

Mark Ruijsendaal

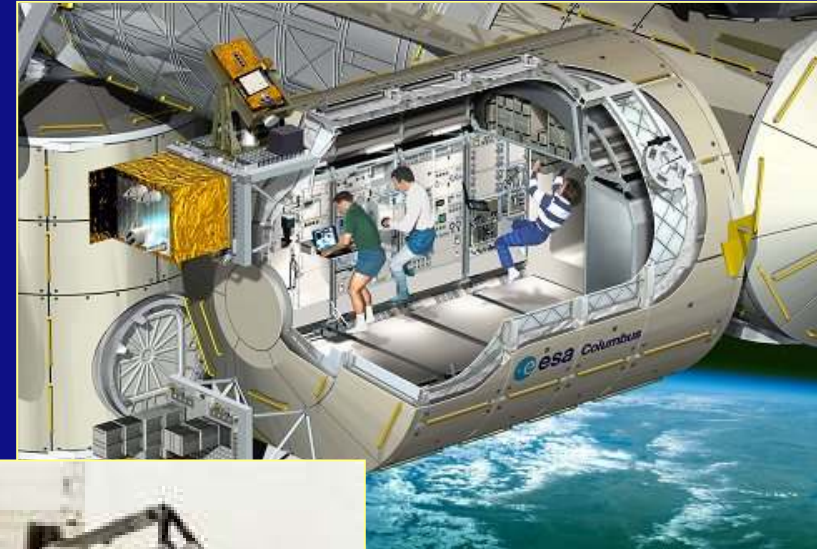
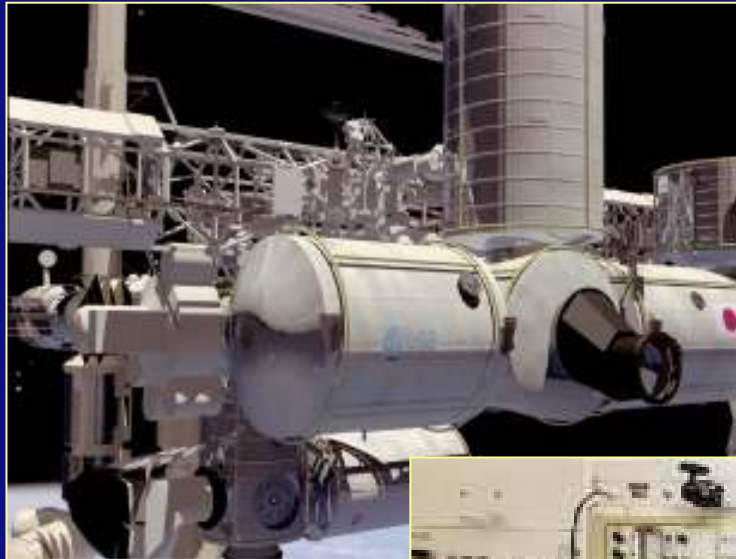
# Usability in Space

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**TNO** | Knowledge for business



