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# Paper Session III-B - Columbus Free-Flyer Center -Tasks and Manpower Profile

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# COLUMBUS FREE FLYER CENTER - TASKS AND MANPOWER PROFILES

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## 1. INTRODUCTION

The COLUMBUS program continues and extends European capabilities in manned space flight which have been initiated with the Spacelab program.

Based on European experience in supporting Spacelab missions and the valuable contribution of industrial personnel for this support, the need for a continuing operations support by the companies involved in the design and development of the Free Flying Laboratory and the Attached Laboratory has been established.

The concentration of this support at industrial sites, rather than attaching it directly to the relevant control centers, has been chosen as the most effective approach, considering continuous utilization of equipment/tools and facilities established during design and development phase, and diversity of the support functions.

Based on different operations concepts for the Free Flying Laboratory and the Attached Laboratory (independent European control of the Free Flyers, NASA control of the Space Station) and potentially different support proceedings the supporting functions are made available in two centers, one for the Free Flying Laboratory and one for the Attached Laboratory.

## 2. ROLE OF ELEMENT CENTERS WITHIN THE COLUMBUS GROUND INFRASTRUCTURE

The Element Centers will support other entities of the COLUMBUS Ground Segment involved in the operations and resupply of the Free Flying Laboratory and the Attached Laboratory by providing system expertise for mission/increment planning, preparation, execution, and assessment.

This will be ensured by establishing the following functions in the centers:

- Engineering Support
- Payload Integration Support
- Integrated Logistics Support

The Engineering Support function will provide the system engineering capability to develop, maintain, and sustain the flight configuration system availability, and to support evolutionary growth of the flight configurations.

The Payload Integration Support function will support users in their preparation and execution of flight activities, will supervise the qualification, and will perform and plan verification and integration of payload flight equipment into the flight configurations.

The Integrated Logistics Support function will provide for timely acquisition and delivery of flight configurations' resupplies including its ground processing, maintenance, and storage to maintain flight configurations and associated ground support equipment.

The Element Centers' support will be given to strategical, tactical and executional levels of operations. The environment in which the Element Centers operate is shown in Figure 1.

## 3. DEFINITION OF CENTER TASKS AND TASKS EXECUTION APPROACH

In performing daily operations the three center functions will be closely linked to each other and will commonly use the to be established center facilities. An administrative function will control the center functions and establish and maintain the working interfaces between the center and other IOI Ground Segment organizations to coordinate their requests for support.

The anticipated support can be categorized as follows:

- o strategical and tactical planning support to ESA Headquarters and mission control authorities
- o increment preparation, execution and assessment support to the elements' control centers, payload operations and coordination centers, and resupply vehicle control authorities
- o crew training support to the European Astronaut Center and to specialized training facilities
- o payload integration support to payload developers, external test facilities and payload integration centers
- o integrated logistics support for system and payload at integration, launch and landing sites, resupply vehicle processing facilities, as well as coordination and control of vendors/suppliers for spares and consumables.

The following sections describe tasks and execution approach for this support.

### 3.1 Strategical and Tactical Planning Support

The Element Centers support strategical and tactical planning levels represented by ESA-HQ and CMCC, respectively, with flight configuration data (such as required resupplies and related activities), payload accommodation and feasibility analyses on flight configuration level, and ground processing plans for all flight equipment (system and payload) and associated support equipment for a specific increment.
This planning support also includes detailed plans for development of new or modified flight H/W and S/W and data base items, for ground processing and verification of payload equipment, and for transportation of flight equipment and associated ground support equipment. This support will be provided to the CMCC for overall increment management functions.

### 3.2 Increment Planning, Preparation, Execution and Assessment Support

The Element Centers support mission control and payload operations and coordination organizations in procedure development and verification, monitoring of up- and downlink telemetry and the assessment of missions.

