



MOONWALK

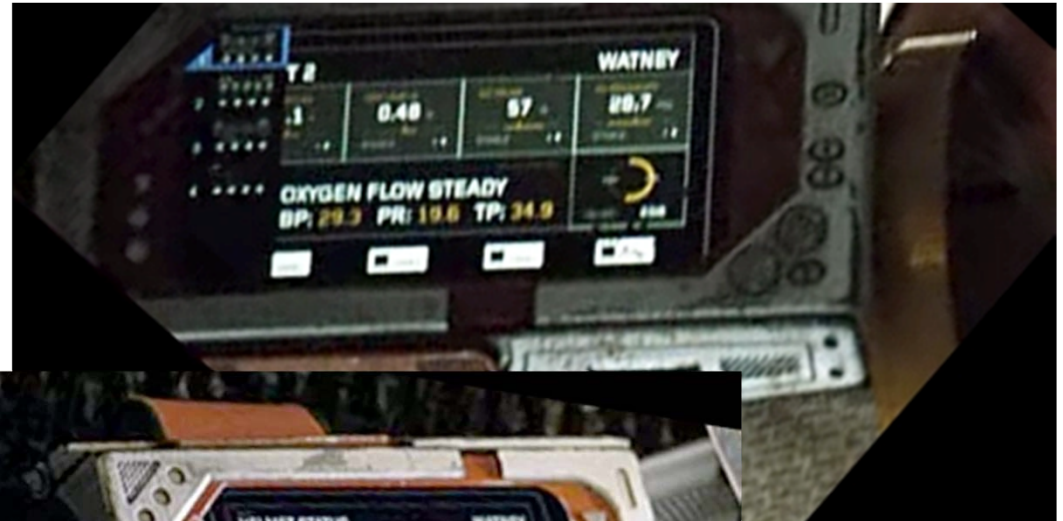
Prototyping the Spacesuit Human Interfaces of the Future for Test in Water Immersion Partial Gravity Simulation

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Image credits: AFP

EVA Computer displays in Sci-Fi



(Real) Spacesuit Control Panels and Information Systems

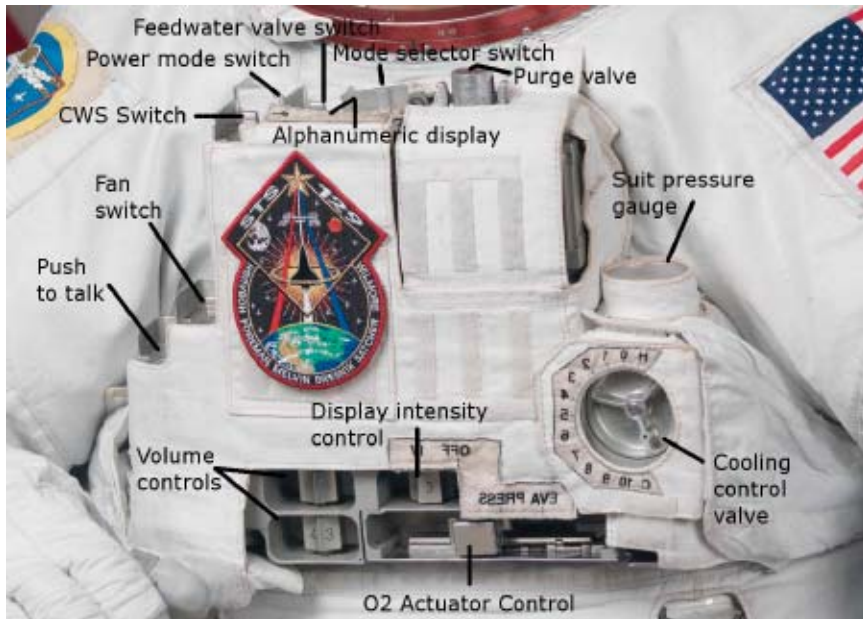


Image credits: NASA

- Extravehicular Mobility Unit (EMU)
- NASA design
- Display and Control Module (LED display) & mechanical buttons
- Used in Shuttle and ISS programs