# Physical context

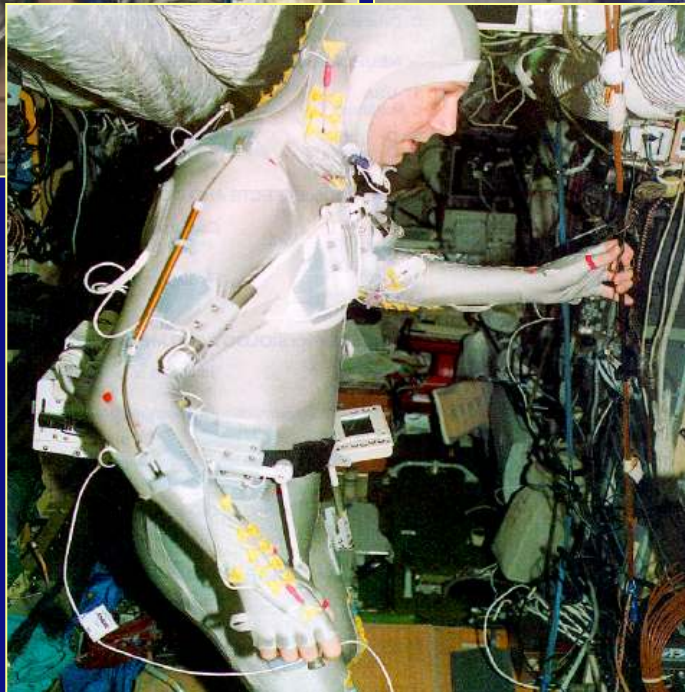


- Unique
- Microgravity
- Technical

- Complex
- Noise
- Limited support
- Many HCl's



# Human/Task context



- Degraded vision
- Degraded cognitive abilities
- Limited movement

- Strenuous time schedule
- Multi-lingual
- Many tasks



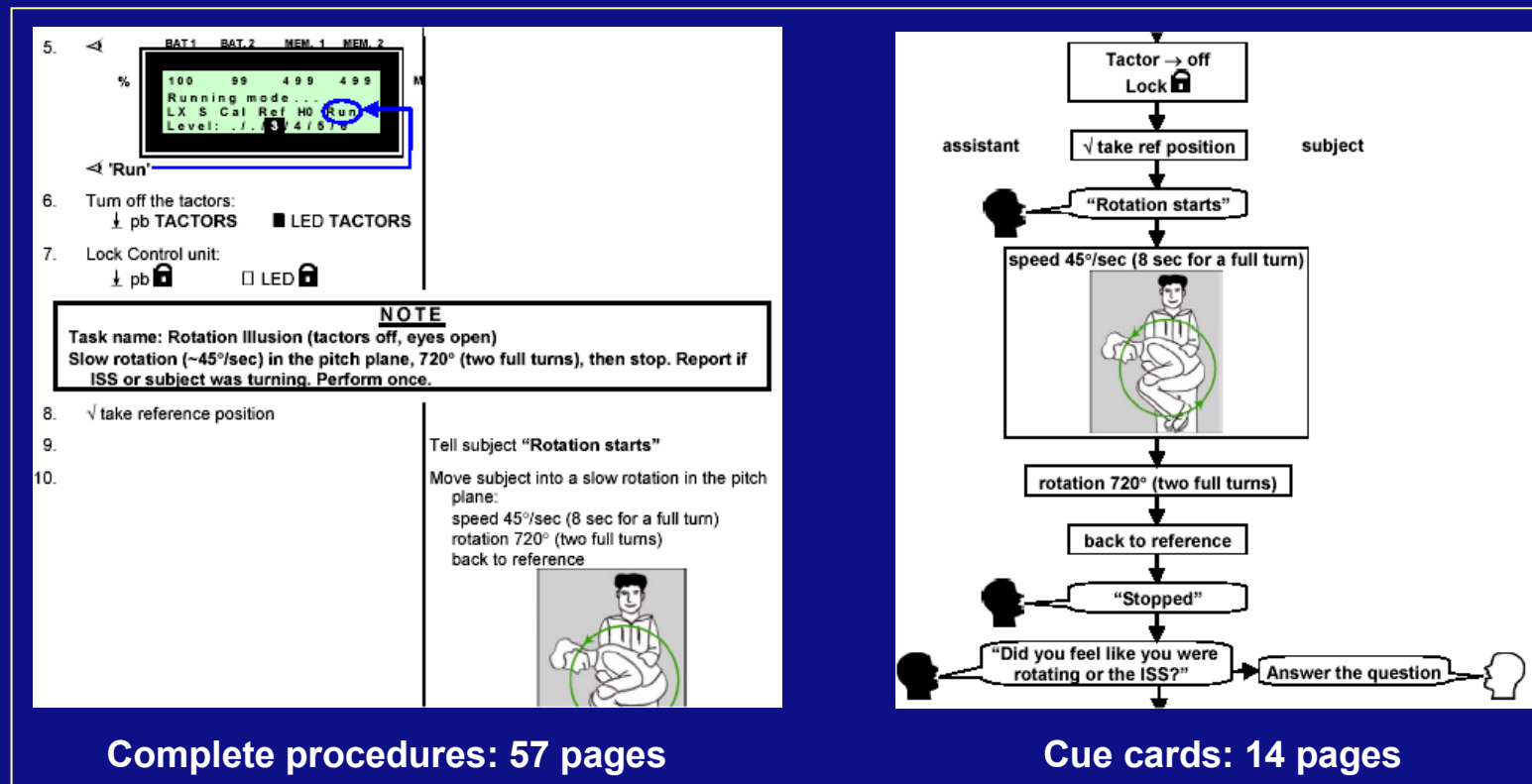
# Procedural support – now (1)

