in Milan, working on nuclear reactors for six years. In 1982 he joined Fiatavio to work on the propulsion and altitude control system for Iris, which was flown on the Space Shuttle. After a three-year stint at Alenia, where he contributed to the launch of Italsat 1 and 2, in 1993 Balduccini returned to Fiatavio, where he worked on a new vehicle concept that would break the ground for the future Vega design.

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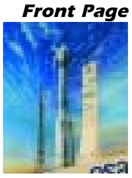


Two tried-and-tested st

The launch complex for Vega will be set up at the CSG in Kourou. But in the meantime, Vega testing will straddle the Atlantic, with one test stand in Kourou for the P80 demonstrator and another in Sardinia for Vega's second and third stages. The focus is on two different test technologies, two different experiences.

Salto di Quirra: from Ariane-3 to Zefiro

Cast your mind back to the time when solid-propellant boosters were still tested horizontally. It was before Ariane-3, before adding twin 7.3 tonne boosters to Ariane-1. The need became apparent to test the interfaces (the attachment systems), connecting the strap-on boosters to the launcher's main body. The designers had to be sure that the structures of these two elements were compatible. This was the early 1980s and preparations were under way for Europe to achieve a first in the area of solid propulsion. A special test stand, enabling vertical testing, was built at the Salto di Quirra military base on Sardinia. It was designed to take over from the horizontal stand at Colleferro, on which Ariane-3 was first put through its paces. Ariane-4 too would soon be tasting the sea air on the cliff-side stand in Sardinia.

Stringent safety measures

The first booster to be tested under the Vega programme, Zefiro has already been put through three tests at Salto di Quirra in its 16-tonne propellant load configuration, the definitive load for the Vega second stage being 23 tonnes. Bulkier than its predecessors on the stand – two metres in diameter as opposed to the one-metre-diameter Ariane-3 and Ariane-4 boosters – Zefiro requires similar safety measures, notably a vast cage-type structure with spikes on which it would impale itself and explode in the event of a wrong manoeuvre.

As head of the Ariane-3 and Ariane-4 programmes, André van Gaver made several trips to Sardinia. As he sees it, the real difference for Vega's is it's composition, which is very hard to evaluate. "The technology to be tested is completely different to that of Ariane-4, as the Vega booster casing material is filament-wound," he explains (see box). Having good mechanical characteristics, this is much lighter than conventional materials, but it is also much more fragile. The static firings will therefore serve to test the casing. The thickness of the carbon fibre will subsequently be adapted in line with the results, the ultimate objective remaining, as always, to keep mass to a minimum. ■

Controlled winding for Zefiro

From a distance, the device is reminiscent of the looms of yesteryear – but look closer and it's ultra-modern. Like a spider, it slowly spins its web around a Zefiro motor, as the Vega programme gets seriously under way at Colleferro. This module, spinning on itself, is wound by a mechanism continually moving back and forth and feeding out filament wire, until completely covered. This is the winding process at work, exploiting this dual movement which lays the filament at a perfect angle. In one week, the machine's twenty reels spew out dozens of kilometres of carbon fibre, a material five times lighter than steel and four times stronger. Thanks to this composite casing, the dry mass is reduced, as is the structural weight, a process that will make it possible to increase the launcher's payload mass, especially as the P80 draws on the same technology.

ands *for the new launcher*

The BEAP, a born simulator!

