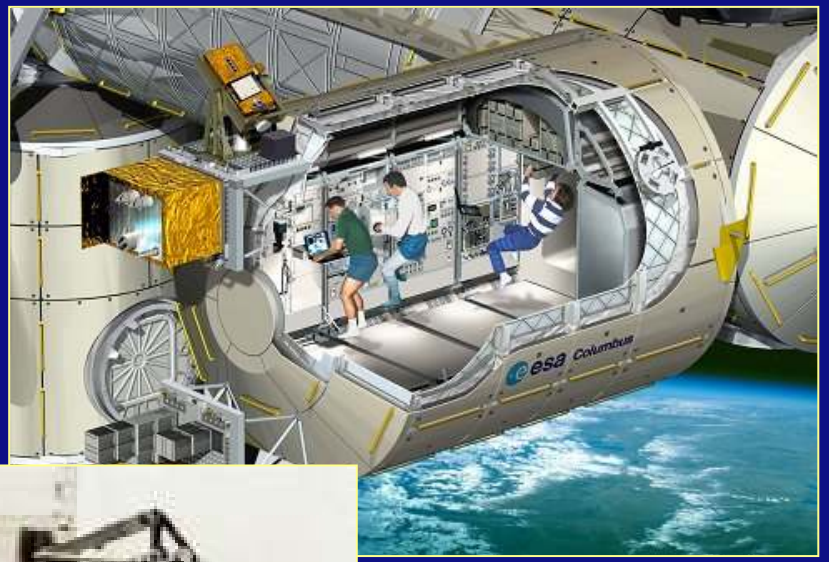
Mark Ruijsendaal

Usability in Space

P.O Box 23
3769 ZG Soesterberg
+31 346 356206
ruijsendaal@tm.tno.nl

TNO | Knowledge for business

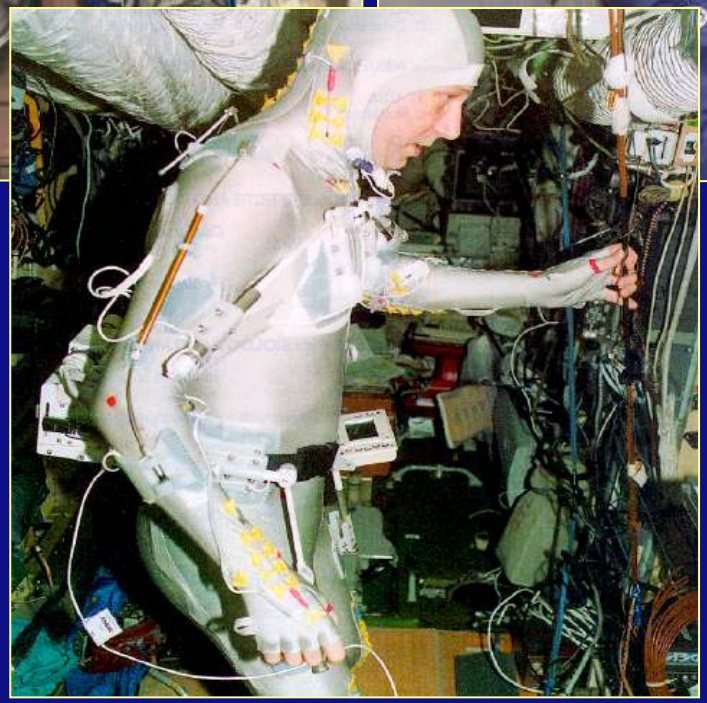
Physical context



- Unique
- Microgravity
- Technical

- Complex
- Noise
- Limited support
- Many HCIs

Human/Task context



- Degraded vision
- Degraded cognitive abilities
