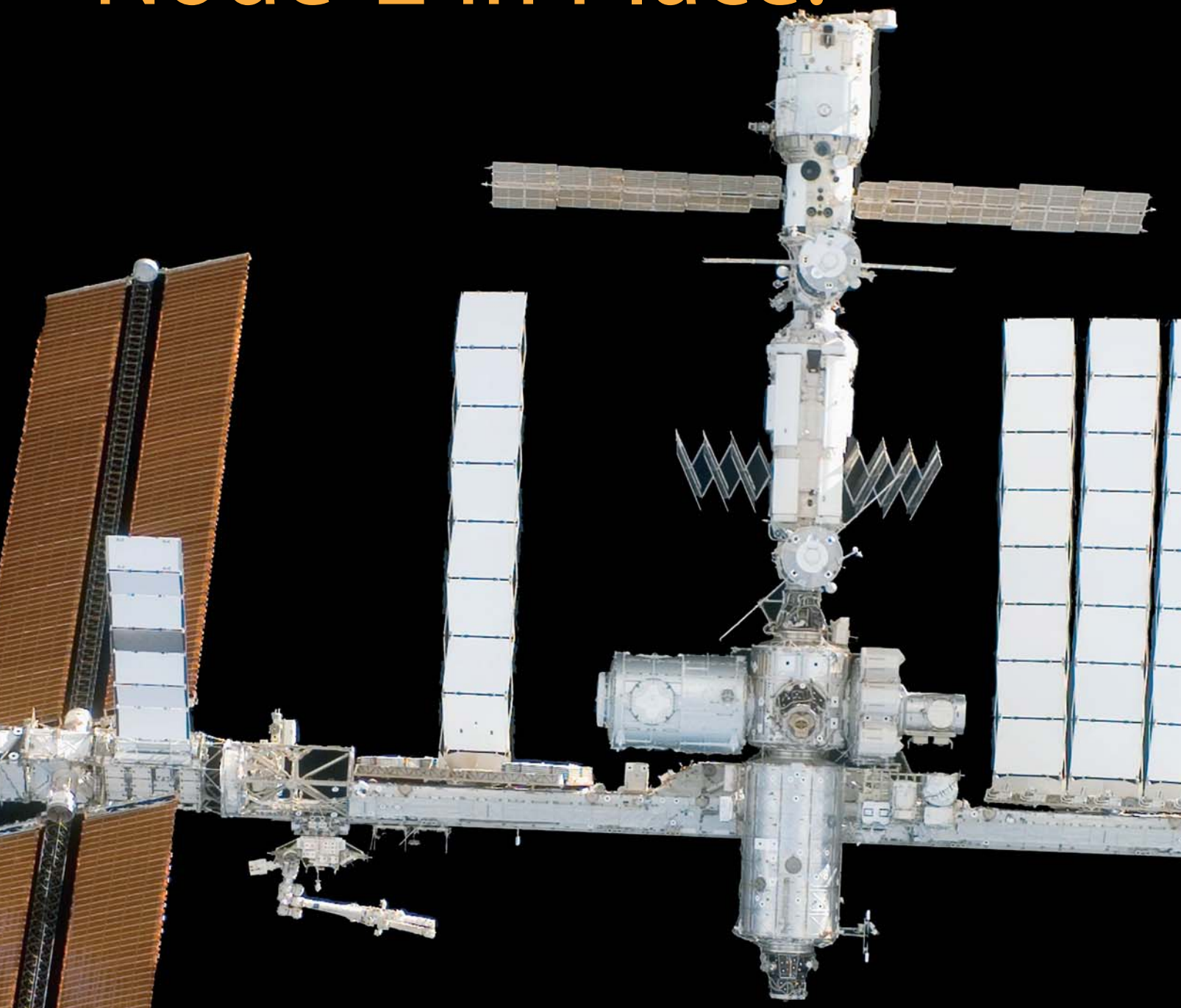