- Almost all actions are described in procedures (also off-nominal)
- Procedures are available in paper manuals with limited background information
- Difficult to change procedures last-minute



## Procedural support – now (2)

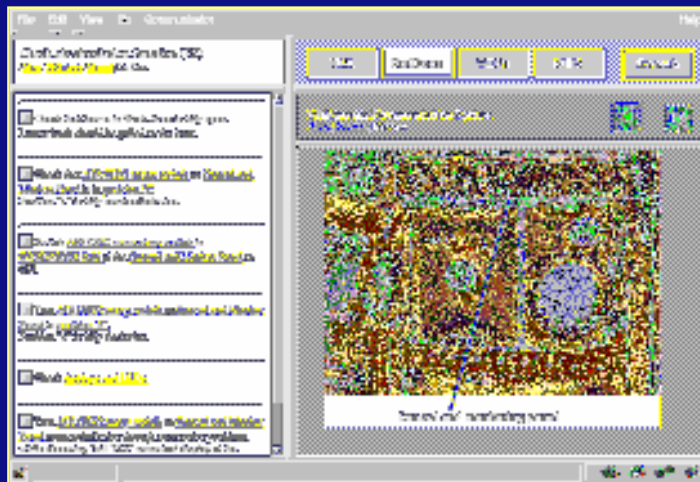
- No integration with and limited tuning to physical payload
- There is a need for layered information (different levels of detail)



# Procedural support - future

## *Different needs:*

- Higher level of automation
- Human-machine collaboration
- Higher autonomy astronauts
- Robotics (autonomous machines)



## *Better support:*

- Integrated procedures
- Better navigation support
- Higher consistency between HCl's
- Diagnosis guide



# How to develop usable Space HCs

*Many standards, limited guidance*

- ECSS (European Co-operation for Space Standardisation)  
Main topics: Space project management (M), Space product assurance (Q) & Space engineering (E)
- ISS DGCS (International Space Station Display and Graphics Commonality Standard)
- ISO, SSP (NASA), FED-STD, MIL-STD, ISA (Instrument Society America), ... etc.