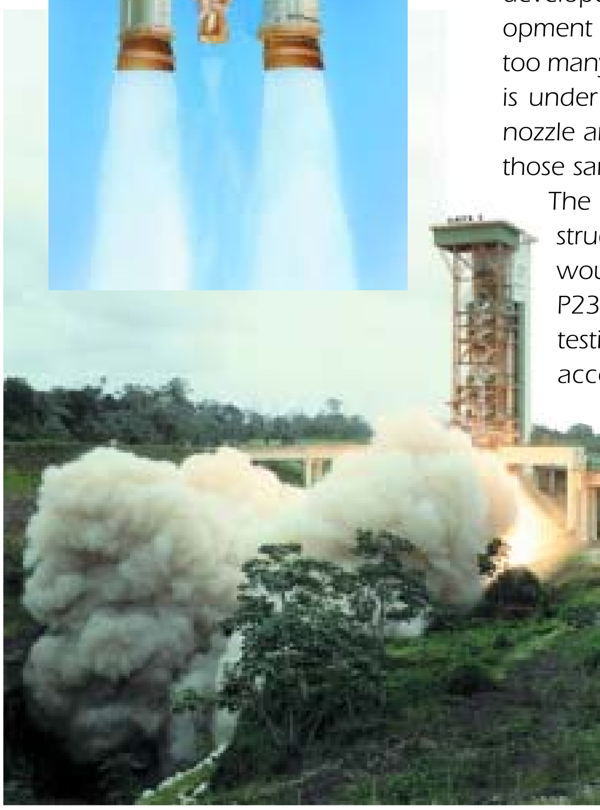
On this occasion, despite delivering 600 tonnes of thrust, the booster will not lift off. And this is apparently the only major difference from an actual launch. “It feels like the real thing,” says Jacques Gigou, head of Ariane operations and installations at ESA, “the Ariane-5 solid-booster test stand having been designed to reproduce flight conditions so faithfully”. A stand configuration that fits the bill for the enormous Ariane-5 boosters and which will soon be adapted to the more modest dimensions of the Vega P80.

Unlike most American stands, which are horizontal, the BEAP stand tests hardware vertically. This configuration obliged CNES (SDS) to dig a huge trench, 60 metres deep and 200 metres long. But doing so has proved highly worthwhile, this option having overwhelming advantages: there is no need, for instance, to calculate the interactions of a booster positioned horizontally on rails.

A 30 mm lift-off!

For safety reasons, the BEAP is fitted with two restraining rings designed to neutralise any anomaly on the nozzle or where two segments interface. This device is reinforced by a cable embedded in concrete, clamping the top of the booster. This kind of lasso would ground the booster and prevent it from damaging the surrounding area in the event of an uncontrolled release.

During the test, the booster will well and truly lift off... all of thirty millimetres, before hitting the thrust measurement device positioned at the top of the stand. “This produces a real thrust measurement taking into account gravity,” explains Gigou. This concern to reproduce flight conditions as closely as possible can be seen in many phases of the test. Right up to the last moment: immediately after burn-out, a cannula pierces the casing to inject water into the booster. The objective is to freeze ablation of the nozzle throat and the divergent’s thermal protection, in order to observe the actual state of erosion, which natural cooling would have distorted.



In all, some 600 measurements are taken on the BEAP, the first firing on which dates back to 16 February 1993. Scheduled to follow are four development tests and two qualification firings. All this spread out over two years. The same should be the case for Vega, even if the cumulative experience gained from testing the Ariane-5 boosters will prove very useful. As Jacques Gigou explains: “The P80 basically corresponds to a segment of the Ariane-5 P230, which has two 100-tonne segments and one 30-tonne. The ballistics and the models having been developed at Europropulsion, development of the P80 should not involve too many surprises.” Especially as work is under way to optimise the booster nozzle and Vega’s first stage will reuse those same technologies.

The main difference lies in the structure of the P80, in filament-wound composite, whereas the P230 has a steel casing. The burst testing will have to be changed accordingly. Apart from that, the safety rings will simply be repositioned and the platforms adapted to match different access points.

Meanwhile, the BEAP will continue to play an active part in Ariane Research and Technology Accompaniment programme tests, with the next stand firing of an Ariane-5 booster scheduled for the end of the year. ■

Lifting the bon

From 15 to 22 June visitors to the Paris Air Show got an inside upcoming ESA missions. From communication and observation Station service vehicle ATV, a wide range of different projects wi Ariane-5. Proof of the European launcher's versatility.