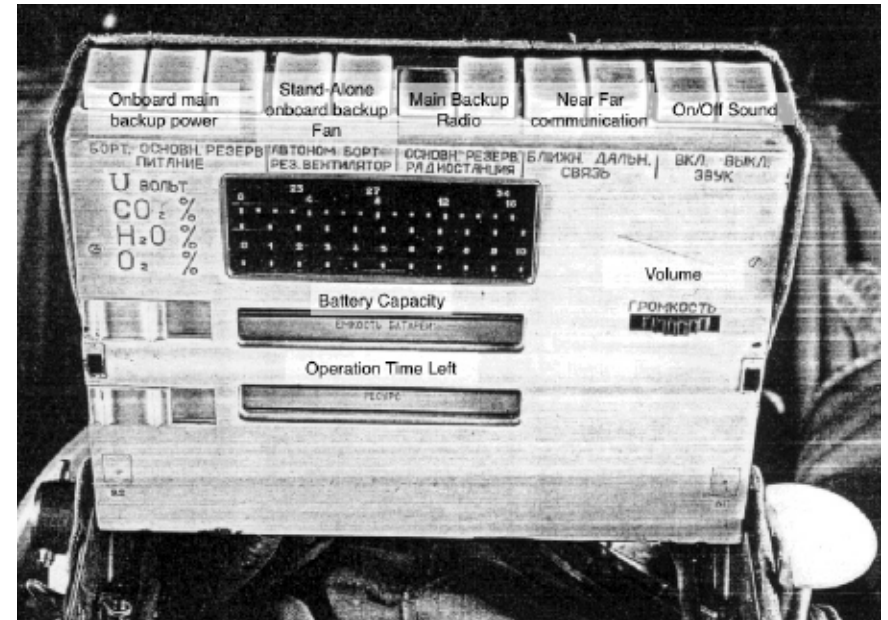
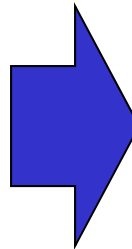


Image credits: Julius DeRoo

- Krechet-94 (designed in 1960s)
- Designed for Russian Moon program
- Chest display (stowable) with buttons for controlling functions & analog indicators
- Never flew due to program cancellation

EVA Constraints for Planetary Surface Missions

- Shuttle and ISS EVAs
 - Near constant communication between EV and MCC, negligible delay
 - UHF radios + telemetry and biomonitors also sent over UHF
 - MCC actively monitors the spacesuit parameters (battery, CO2 scrubbing, temp, etc.)
 - Crew typically asks permission to proceed with certain steps
- Future Planetary Surface EVAs
 - Operations with communication delays
 - Reduced situational awareness in MCC
 - More autonomy for Crew (consequence: more information needs to be provided in a concise manner to the crew)
 - Analogue missions: MCC has resorted more to text messages and less to voice communication



Overview of the MOONWALK Project

- 3-year cooperative R&D project funded by the European Commission 7th Framework Programme [DFKI, COMEX, INTA, Space Applications, Liquifer, NTNU, Airbus]
- Goal:
 - Creating in Europe the **capability of simulating Extravehicular Activities (EVAs)** on the surfaces of planetary bodies
 - Studying scenarios of **Astronaut-Astronaut and Astronaut-Robot collaborations**
 - Conducting **analogue simulations: Rio Tinto (Mars analogue) and subsea Marseille (Moon)**
- Developments:
 - EVA astronaut training suit for future surface Extra-Vehicular Activities (EVA)
 - **EVA information system, integrated in the training suit**
 - **Mission Control Centre (MCC) for international analogue simulations**
 - Rover to assist the astronaut during EVA activities