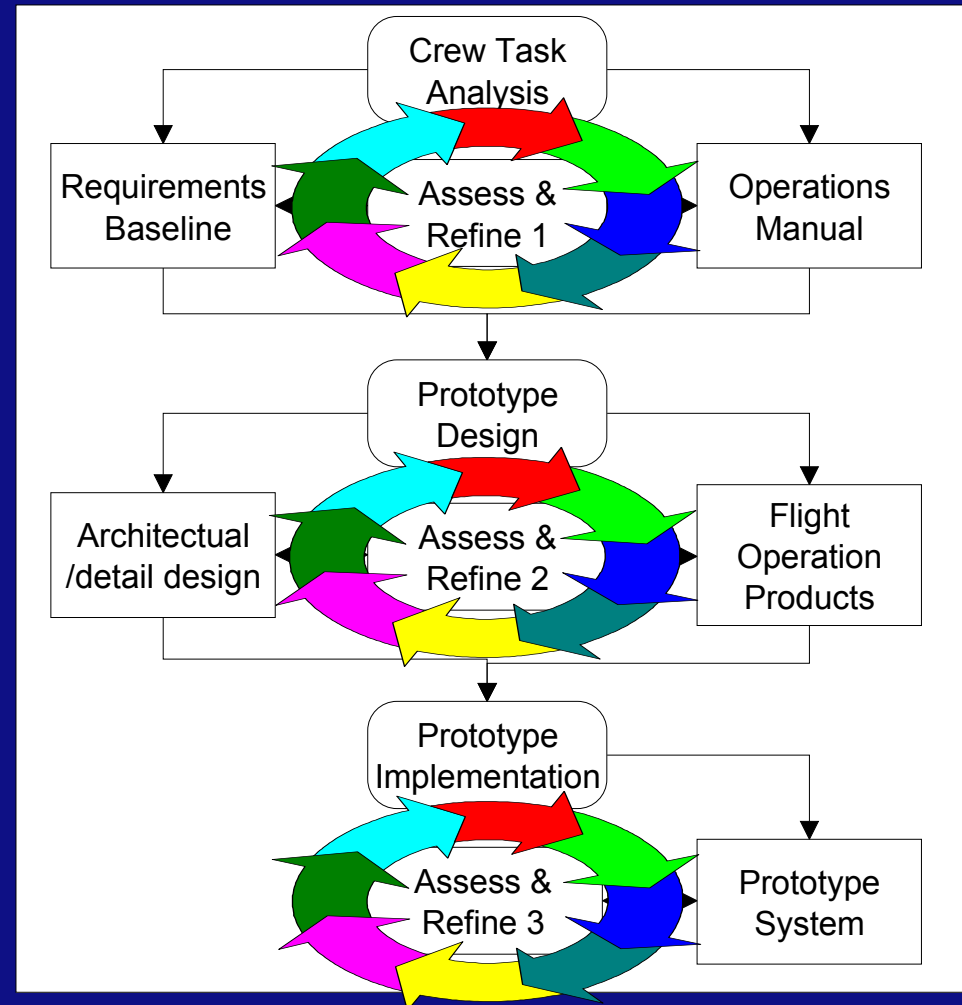
# Development process

## *Operability-centered design*

- Operations and system usage coherently addressed from early development
- Process guidance for cost- & time-effective HCI development

## *Tuning to linear process*

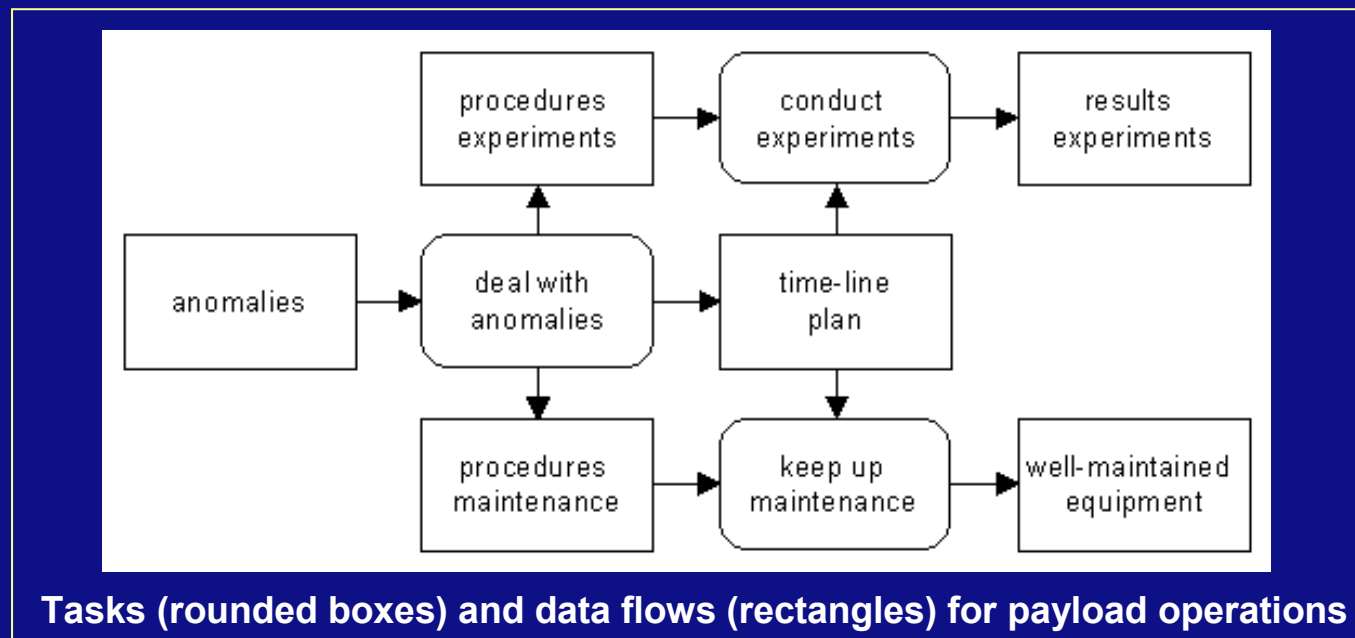
- Iterations in distinct steps
- Same formal deliverables





# Usability Engineering methods used

- Task decomposition (also basic procedure structure)
- Task allocation (between humans, between human and machine)
- Scenarios (for instance for anomalies)
- User requirements, interface requirements
- Expert reviews (usability, experiment, space)
- User walkthroughs (limited access to astronauts)



Tasks (rounded boxes) and data flows (rectangles) for payload operations



# Design of navigation support

Storyboard ACT - Microsoft Internet Explorer

File Edit View Favorites Tools Help

**Check air circulation function (FS)**  
[/Main/GBXcheck/Manual/Air Circ.](#)

Check that Louver in Work Area is fully open. Louver knob should be pulled to the front.

