ESA Human Spaceflight Capability Development and Future Perspectives

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Scott Hovland
Head of Systems Unit,
System and Strategy Division, Exploration Programme,
Human Spaceflight, Microgravity and Exploration Directorate
Scott.Hovland@esa.int
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**Exploration Heritage**

- ESA has been actively involved in space exploration for many years and is currently conducting several scientific missions in the Solar System
  - SMART-1 is orbiting around the Moon
  - Mars Express is orbiting around Mars
  - Europe has successfully landed on Titan with the Huygens probe as part of the joint ESA/NASA mission Cassini-Huygens
  - Europe is on route to a comet encounter with Rosetta

- In addition, ESA is also planning the exploration of other solar system bodies
  - Venus with Venus Express (due for launch in October 2005)
  - Mercury with BepiColombo, in cooperation with Japan
Aurora

- ESA Member States have agreed to consider Space Exploration as one of the ESA priorities for the future, with the underlying goal to:
  - increase knowledge
  - foster innovation
  - strengthen the European identity
  - inspire the young generation

- Within the Aurora programme, ESA is elaborating an extended missions roadmap for the robotic and human exploration:
  - with Mars as its main objective
  - and the Moon an intermediate step

- The work carried out in the framework of Aurora will provide the basis for defining the European participation in future exploration
Four Cornerstones

“Europeans in space”
- allowing Europe to be a significant Partner for Exploration by assuring a European access to enabling technologies, the presence of European culture in future space endeavours, the enhancement of European integration, the creation of European pride around an inspiring and ambitious cooperative project;

“History and fate of life in the Universe”
- understanding the origins and evolution of life on Earth and the search for extraterrestrial life in the Solar System, and beyond;

“Sustainable human life in space”
- the development of enabling technologies to support life and protect health, to access energy, manage environmental risks and exploit local resources; and

“Sharing the space adventure and benefits”
- communicating the excitement of human space flight and exploration and sharing the resulting benefits, with the general public.
Core Programme

- Exploration roadmaps, scenarios and associated architecture studies
  - These activities will enable Europe to determine its objectives, interests and priorities in participating in a meaningful way in the global inspirational space exploration adventure, through the identification of further missions and mission elements

- Mars Sample Return (MSR) enabling technology developments
  - The goal of bringing back the first-ever sample of Martian soil is a major technological challenge, as well as a great opportunity for the scientific world
  - It has important implications for planetology, the study of the origin of the Solar system and the search for life on Mars.
  - MSR is also a major milestone on the road to exploration, as it has a mission profile representative of a subsequent human visit to Mars
Core Programme (cont.)

• General exploration enabling technology developments
  – flight demonstrations of selected enabling capabilities (robotics, habitation, etc.)
  – preparation of potential European contributions to the exploration of the Moon
  – Regenerative Life Support System ARES
  – Rendezvous and Docking Demonstration

• Awareness activities
  – engagement of European citizens in space exploration
  – inspiring generations of youth and students through involvement of universities in the elaboration of future exploration missions
Exploration Missions

• The first European led robotic exploration mission to Mars proposed for realization is the **ExoMars** mission to be launched in 2011.

• Main scientific objectives
  – Search for traces of past and present life
  – Characterise Martian geochemistry and water distribution
  – Improve the knowledge on Martian’s environment and geophysics
  – Identify surface hazards to future human missions

• Main technology objectives
  – Safe Entry, Descent and Landing of a large size payload
  – Surface mobility (Rover) and access to the subsurface (Drill)
  – Rover power generation using solar arrays
  – Forward Planetary Protection
Clipper Preparatory Programme

• A preparatory programme of 2 years in order to:
  – Acquire human access to space capability for Europe
  – Maintain and enhance the European human spaceflight competences and capabilities in industry
  – Participate in the development, together with Russia and possibly Japan, of a crew transport system for LEO and exploration missions
  – Ensure compatibility with other exploration elements
  – Promote cooperation with Russia
• Identification of the system requirements and preliminary design of the elements and subsystems
• Prepare for a decision to participate in full development and operation programme
CDF

• ESA has performed several studies of lunar and Mars exploration missions using the ESTEC Concurrent Design Facility (CDF)

• The Concurrent Design Facility was established at ESTEC in November 1998 with the scope
  – to provide a mission design environment for the conceptual design of new space missions
  – a set up for the application of concurrent engineering principles
  – a more effective organisation of existing mission analysis
  – design tools and human resources and a generic approach to capture corporate knowledge for further reuse
CDF Study Human Spaceflight Vision

- Looked at the feasibility of building and operating a human tended lunar base using European launchers
- The main objectives were
  - to determine the number of launches required to launch and maintain such a base
  - perform trade-offs of propulsion system combinations (chemical and electrical)
  - determine ΔV requirements for all transfers
  - determine need of structure assembly in LEO
  - determine mission scenario and lunar base assembly strategy
  - determine the gross architecture and required infrastructure
  - identify technologies to be developed.
- A possible upgrade of the Ariane 5 launcher, capable of placing 27 tons into LEO was used for this study
The study, completed in December 2004, designed a set of spacecraft, which together describe an architecture, satisfying two main objectives:

- To perform lunar mission(s) to demonstrate technologies and operations for future human Mars missions (e.g. long term habitation and surface operations)
- and to perform sustainable lunar exploration, meaning building the capability for several short duration surface missions to any location on the Moon

The study defined an architecture allowing long duration habitation demonstration in orbit as well as excursion type missions to the lunar surface with up to 14 days surface duration with:

- a habitable hub in LLO
- several lunar landers can be attached
CDF Study Lunar Exploration Cargo Transportation System

- The Lunar Exploration Cargo Transportation System CDF Study was finalised in June 2005
- It assessed a cargo transportation system for both lunar orbit and lunar surface applications
- Cargo can be pressurised and unpressurised
- Commonality between elements, as well as the European heritage from the ISS programme, has been pursued when advantageous
- For delivering cargo to the lunar hub, a dedicated system comprising a Propulsion Module, a Service Module and a Cargo Carrier can supply up to 1900 kg of payload to the Lunar Orbital Hub when launched by an Ariane 5 ES vehicle.
- For delivering cargo or other payloads to the lunar surface, a dedicated system comprising the same Propulsion Module and a Descent Module can supply up to 486 kg of payload to the lunar surface when launched by an Ariane 5 ES vehicle.
Ongoing and Future Activities

• Several additional studies will be conducted both in the CDF and by industry under ESA contract in the future dealing with aspects of lunar exploration
  – Lunar Exploration Architecture
  – Lunar Robotic Missions
  – Habitation

• Other activities deal with how the ISS can best be utilised for future exploration missions. Main areas that have been investigated are:
  – using the ISS as a test-bed for technology and capability demonstration
  – research opportunities for exploration and specifically human related research
  – and last but not least looking at the ISS as a Spaceport able to service future exploration missions
Conclusions

• The launch and operation of the European elements of the ISS remain top priority for ESA. The European exploration programme Aurora is taking shape and several missions are being prepared.

• For robotic Mars exploration ESA has firm plans available for the first mission ExoMars, and is defining participation in other future endeavours.

• For human lunar exploration both ESA and European National Agencies are defining possible missions that would fit into the overall international lunar exploration context. Currently only preparatory activities are approved and funded.

• European human spaceflight capability is under preparation with the Clipper programme participation preparation.

• The ESA Ministerial Conference planned for December 2005 will make decisions on the way forward for Europe, both for lunar exploration as for exploration as a whole.