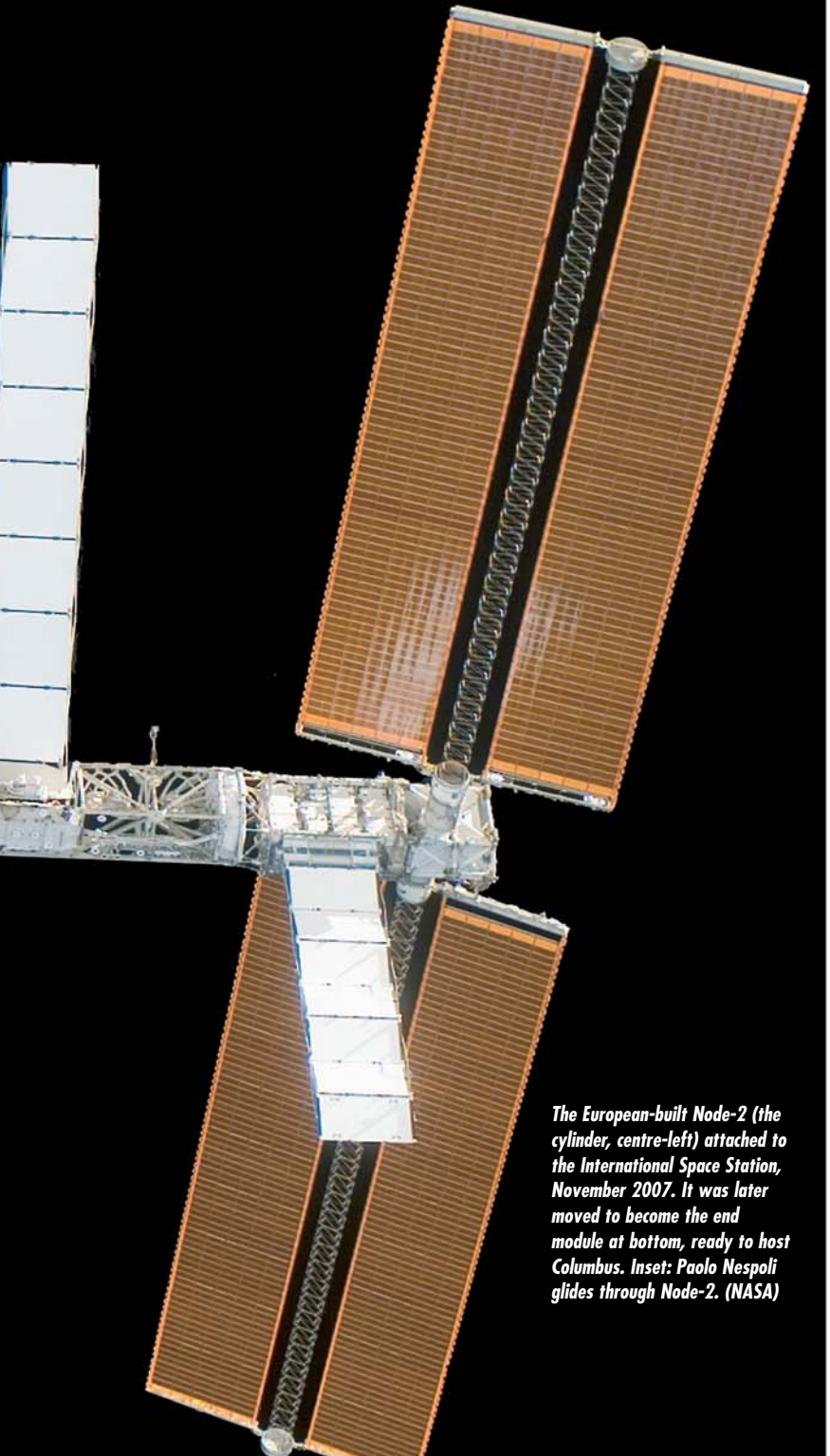
Node-2 in Place!