Procedures will be prepared and maintained utilizing the Software Development Environment (SDE) equipment and the Mission Planning Software (MPS) of the C/D program, and will be verified on the flight configuration's simulation facilities.
Mission execution support includes telecommand processing, troubleshooting support, recommendations and assessment for/of corrective actions, and system performance assessment. For this purpose raw or processed telecommands, voice/ video and

down-linked housekeeping data will be routinely acquired and archived. Near real time processing at any given time after request shall be possible.

The centers will provide and maintain system and payload references (e.g. engineering models) of the on orbit configurations to simulate on orbit behavior in support of troubleshooting. Control rooms will be equipped with consoles to enable flight data display and up- and downlink communication via the mission control centers. The archived data can also be used to perform trend analyses of system's performance/behavior.

The Mission Execution Support concept is shown in Figure 2.

3.3 Crew Training Support

The Element Centers have the capability to support crew training by offering their high fidelity engineering models of the flight configurations for on the job training of on orbit resupply activities. This will generally be limited to system related activities but may in special cases also include payloads. Also crew familiarization with the elements' workstations can be supported by use of the engineering models.

3.4 Payload Integration Support

The Element Centers support COLUMBUS users during development, integration and verification of payloads. This starts with familiarization courses for users' acquaintance with COLUMBUS system capabilities, policies and processes to be followed for the design, development and verification of their individual instruments.
The centers perform analytical integration of payload increments to ensure compatibility with the on orbit configuration. Further support will be the coordination of qualification tests necessary to gain instrument acceptance.

Payload increment verification on system level will be done with Rack Level Test Facilities (RLTF), which can be configured to represent the reference for the relevant on orbit configuration. These RLTFs are installed in User Support Operations Centers (USOCs) and will be controlled and maintained by the Element Centers.
A further RLTF in each Element Center is to be maintained for troubleshooting and as the reference configuration for the remotely located RLTFs. This allows also for centralized processing of payload increments.

The transportation of Payload increments from the USOCs or the Element Centers to the launch sites are planned and performed by the centers' Logistics Support Function.

The Element Centers' Payload Integration Support concept is shown in Figure 3.

3.5 Integrated Logistics Support

The Element Centers perform acquisition, storage, movement, distribution, evaluation and disposition of system resupplies by operating an Integrated Logistics Support System. This system will provide the analytical tools to perform on-condition monitoring and plan corrective actions, but also the facilities for ground processing of resupplies.

Processing of resupplies at launch and landing sites will be supported by center personnel. This includes planning for and processing of system and payload resupplies for launch and post mission, and transportation between Europe and launch/landing sites.

In addition to storage of spares, maintenance and repair of returned items, coordination and control of vendors, suppliers and other external support required will be performed.

The Element Centers' Logistics Support concept is shown in Figure 4.

## 4. IMPLEMENTATION APPROACH

For their architectural design the Element Centers are to make maximum use of equipment and tools developed in the COLUMBUS elements C/D programs. This implies utilization of flight configuration engineering models, flight configuration simulators, ground support equipment, software development tools, data bases and established communication systems, and includes the necessary refurbishment/upgrading as part of the centers' implementation process.

The following functional entities will be part of the centers to provide for the required support functions:

- Telemetry data acquisition, processing and archiving; capable to receive downlink telemetry via the control centers and the European Earth Terminal (EET) and to transmit commands to the control centers for uplink. Selected data will be used in the engineering support function and by the integrated logistics system.

- System and payload references; capable to be configured in a given time to represent the elements' on orbit configuration and to process telemetry data in near realtime. These facilities shall be based on the use of EMs, flight configuration simulators and EGSE for system representation. The payload reference will be provided by a Rack Level Test Facility (RLTF) which represents the system functions by use of C/D breadboard models or real flight hardware and the actual on orbit payload configuration by payload models to the extent necessary for payload increment verification.

- Control room with consoles for real time support; capable to present the mission control displays. Three to four consoles are considered adequate to support mission control centers in their tasks execution.

- For SW development and maintenance the C/D facilities SDE and MPS shall be maintained and upgraded for use for system and payload software development. Procedure and SW verification will be performed on system and payload references.