- Limited movement

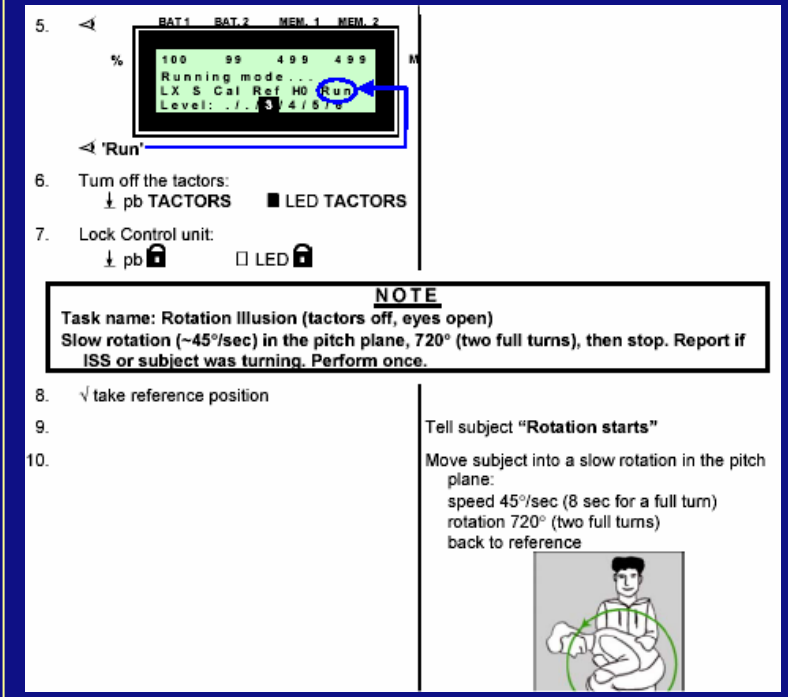
- Strenuous time schedule
- Multi-lingual
- Many tasks

Procedural support – now (1)

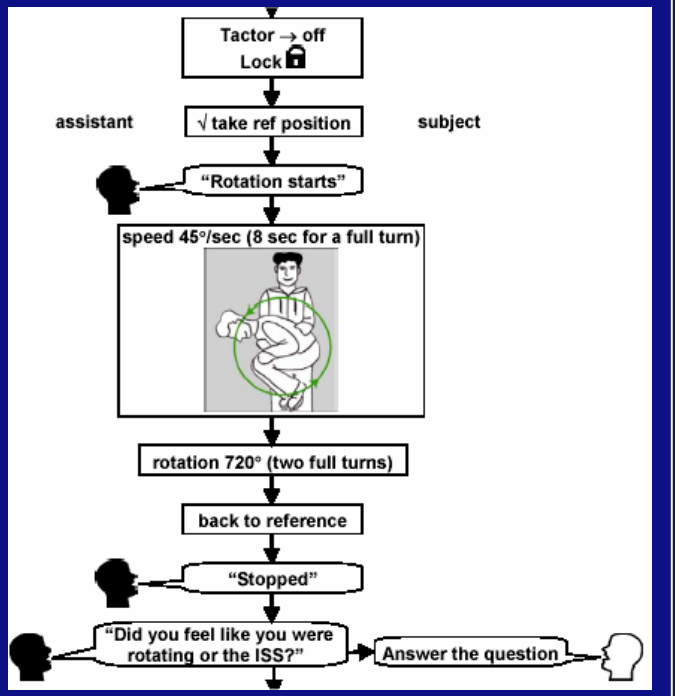
- Almost all actions are described in procedures (also off-nominal)
- Procedures are available in paper manuals with limited background information
- Difficult to change procedures last-minute

Procedural support – now (2)