Europe's First Module Permanently Attached to the ISS



The European-built Node-2 (the cylinder, centre-left) attached to the International Space Station, November 2007. It was later moved to become the end module at bottom, ready to host Columbus. Inset: Paolo Nespoli glides through Node-2. (NASA)

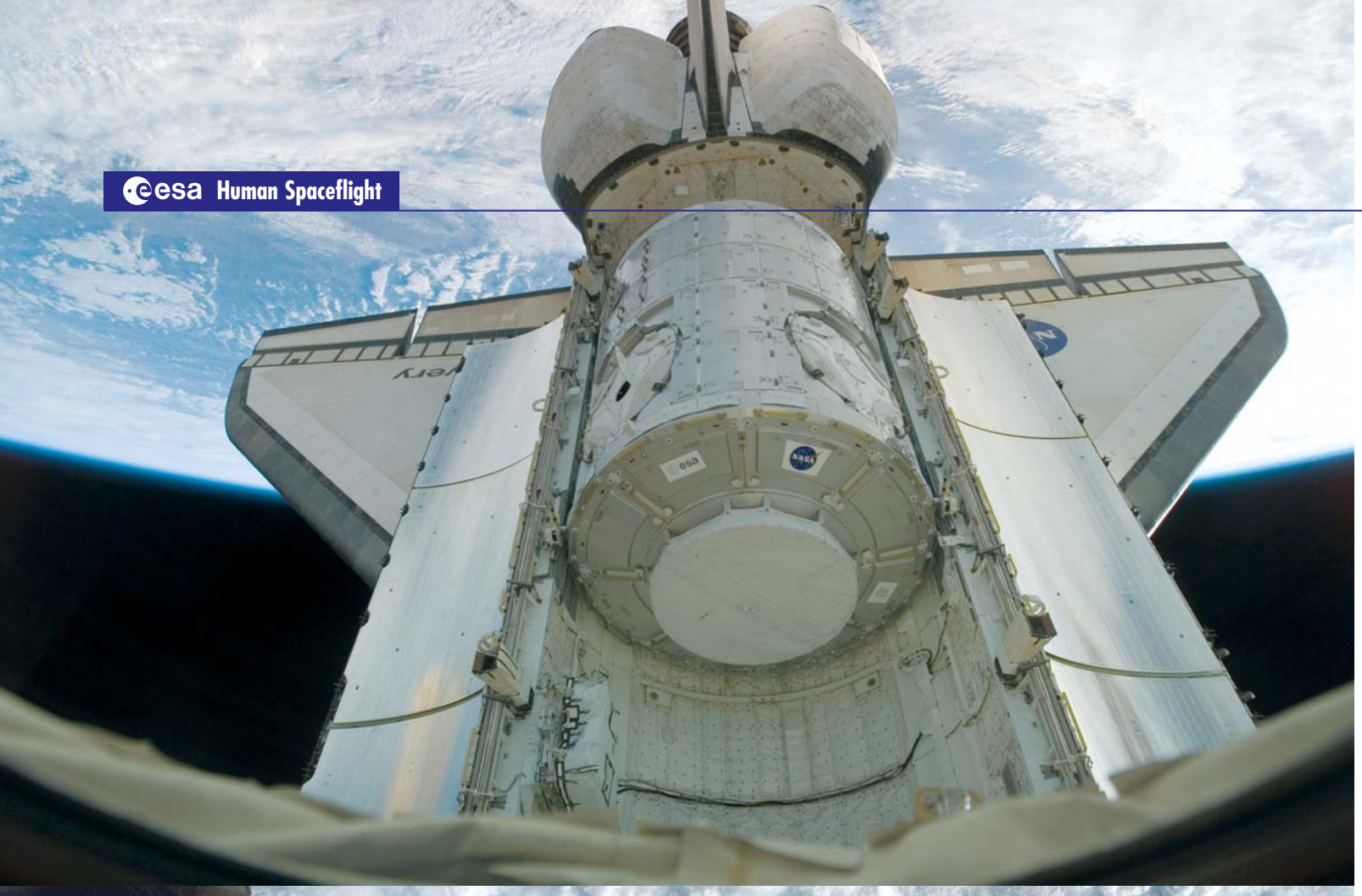
Philippe Deloo
Head of Cupola/Nodes Project Office,
Directorate of Human Spaceflight, Microgravity & Exploration, ESTEC, Noordwijk,
The Netherlands

Node-2 is now safely attached to the International Space Station (ISS), opening the way for expanding the outpost's research capabilities. This interconnecting node is crucial for the Station to host Europe's Columbus and Japan's Kibo modules. These laboratories will offer the long-awaited facilities for performing full-scale research and experiments aboard the ISS.