A venue for insiders

After a two-year interval, it was time to refresh the show-case. New programmes, new launchers, new prospects: the space world had undergone major changes since the last Paris Air Show.

Once again, ESA and CNES were sharing a pavilion, under an impressive dome providing a view of the sky and the stars. The whole space clan was represented; notably, the complete family of European launchers, modelled at 1/10th scale. Major themes such as navigation, Earth observation and protection, space exploration, science, and orbital infrastructure (of which the ISS is an example) were presented in videos and panels.

Visitors were given a comprehensive overview of major projects, existing and planned, spanning both commercial and institutional missions. "A chance to take a look at what Europe is doing in space," said Philippe Willekens, an engineer at ESA's Directorate of Launchers and in charge of presentations at the pavilion.

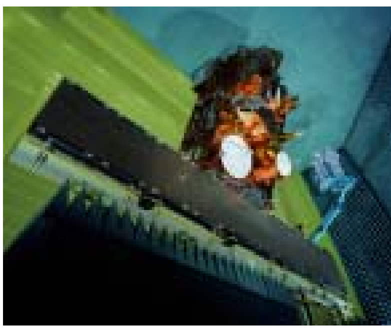
The important stakeholders, decision-makers in politics and industry, could all avail themselves of the ESA/CNES facilities in an environment amenable to fostering contacts, holding discussions and conducting negotiations. Willekens pointed out: "In many cases, this is a chance to crown months of hard work and negotiations with the announcement that a contract has been awarded or an agreement finalised." And that was an important part of the business of this Air Show.

Rosetta, the comet chaser

A long chase is about to commence: spacecraft Rosetta has its sights set on comet Wirtanen. The launch, planned for January 2003, will signal the start of an eight-year pursuit before the target is reached, in August 2011. That calls for endurance. Rosetta will have to pace itself, economising on energy and making the most of three planetary swing-by manoeuvres, once around Mars and twice around the Earth. These active phases will punctuate prolonged dormant phases during which Rosetta hibernates or overflies one of the two asteroids Otawara and Siwa. The target will finally be reached on day 3140 of Rosetta's mission. At this point the space probe will go into orbit around the comet, compiling a detailed map of its surface and deploying a lander equipped with scientific instruments. These will be used to study the internal structure of the comet's core and perform mineralogical, chemical and isotope analysis. The information gathered will be relayed back to Earth by the main spacecraft, which remains in orbit. Rosetta will take the comet's 'pulse' by monitoring the surrounding plasma and vapour jets emanating from the core. This will contribute immeasurably to the knowledge gained when Giotto flew past Halley's comet at 70 km/sec on 14 March 1986.

Envisat, a guardian angel for planet Earth

Climate change, ocean movements, melting ice-caps, global warming, depletion of the ozone layer, atmospheric changes: there is no shortage of vital environmental phenomena for Europe's Envisat to track, helping scientists to understand them better. Following on from the successful European remote-sensing satellite programme (ERS) launched in 1991, Envisat's capabilities will mean a quantum leap in the data available to European researchers. Over its lifetime of five years the satellite will circle the Earth fourteen times a day in its polar orbit. The launch is scheduled for late 2001.