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



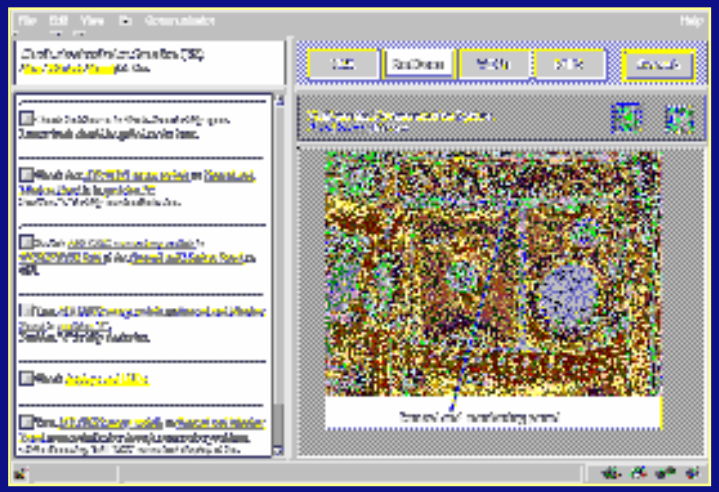
Complete procedures: 57 pages



Cue cards: 14 pages

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 HCIs
- Diagnosis guide

How to develop usable Space HCIs

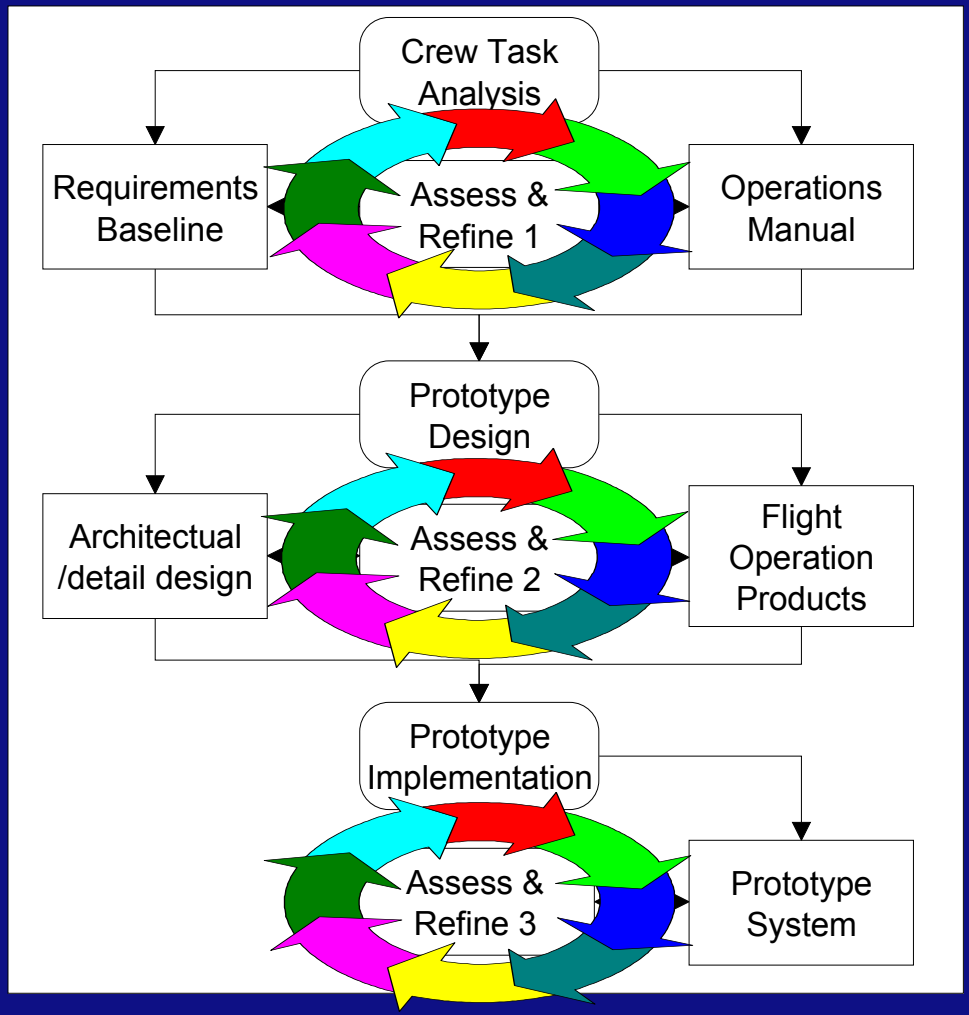
Many standards, limited guidance

- 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

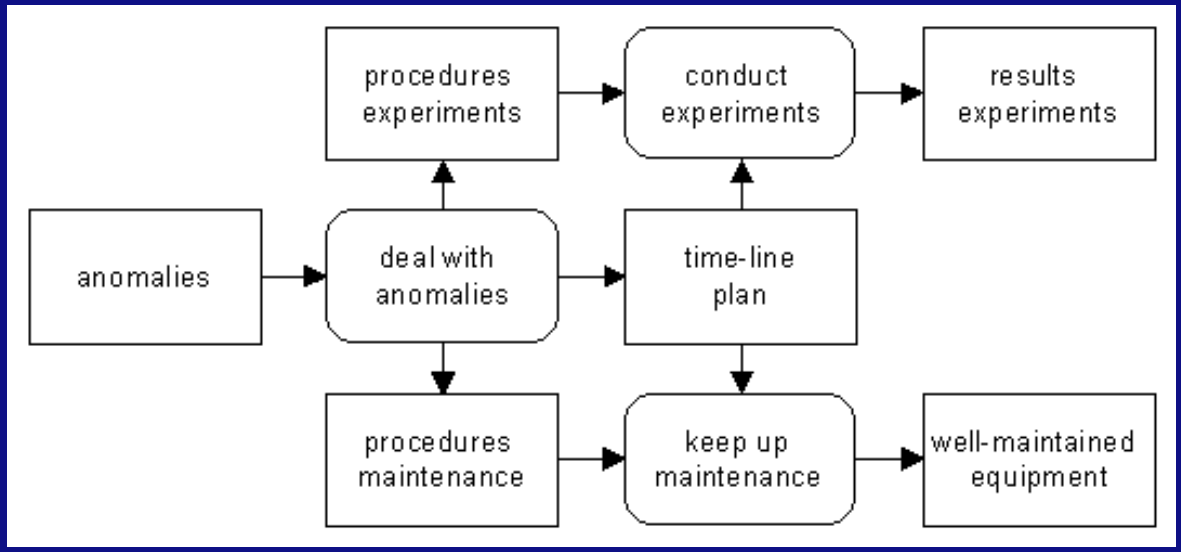
Operability-centered design
- Operations and system usage coherently addressed from early development
- Process guidance for cost- & time-effective HCI development