Introduction

European involvement in Node-2 began in 1997 with the signature of the Columbus launch barter arrangement: ESA committed to provide goods and services to NASA to offset the cost of a Shuttle launch for Columbus, the European laboratory module. The goods and services promised by ESA included Node-2 and Node-3. (NASA's own Node-1 was launched in 1998 as the Station's second element.)

Strictly speaking, Node-2 is not the first European-built module attached to the Station, but it is the first that will stay for the rest of the Station's life. Two Italian Multi Purpose Logistic Modules (MPLMs) have already flown several



Above: Node-2 arrives in the Shuttle's cargo bay (NASA)
Below: the Station's robotic arm hoists Node-2 to its temporary attachment point, 26 October (NASA)

times to the Station, delivering and returning cargo aboard the Shuttle. They are docked to the Station for around a week before being returned to Earth.

To take advantage of the organisation and procedures developed for the MPLM programme, full management responsibility for the two Nodes was delegated by ESA to ASI, the Italian space agency. In June 1997, ASI and Alenia Spazio of Turin (now Thales Alenia Space) signed the contract for their design, development, manufacture, integration, test and launch processing.

NASA's participation in the programme and in the oversight of Alenia's activities was very strong throughout the programme. The Marshall Space Flight Center in Huntsville, Alabama, and the Johnson Space Center in Houston, Texas, were the main NASA centres following the development. This extensive NASA involvement was justified by the amount of NASA equipment to be integrated into the modules and the fact that the American agency is the final owner.

Following the successful design review in 2001, the start of Node-2's integration and verification phase was authorised.

In May 2003, Node-2 was declared ready for shipment from Turin. Loaded into a 'Beluga' Airbus, it was shipped to the Kennedy Space Center (KSC) in Florida and its ownership transferred to NASA after an acceptance review. From then on, Node-2 was under NASA responsibility for the rest of its preparation for flight.

In 2004, following an agreement with NASA and ASI, ESA took over from ASI the management of the Nodes programme. This entailed direct responsibility for supporting Node-2 ground operations at KSC and for Node-3's integration and verification.

Although NASA was now leading the Node-2 activities, the level of European support remained high and indispensable, as the knowledge of the element and the design authority remained with ESA's contractor Alenia Spazio. Also, the contractor was asked several times to make modifications to Node-2 at KSC. These arose from changes to the baseline design to adapt it to new requirements of the ISS programme. European support to the Node-2 ground operations ended this September with the Flight Readiness Review.