- Warehouse, workshops and transportation equipment for the storage, maintenance and movement of hardware. The workshops are to include the necessary unit test equipment.

- Data processing facilities for generation, archiving, maintenance and distribution of information within the center and to authorized users of the Ground Segment infrastructure.

A conceptual approach of grouping Element Center functional entities is shown in Figure 5.

The center building infrastructure provides for offices, control rooms, computer rooms, special equipment rooms, conference rooms, warehouse, workshops and a high bay type clean room.

## 5. MANPOWER REQUIREMENTS

Based on required support functions and support availability requirements staffing requirements have been established. The individual center functions require the following types of support personnel:

### 5.1 Engineering Support

Operators for maintenance and operation of center facilities and equipment; engineers for System Engineering, Operations and Product Assurance; subsystem engineers for Power/Harness, Thermal, ECLS, Structure/Mechanisms, GN&C, DMS, COMMS; specialists for ground - and flight software development and maintenance; Configuration Control specialists; operators for Documentation and Data Base Maintenance.

### 5.2 Payload Integration Support

Engineers for P/L Analytical Integration; specialists for coordination of User Support/Familiarization; Payload Increment Management teams for planning, development support, acceptance test and launch site support, payload documentation; operators for maintenance and operation of RLTFs; verification supervisors; software developers for payload simulators and payload flight software.

### 5.3 Logistics Support

Engineers/technicians for storage and maintenance; engineers/operators for development, maintenance and operation of unit test equipment; staff for handling of external contracts with suppliers and other support functions; transportation personnel; resupply flight support staff at the launch site.

### 5.4 Center Management

Center and Center Function managers; secretaries; administrations staff for contracts handling, personnel management, project control; clerical services for typing pool, documentation center; security staff.

## 6. MANPOWER PROFILE

A staggered implementation of center functions is required, i.e. support to instrument development shall be provided approximately 5 years before launch, the capability for processing of payload increments already 2 years before launch in order to validate the intended verification approach for later payload increments with the initial launch payload. Logistics support will have to be built up to be operational in time to support the elements' first resupply launch. The Centers' support to mission control and payload operation and coordination organizations shall be available 1 year before launch.

Based on these requirements the personnel build up to a steady state operations support is shown in Figure 6.

The numbers shown here, relate to the Free Flying Center. Manpower requirements for the Attached Laboratory Center will be different in some areas, due to the different increment lengths and operational scenarios of the two flight configurations.

The personnel required will generally be recruited and phased in from the outrunning flight configuration development program and from the Element Center implementation staff.