MOONWALK Human Machine Interface

- Human Machine Interface (HMI) is being developed by Space Applications Services
- Objectives:
 - **Improve the exchange of information** between astronaut and MCC during EVAs
 - **Allow the control of payloads and robots** on the planetary surface
 - **Improve situational awareness and autonomy** of the Extravehicular Crew
- Technical Features:
 - **Procedure viewing** (accepting Operational Data File – ODF standards currently used in the ISS)
 - **Note taking**
 - **Telemetry, Cautions and Warnings (also biomonitoring)**
 - **Video** streaming delivery, incl. video from a helmet camera and from a scouting robot with omnidirectional camera
 - **Voice** comms
 - **Text messages** (chat communication)
 - **Robot (and payload) control** through buttons - and gestures (DFKI)
 - **Communications during emergency** situations



A Novel Human Machine Interface for EVAs (1/2)

- Requirements for HMI use in Earth-base Analogue Simulations
 - Capability to introduce **variable communication delays**
 - Capability to introduce **real and/or mock telemetry and Cautions/Warnings** (e.g. for radiation profiles or Life Support System parameters)
 - **Fully operational in Water Immersion**
Partial Gravity conditions, i.e. subsea in a natural setting down to -20 meters
- A MOONWALK MCC is being created in Brussels, Belgium, to support remote operations with the EVA Crew and a Robot on the Analogue Sites





A Novel Human Machine Interface for EVAs (2/2)

- **Chest Display**
 - Touch display: hardware and UI take into account pressurized gloves to operate the display
 - Stowed configuration: flat at the chest
 - Deployed: in front of the face of the astronaut + allowing space for the arms and hands to interact with the display + allowing a line of sight that is an angle smaller than the critical angle for use in water (avoiding full reflection)
- **Wrist Display**
 - Display and array of mechanical buttons to interface/navigate (joypad-like interface)
 - Joypad interface can be either hanging on a retractable tether or on one of the wrists
 - Mainly intended to replace the standard US EVA cuff checklist
- **Heads-Up Display**
 - Similar to the wrist display
 - Permanently in front of the suited crew





Software Development - HMI

The HMI interface displays the following information:

- Top Bar:**
 - spaceapplications logo
 - CO2 : 58:03
 - O2 : 30:03
 - Batt : 01:01
 - 11:56:30 ECL -W- O2 LOW (Warning)
 - 11:10:11 ATT -C- HAZD ATT (Warning)
 - 11:56:30 ROV - C - LOST SIGHT (Warning)
 - HR : 70
 - P : 8.3 psi
 - RH2O : 1:50
 - 11:56:21 GMT
 - 01:31:18 EVA ET
 - Call : Bd-Hm-MC
 - Rov : Mod 1
- EV 1 Tasks:**
 - 1. EVA ET+10 MWK EGRESS
 - ☐ EGRESS FROM LEM
 - ☐ TRANSLATE TO CAVE (50.01 POINTE MARLET EAST MAP)
 - 2. EVA ET+15 CAVE EXPLORATION
 - ☐ ASSESS SAFETY OF CAVE
 - ☐ GO/NOGO FOR ENTRY
 - 3. EVA ET+20 CAVE EXPLORATION
 - ☐ Move the rover straight for 10 meters
 - ☐ Take Pictures
 - ☐ Check the tasks
 - 4. EVA ET+24 RETURN TO SAFETY
 - ☐ REPORT AIR RESSOURCES
 - ☐ DOCUMENT WAY BACK
- EV 2 Tasks:**
 - 1. EVA ET+10 MWK EGRESS
 - ☐ EGRESS FROM LEM
 - ☐ TRANSLATE TO CAVE (50.01 POINTE MARLET EAST MAP)
 - 2. EVA ET+15 CAVE EXPLORATION
 - ☐ ASSESS SAFETY OF CAVE
 - ☐ GO/NOGO FOR ENTRY
- Bottom Navigation Bar:**
 - Procedure (Icon: Grid)
 - TOC (Icon: Document)
 - Note (Icon: Pencil)
 - Comms (Icon: Speech bubble)
 - C & W (Icon: Warning triangle)
 - Telemetry (Icon: Gauge)
 - Rover (Icon: Rover)
 - Emergency (Icon: Bell)