Tuning to linear process
- Iterations in distinct steps
- Same formal deliverables



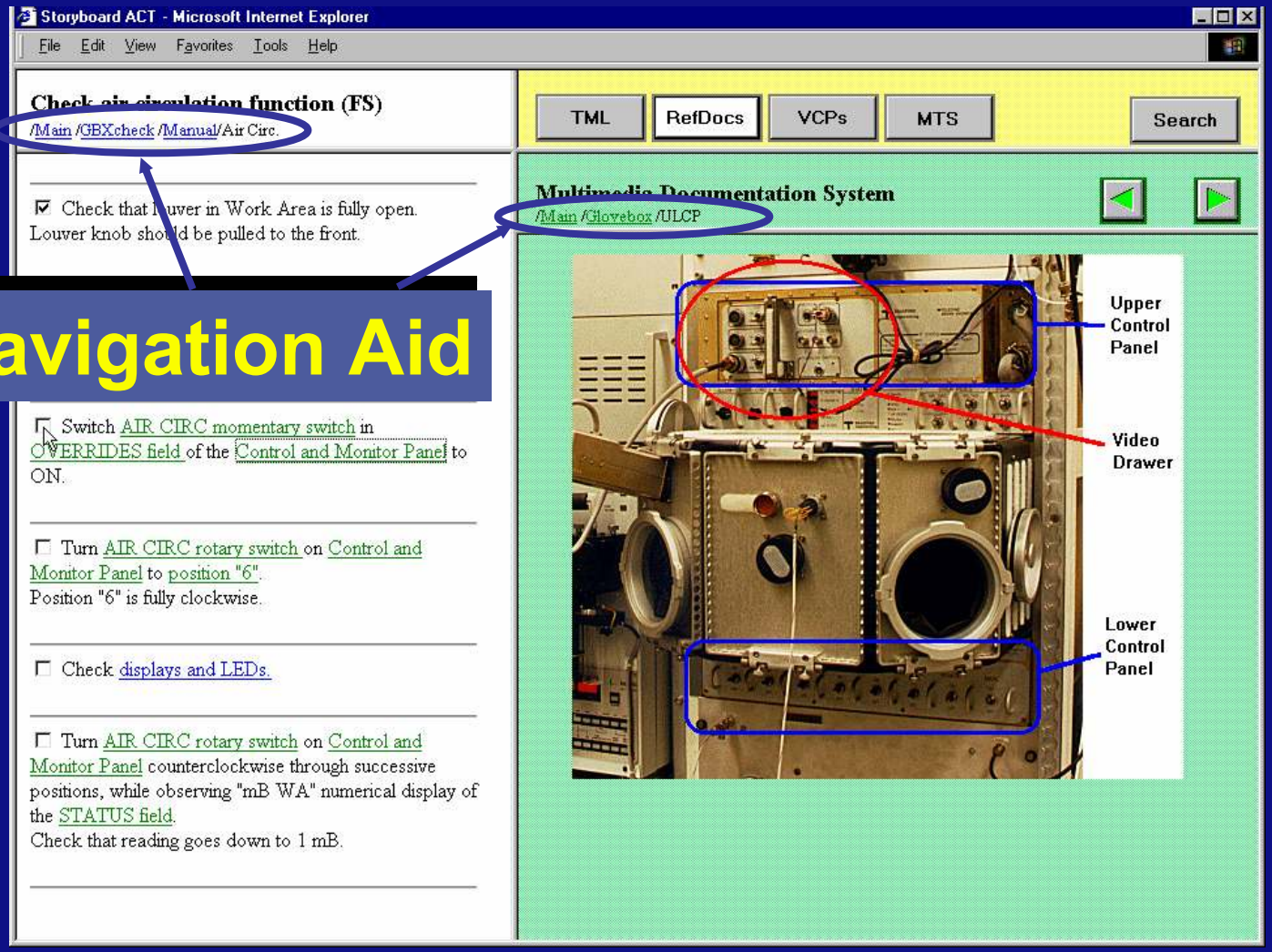
Usability Engineering methods used

- 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)