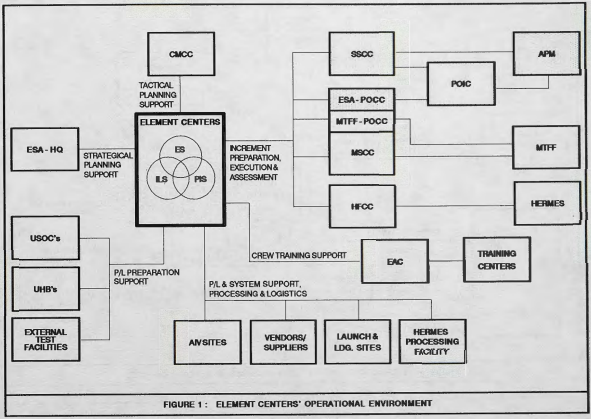


FIGURE 1 : ELEMENT CENTERS' OPERATIONAL ENVIRONMENT

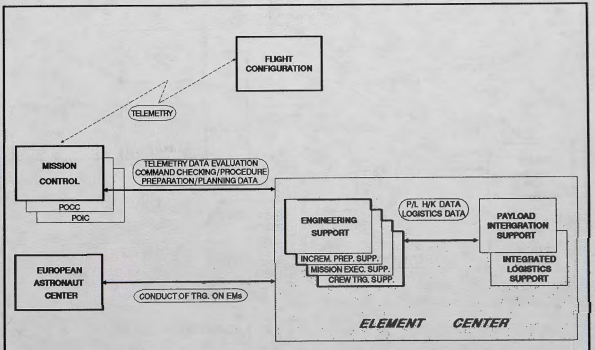


FIGURE 2 : ELEMENT CENTERS' MISSION EXECUTION SUPPORT

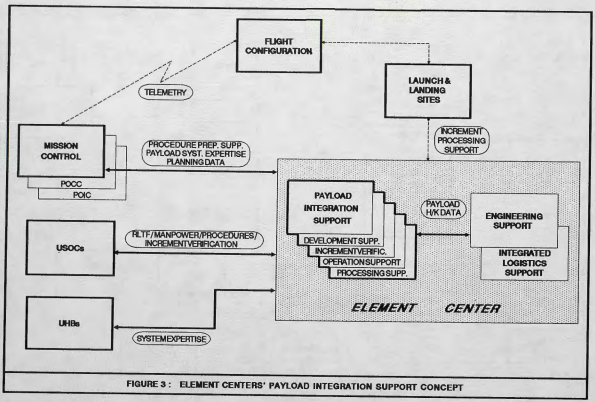


FIGURE 3 : ELEMENT CENTERS' PAYLOAD INTEGRATION SUPPORT CONCEPT

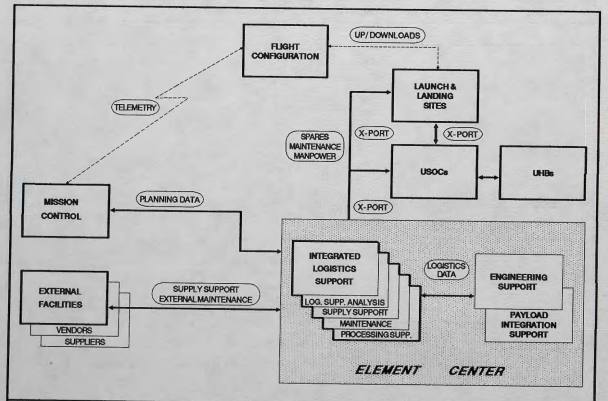


FIGURE 4 : ELEMENT CENTERS' INTEGRATED LOGISTICS SUPPORT

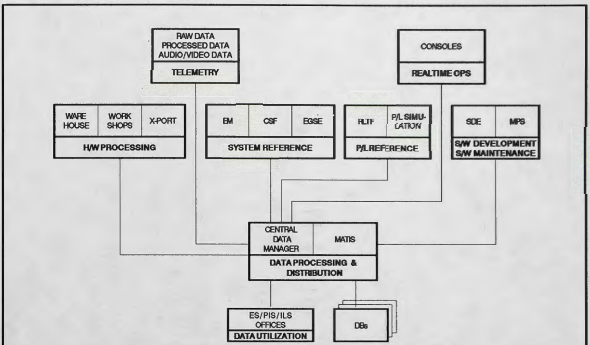


FIGURE 5 : FREEFLYER CENTER CONCEPTUAL FUNCTIONAL ARCHITECTURE

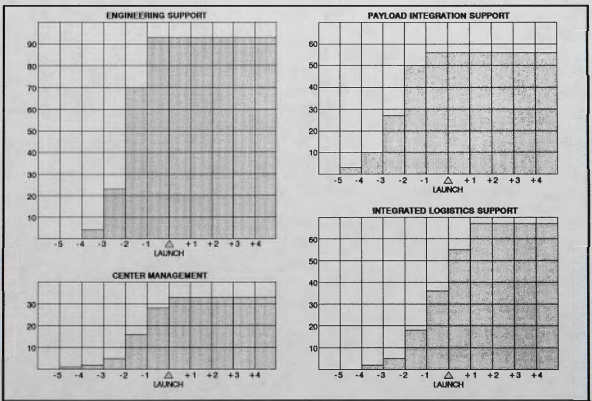


FIGURE 6 : FREEFLYER CENTER MANPOWER PROFILES