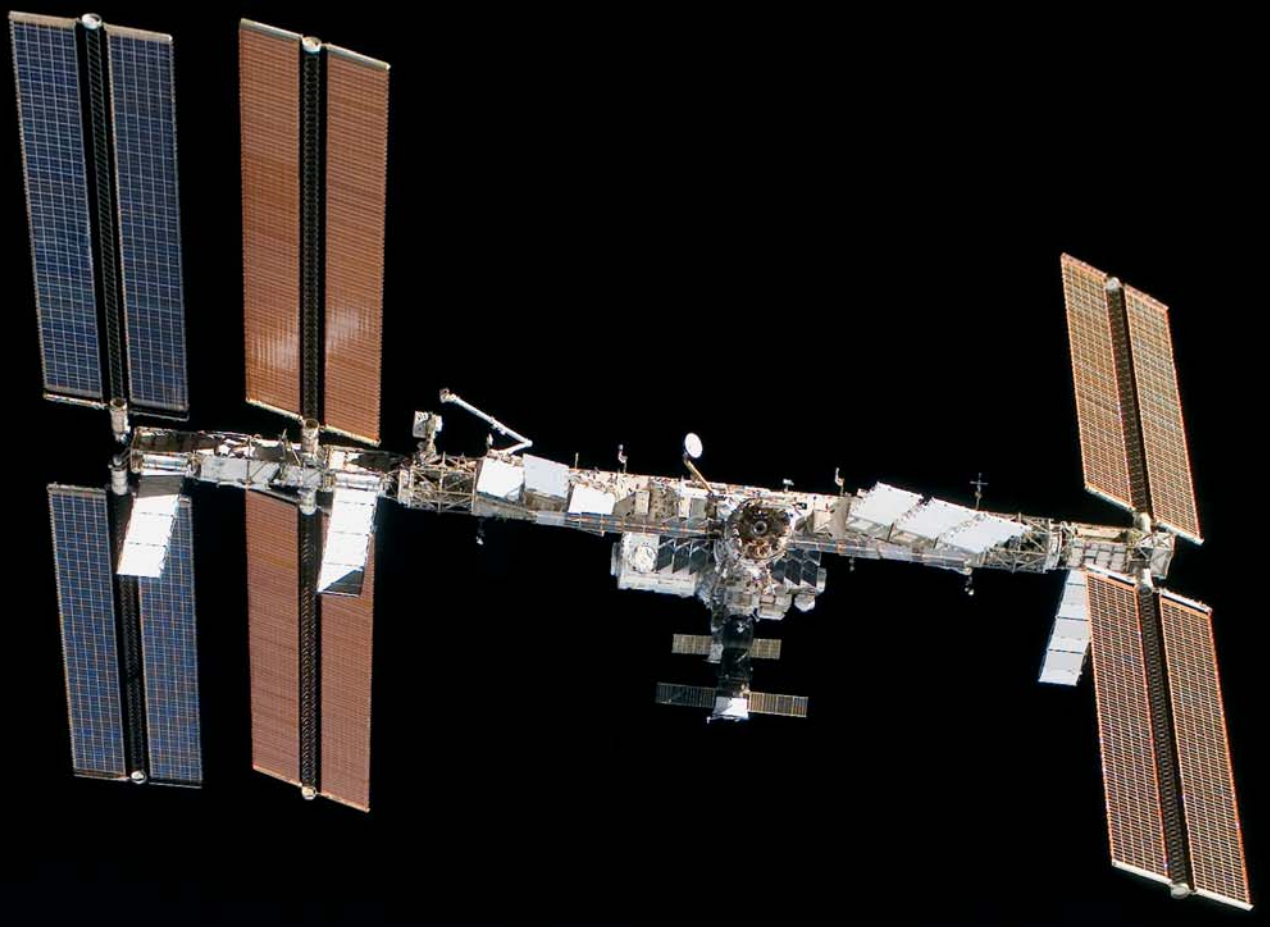
Node-2 is now also known as 'Harmony', the name selected by NASA following a contest among more than 2000 American schoolchildren.

From the top: ISS Commander Peggy Whitson and Paolo Nespoli prepare to open Node-2's hatch for the first time, 27 October; entering Node-2; the ISS and Shuttle crews pose in Node-2; Paolo Nespoli with a Node-2 model (NASA)

A Strategic Element

Node-2 is a strategic element for the Station's growth. It is particularly important for Europe because it is essential for attaching the Columbus laboratory to the Station. It has six docking ports: two at the ends and four around the cylinder. Node-2 is now attached to the forward end of the US Destiny laboratory and will host up to five other elements: Columbus to starboard, Kibo to port, a NASA Pressurized Mating Adaptor (PMA) on the front as the main docking location for visiting Space Shuttles, and a PMA below for MPLM or Japan's visiting HTV unmanned cargo ferry. There is no element yet assigned to the top port, following cancellation by NASA of the Centrifuge Accommodation Module. This position will be used for storing Japan's Experiment Logistic Module until Kibo arrives.

In addition to holding these elements, Node-2 will also provide them with vital resources: power, heating, cooling and data and video exchange with the ground and the rest of the Station. Node-2 is outfitted like a small power substation, handling the links between the Station's solar arrays and radiators and the users in the attached modules. The Node carries four avionics racks for power conversion and distribution, command and data handling, and



The Next European-built Elements

Node-2 is the first of a large family of European elements that will fly to the ISS in the near future. Columbus will follow next, aboard the next Shuttle flight, scheduled for launch on 6 December. Columbus has been at KSC since May 2006 and completed its last verifications tests this summer.

In February 2008, it will be the turn of the first Automated Transfer Vehicle (ATV), 'Jules Vernes'. The ATVs are launched by Europe's Ariane-5 and are designed to rendezvous and dock with the Station automatically.