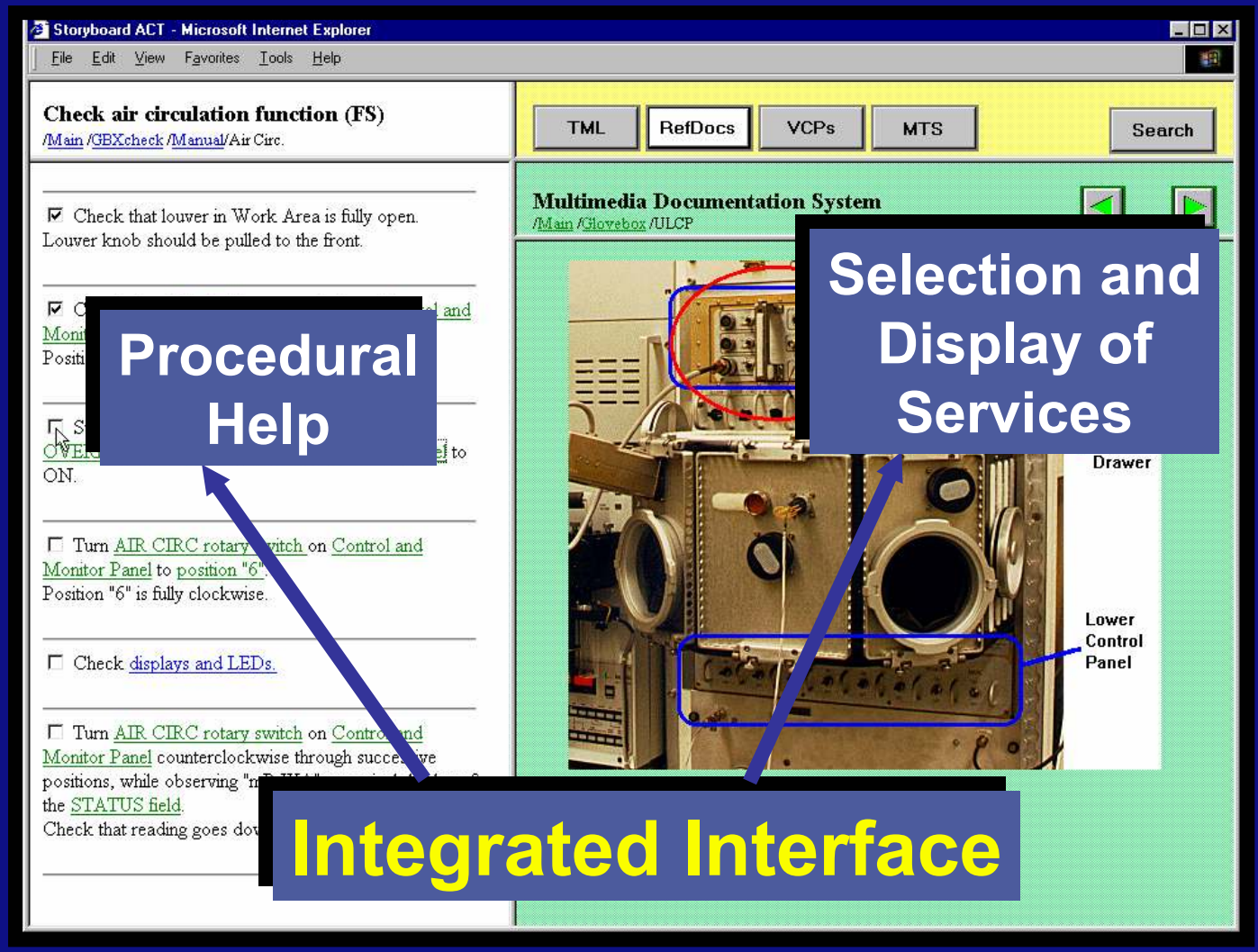


Tasks (rounded boxes) and data flows (rectangles) for payload operations

Design of navigation support



Design of integrated procedures



Usability test & User walkthrough

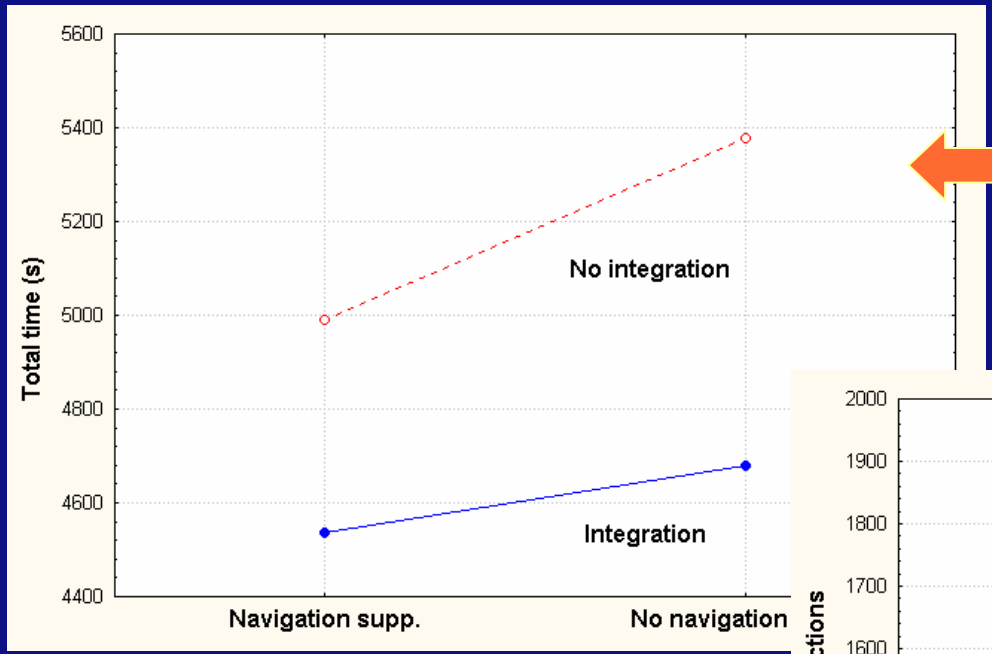
Usability test