Time Information

Main Telemetry

Caution and Warnings

Page content

Navigation

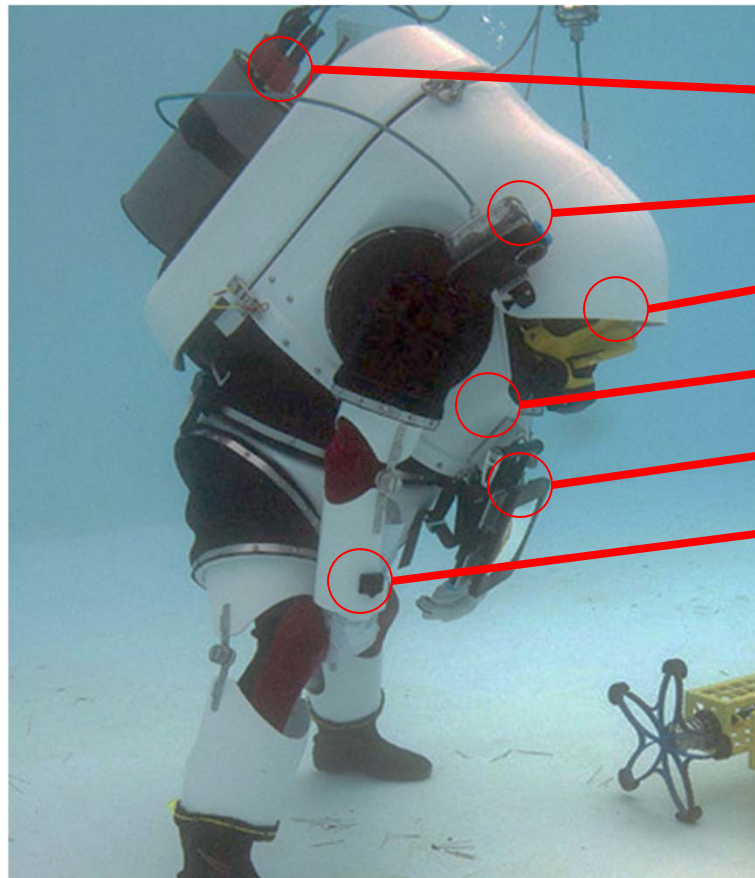
GUI – Wrist Display and HUD

The GUI displays the following information:

- Top Bar:** Status icons (USB, download, upload, camera, clipboard), signal strength, 100% battery, and time 11:55.
- Notes Section:**

| | | |
|------------------|---------------------|-----------------------|
| BIO_HeartRate | (worst) : 185.67627 | (current) : 148.17627 |
| EM_CarbonDioxide | (worst) : 3.09017 | (current) : -3.09017 |
| BIO_Welfare | (worst) : 0.9045085 | (current) : 0.6545085 |
- Left Panel:**
 - HR : ...
 - P : ...
 - RH... : ...
 - CO2 : ...
 - O2 : ...
 - Batt : ...
- Central Video Feed:** A live feed of an astronaut on the moon surface.
- Bottom Control Bar:**
 - Emergency:** Bell icon.
 - Voice Comms:** Two people icon.
 - Astro Cam:** Red camera icon.
 - Rover Cam:** White rover icon.
 - Microphone:** White microphone icon.
 - Start:** White circle icon.
 - Cancel:** White circle with an X icon.
 - Snapshot:** White gear icon.

New Gandolfi



→ SCA1 Wet (shown) / SCA1 (dry)

→ Helmet camera

→ Heads-Up display (not shown)

→ Retractable controller for wrist display (not shown)

→ Chest display

→ Wrist display (not shown)