net *on Ariane-5*

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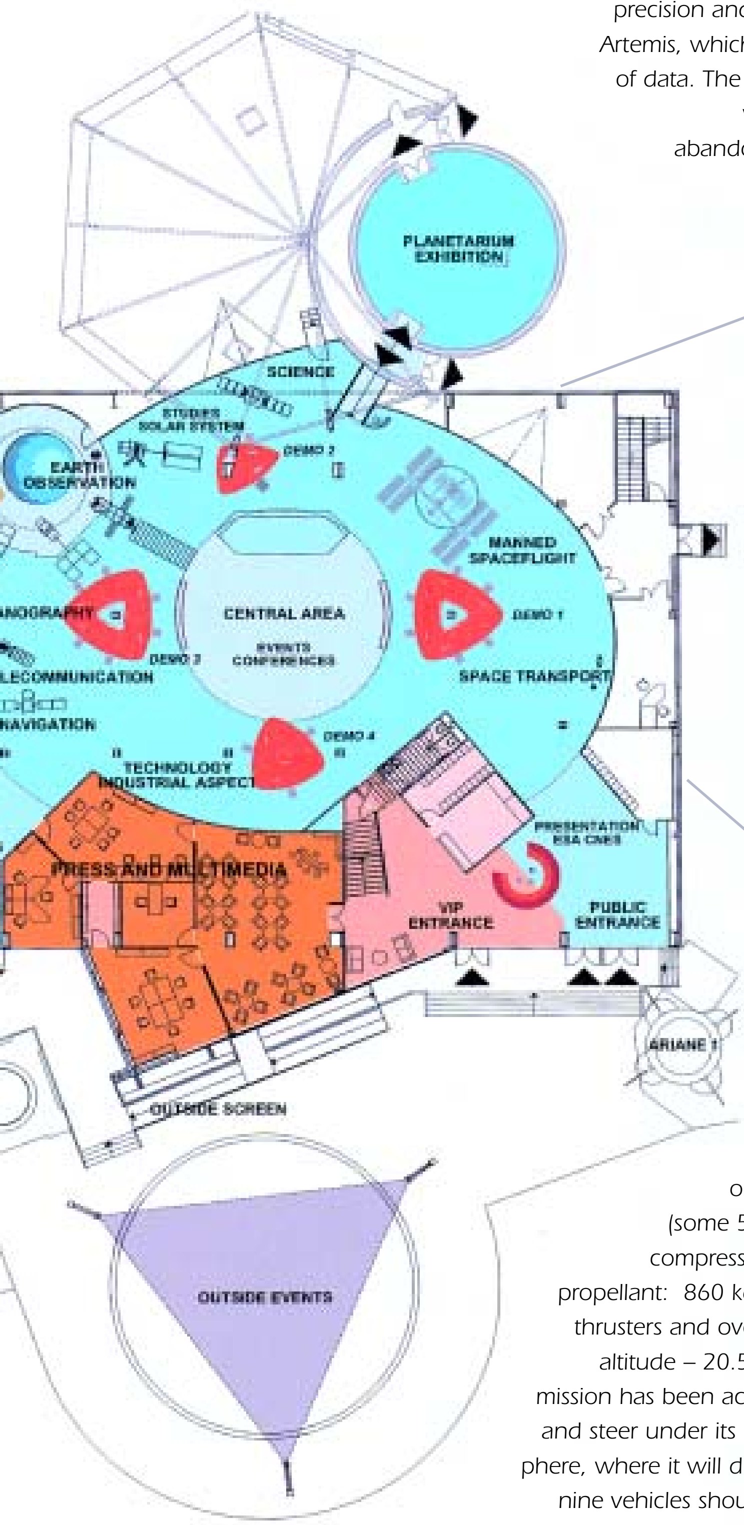
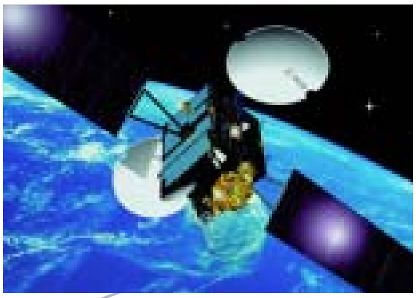