Switch [AIR CIRC momentary switch](#) in [OVERRIDES field](#) of the [Control and Monitor Panel](#) to ON.

Turn [AIR CIRC rotary switch](#) on [Control and Monitor Panel](#) to position "6". Position "6" is fully clockwise.

Check [displays and LEDs](#).

Turn [AIR CIRC rotary switch](#) on [Control and Monitor Panel](#) counterclockwise through successive positions, while observing "mB WA" numerical display of the [STATUS field](#). Check that reading goes down to 1 mB.

**Multimedia Documentation System**  
[/Main/Glovebox/ULCP](#)

Upper Control Panel

Video Drawer

Lower Control Panel

**Navigation Aid**



# Design of integrated procedures

The screenshot shows a web browser window titled "Storyboard ACT - Microsoft Internet Explorer". The page is divided into two main sections. The left section, titled "Check air circulation function (FS)", contains a list of procedural steps with checkboxes. A blue callout box labeled "Procedural Help" points to the first step: "Check that louver in Work Area is fully open. Louver knob should be pulled to the front." The right section, titled "Multimedia Documentation System", displays a photograph of a piece of equipment. A blue callout box labeled "Selection and Display of Services" points to a red circle on the equipment's upper panel. Another blue callout box labeled "Lower Control Panel" points to a lower section of the equipment. A large blue callout box at the bottom, labeled "Integrated Interface", encompasses both the procedural list and the multimedia documentation area. At the top right of the page, there are navigation buttons for "TML", "RefDocs", "VCPs", "MTS", and a "Search" button.



# Usability test & User walkthrough

## *Usability test*

- 45 physics and chemistry students
- Tasks: experiments, maintenance, anomalies
- Dependent variables:
  - effectiveness (# correct VCP-actions)
  - efficiency (time, # actions, load)
  - satisfaction (subjective opinion)
  - learning (performance, knowledge)

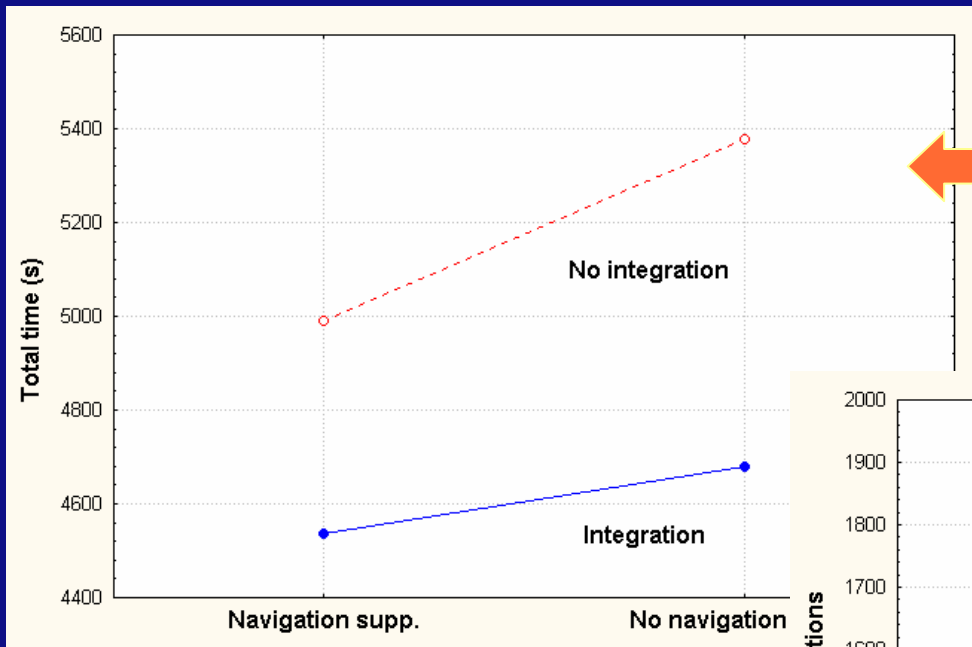


## *User walkthroughs*

- 1 ESA representative, 2 payload developers, 2 ESA astronauts (end users)
- Tasks: experiments, maintenance, anomalies
- Questionnaires, remarks, observations