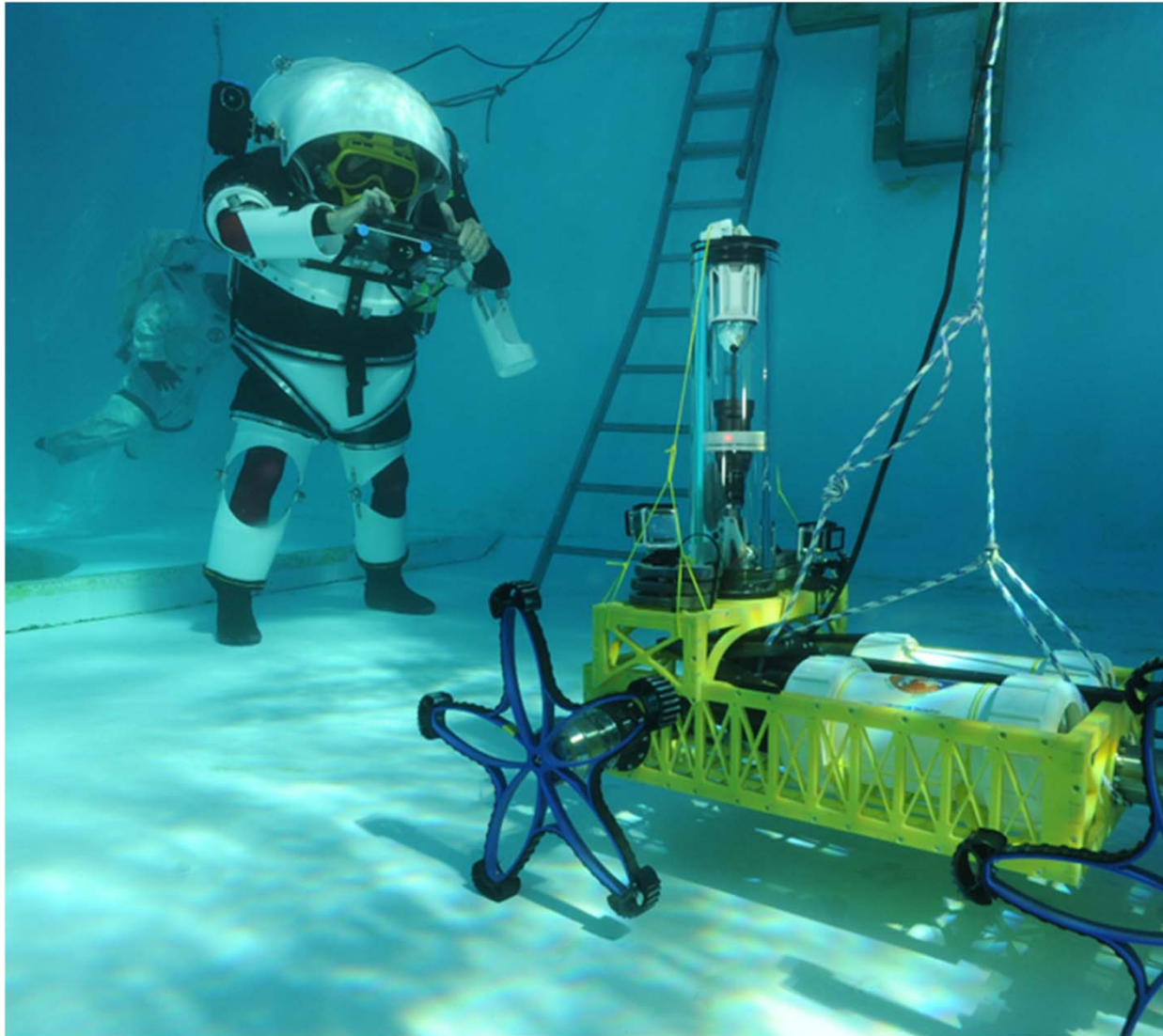


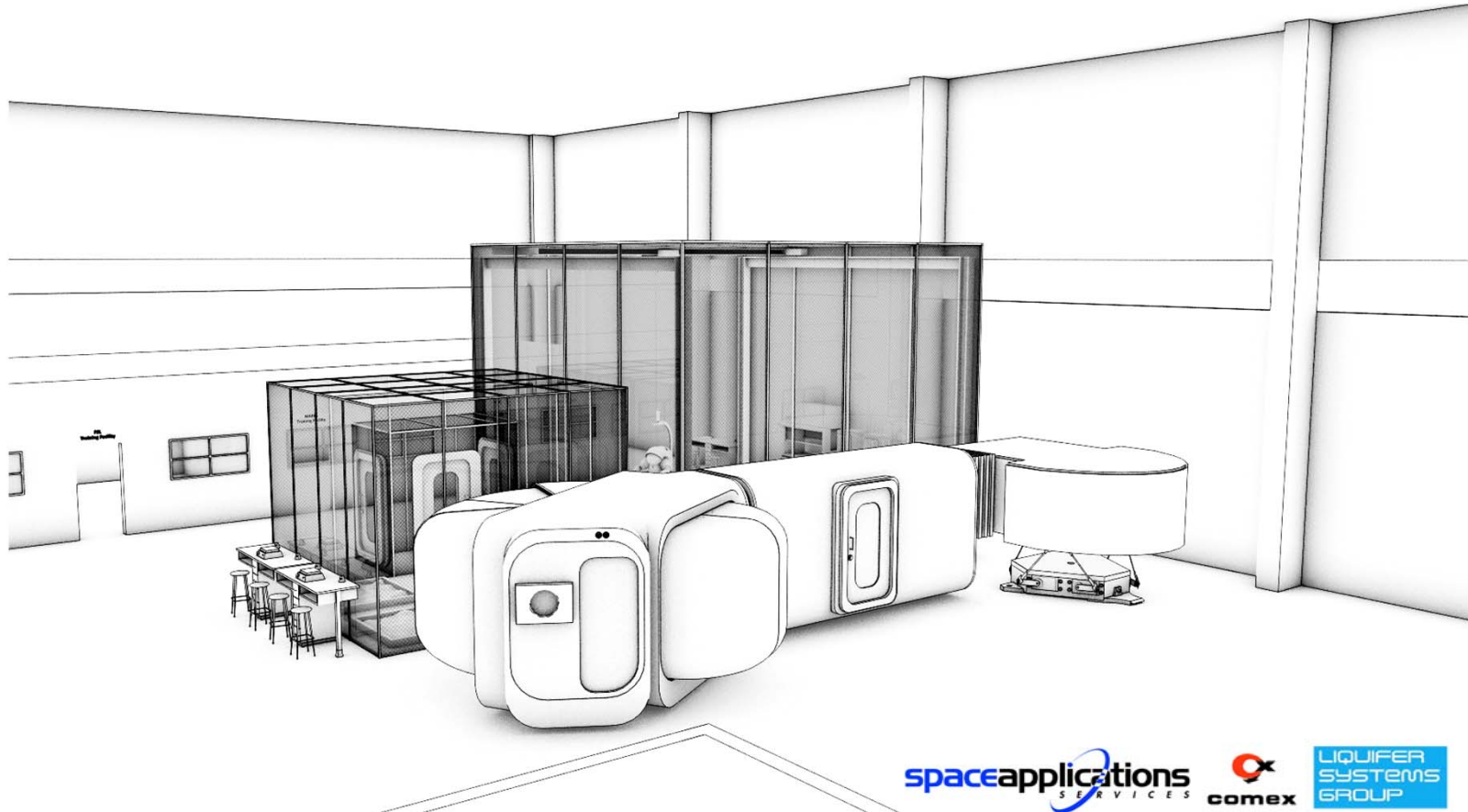
Image credits: COMEX

NASA SCALE study (as part of AO)

- Goal:
 - To study group cognition
 - To develop countermeasures for team cognition issues
- Role of Moonwalk:
 - Record and metatag interaction (voice, communications, text)
 - During nominal Moonwalk operations (with MCC)
 - In dedicated HERA-Moonwalk interactions
- Test submitted and approved by NASA ethics review board



European Surface Operations Laboratory (ESA LUNA)



Current Status and Future Work



- Current Status
 - HMI software development almost complete
- Future work
 - Field trials in Rio Tinto (Mars Analogue simulation): 16-30 April 2016
 - Field trials in Marseille (Moon Analogue simulation): 28 May – 12 June 2016



Thank you!

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