Artemis, the space-based data hub



In Greek mythology Artemis was the daughter of Zeus and Leto. She was renowned for her unerring skill with bow and arrows. The same qualities of precision and speed are built into the satellite Artemis, which will be relaying large quantities of data. The initial plan to launch the satellite with a Japanese H-IIA rocket was abandoned, and Artemis was placed in orbit from Kourou this summer onboard an Ariane-5 launch vehicle. In a sense Artemis signals the start of construction for a huge navigation and communication system that will be crowned by Galileo. As the first element in place, Artemis will provide mobile communications services between Europe, the Middle East and North Africa, primarily for road and rail traffic but also for maritime traffic. The zone covered extends from the North Sea to the Mediterranean and the eastern Atlantic Ocean. Artemis is also equipped with Silex, a laser-optics communications system that will revolutionise the transmission of data to and from satellites in low-Earth orbit. In its relatively high geostationary orbital slot, Artemis will act as a hub connecting Spot-4 and Envisat, which sweep low over the Earth, continuously gathering large volumes of data, with the data collection centres at Frascati, Italy and Toulouse, France. The system will provide a similar data relay service for the International Space Station, giving scientists real-time control of operations and experiments in space.

ATV, a St. Bernard for the Space Station

Without it, the International Space Station would not last long. The Automated Transfer Vehicle, ATV, will travel to the Space Station on a regular basis, carrying the vital cargo needed to keep the Station operational on a long-term basis. At 8.5 m in length, the ATV is three times the size of the present Progress freighter. It will dock to the Russian service module on the Space Station, bringing provisions, spare parts and scientific material (some 5.5 tonnes), 840 kg of water and compressed gases, and large quantities of propellant: 860 kg for the Station's attitude-control thrusters and over four tonnes for maintaining its altitude – 20.5 tonnes of freight in all. Once its mission has been accomplished, the ATV will undock and steer under its own power back into the atmosphere, where it will disintegrate. The first of a planned nine vehicles should be launched in 2004, the rest following at twelve-month intervals.

Take a spin in **cyberspace**

A new window on the stars

Indulge your imagination – with your eyes wide open. Take off is now, from the new Internet site of ESA's Directorate of Launchers. The site gives you access to a mine of information about launchers, and it's fun to use. "We redesigned the Launchers site with a view to making it easier to use so that it will meet the needs of the general public, including students, engineers and decision makers," explains Florence Benaitier, a communication specialist at ESA who supervised the creation of the new site.

The outcome: an enticing introduction to the world of launchers, with valuable information presented in a convincing format. Need help finding your way through this maze? You can take a complete guided tour, or look at the inside of the launcher, stage by stage, or go to a thematic overview. "Don't worry if you get overwhelmed at first," Benaitier hastens to reassure us. "Just stop the animation wherever you happen to be and take a closer look at the details that interest you."

Flash animations and video clips

The new site is packed with technical, historical and even economic information. In addition to files on every launcher's performance and unique features, Flash animations let the user dissect the launcher and peer inside. Just click on the link for a close-up view of the boosters, the main stage, or the payload fairing. And there are numerous video clips to illustrate the technical information. While you're visiting, take a walk down memory lane and look at some of the historical Ariane launches.

Where this site really excels is in depicting the long and complex process that precedes a successful launch mission. You can visit manufacturing and assembly sites for different launcher components in Europe, then follow the satellites' progress from an aerial perspective, all the way to Kourou and the space centre.

A personal angle on the news

The new site is not only an invaluable basic reference on Europe's launchers, but also a source of reports, interviews and other articles highlighting the people at the European Space Agency who make it all happen. Use the site to keep up with news on the launchers, get the latest launch schedules and the technical specifications of individual missions, and view the post-flight commentary. ■

Spotlight on the Member States

Every mission, every new success achieved or record established, owes much to the combined efforts of a talented and diverse team. This is why we have created a separate portion of the site that deals with the twelve Member States who participate in the launcher programme. The goal is to show how each country makes its unique contribution to this vast joint project. This gives you a snapshot of Europe's current state of the art in terms of technology, know-how and coopera-tion. All of this, naturally, in several different languages.