There will also be a number of MPLM missions carrying supplies and returning results. Finally, the combined Node-3 and Cupola, will be launched in early 2010 to complete the Station's assembly. The Cupola was also built by AleniaSpazio under ESA contract following an agreement with NASA. It was delivered to NASA in 2005 and is stored at KSC. Node-3 is also in storage, but in Turin, following the completion of its integration and verification last summer.

The family might continue to grow in the coming months. NASA, ESA and ASI are discussing the possibility of modifying an MPLM so that it can stay permanently attached to the Station as a storage volume, an increasingly critical need for the outpost.

With completion of the Station's assembly, we can look forward to at least 10 years of exploiting this huge global investment, the largest cooperative space venture to date.

audio/video switching. Six heat exchangers transfer the heat transported via water loops from the attached elements to ammonia loops flowing to the large radiators on the Station's truss.

The Installation of Node-2

Node-2 was delivered to the ISS by Shuttle mission STS-120, also designated ISS Assembly Flight 10A. That complex mission was highly successful but the installation was far from finalised. Node-2 was sitting at a temporary position and was later moved during November to the front face of Destiny, to await the arrival of Columbus in December.

This protracted choreography is dictated by the fact that Node-2's final position was already occupied by PMA-2 for docking Shuttles. So with STS-120 docked to PMA-2, Node-2 was lifted out of the Shuttle's cargo bay and attached to Node-1's port side. With the Shuttle gone, the ISS crew could shuffle PMA-2 and Node-2 around, using the Station's robot arm. All of this effort involves several spacewalks.

STS-120 included other important assembly tasks, such as the relocation of the P6 truss segment to its final position at the extreme port end of the ISS main truss and the deployment of the related solar arrays, the full deployment of the thermal radiators on the back of the S1 truss, the delivery of essential supplies and equipment, and the exchange of one member of the Station's permanent crew.

The very capable crew consisted of commander Pamela Melroy, pilot George Zamka and Mission Specialists Scott Parazynski, Stephanie Wilson, Douglas Wheelock and Paolo Nespoli, an ESA astronaut from Italy. The ISS crewmembers were Flight Engineer Dan Tani for the ascent and Flight Engineer Clayton Anderson for the return. While Parazynski, Wheelock and Tani were assigned to EVA tasks, Paolo Nespoli coordinated the operations between the spacewalkers, the Shuttle and ISS robot-arm operators and the ground controllers, helped to prepare for the spacewalks by assembling tools and setting up the EVA suits, and assisted with the airlock operations before and after the spacewalks.

Above: Node-2's interior before the hatch is opened for the first time in orbit. Right: preparing Node-2 for launch (NASA)

Nespoli also played a prominent role during the robot-arm operations in the early and final days of the mission that checked the Shuttle's thermal protection for any launch damage. Nespoli was the arm's prime operator for inspecting the spaceplane's nose and wing leading.

Node-2's big day came on Flight Day 4 with astronauts in the cargo bay standing by as the Station's own robot arm lifted the module out and attached it to Node-1. The whole process took about 3 hours. While on the arm, it drew current to power the heaters to stay warm in the extremely cold conditions found in some Station's attitudes.

It was not until Flight Day 5 that astronauts could open the hatch and enter the Node, after the basic life support functions had been activated. The first event right after crossing the threshold was a press conference with ESA and ASI. Station Commander Peggy Whitson and Paolo Nespoli marked this important milestone for Europe.

For the remainder of STS-120, Node-2 activities consisted of outfitting and preparation for the relocation to the front of Destiny, after the Shuttle's departure. Nespoli took part in this effort and helped to transfer important equipment to the Station for Columbus.

In the month after STS-120, and before the arrival of STS-122 with Columbus, PMA-2 was moved on 12 November using the Station's arm from Destiny to Node-2's end port. Then, the combination was attached to Destiny's forward port, its final location, on 14 November.

The final connection of all the utilities was done by Peggy Whitson and Dan Tani during two EVAs, followed by the full activation and checkout. Their successful completion will clear the way for the installation on Node-2 of Columbus in December and Japan's logistics and science modules early next year.

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Detailed information on Paolo Nespoli's mission and Node-2 can be found at www.esa.int/esperia