- 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

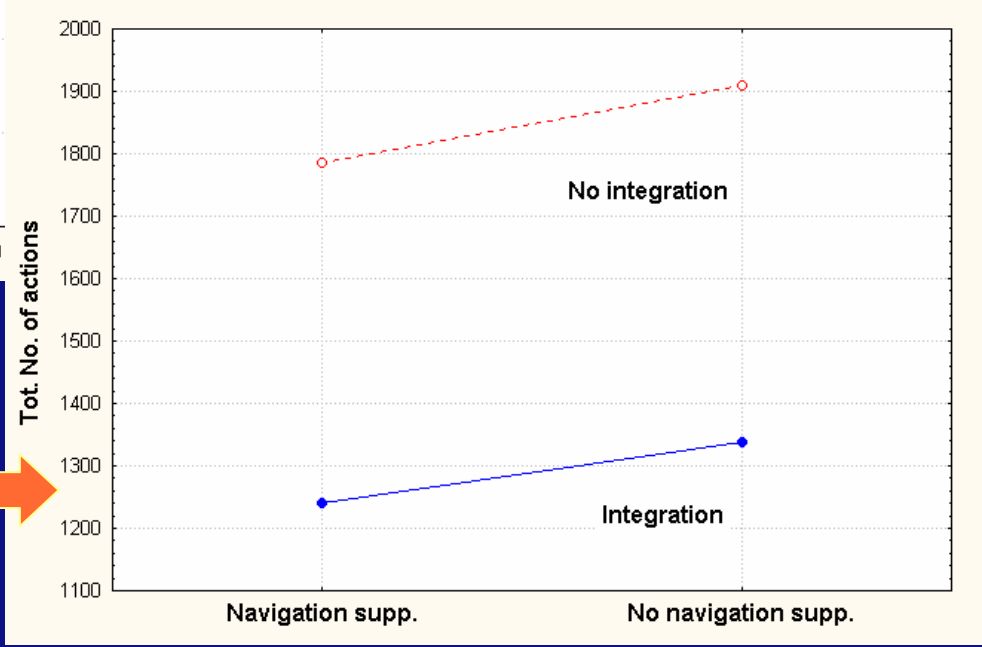
- 1 ESA representative, 2 payload developers, 2 ESA astronauts (end users)
- Tasks: experiments, maintenance, anomalies
- Questionnaires, remarks, observations

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