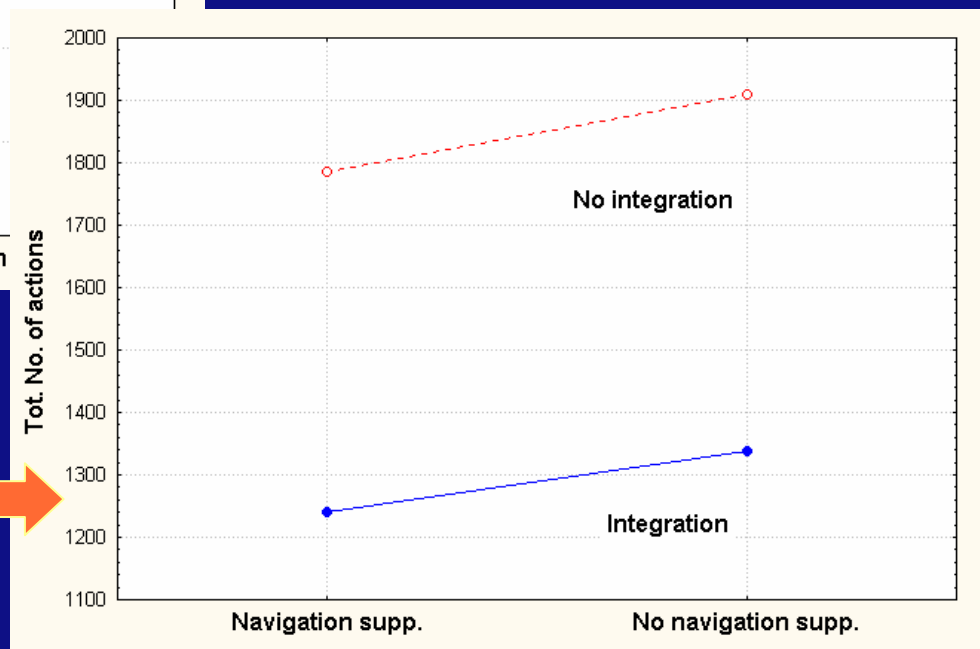


# Proving value of integrated procedures



Quicker with integrated procedures

Less interactions with integrated procedures



# Resulting design (work in progress)

To Do list & Diagnosis

Procedures next to control and documentation

Speech control

SCOPE: Supporting Crew OPERations v1.0d13

File Speech Help

Status Cardiopres: OK August 18, 2003 4:34:45 PM CEST

CONTROL PANEL PROCEDURES DOCUMENTATION STATUS SEARCH ENGINE

SCHEDULED PROCEDURES

up Main/Apply Cardiopres belts/Turn around display/

- Press the menu button**  
Press the Menu button (arrows both ways) to enter the menu.
- Scroll through the menu**  
Scroll through the menu to the option "system options" by (up) or (down).
- Select system options**  
Select option "system options" by pressing the Menu button: You enter the submenu "system options".
- Scroll through submenu**  
Scroll through the submenu to the option "select display" by (up) or (down).
- Select display option**  
Select option "select display" by pressing the Menu button: The cursor goes to the display options left/right.
- Choose display**  
Select the display by <- or -> (display left/right).


hide disable speech to do diagnosis procedures documentation control panel status search engine focus up focus down expand move up uncheck check

Hypertext Documentation

back forward main

**Battery Pack**

Cardiopres comprises a number of units and items. They are described in Paragraph ['Overview Cardiopres components'](#).



*Battery pack*

A Cardiopres NiCd battery pack (ground based use only)  
Cardiopres rechargeable NiCd batteries have an energy content of 2.4 Ah, giving a typical 3-4 hours operation when fully charged for a continued blood pressure and ECG recording.

The Pump unit, a Main unit, and a battery are placed in the waist belt. See for more information ["Storage in belt"](#)

The battery pack should be connected to the Power connector block located in the battery compartment of the Waist belt.

Other components of the Cardiopres:  
[Main unit](#) | [Pump Unit](#) | [Battery pack](#) | [Frontend-Main unit assembly](#) | [Waist belt](#) | [Cuff](#) | [ECG leads](#) | [ECG disposable pads](#) | [Respiratory belts](#)

Links to other documentation:  
[Overview Cardiopres connections](#)  
[Battery pack connectors](#)  
[Battery related errors](#)  
[Battery replacement](#)

