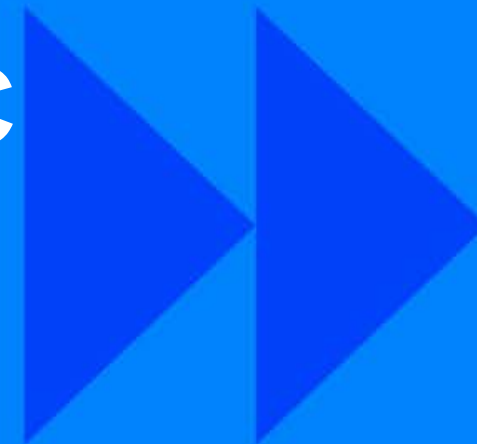


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Wearable Technology Development at NASA JSC

presented by Justin Bautista



Background – NASA JSC



Aerial of the Johnson Space Center (JSC)

Leader in human space exploration

Houston, Texas

Programs

- International Space Station (ISS)
- Orion
- Commercial Crew Program

Background – Human Interface Branch

Engineering Directorate, Avionic Systems Division

Human Interface Branch

- Systems that connect humans to the electronics in a spacecraft

Domains

- Audio Systems
- Displays and Controls
- Imagery Systems
- Lighting Systems
- Wearable Technology





Maximizing Productivity with Wearable Tech

Improve Efficiency

- Maximize time on productive tasks
- Minimize time on support tasks
- Minimize errors
- Automate monitoring

Provide Natural Interfaces

- Comfortable: on-body, long term
- Controls: hands, voice, eyes, body
- Display: visual, auditory, tactile
- Smart: adaptive and collaborative

Augment Human Capabilities

- Monitor and control remote systems
- Access information on demand
- Detect danger and respond

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Previous Work

experience. discover. create.

WEAR Lab Development

Wearable Device Base Board

Common platform with basic features to jumpstart wearable device design

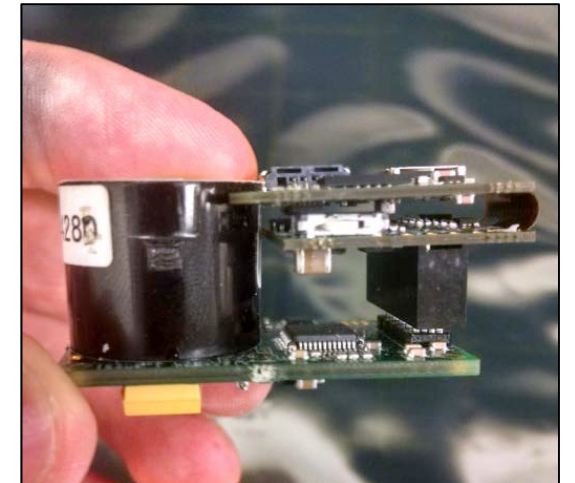
Features

- Bluetooth Low Energy Communication
- Rechargeable Battery Regulation
- On-board Data Storage
- On-board Processing
- Variety of I/O interfaces
- Small form factor



Version 1.0 (2014)

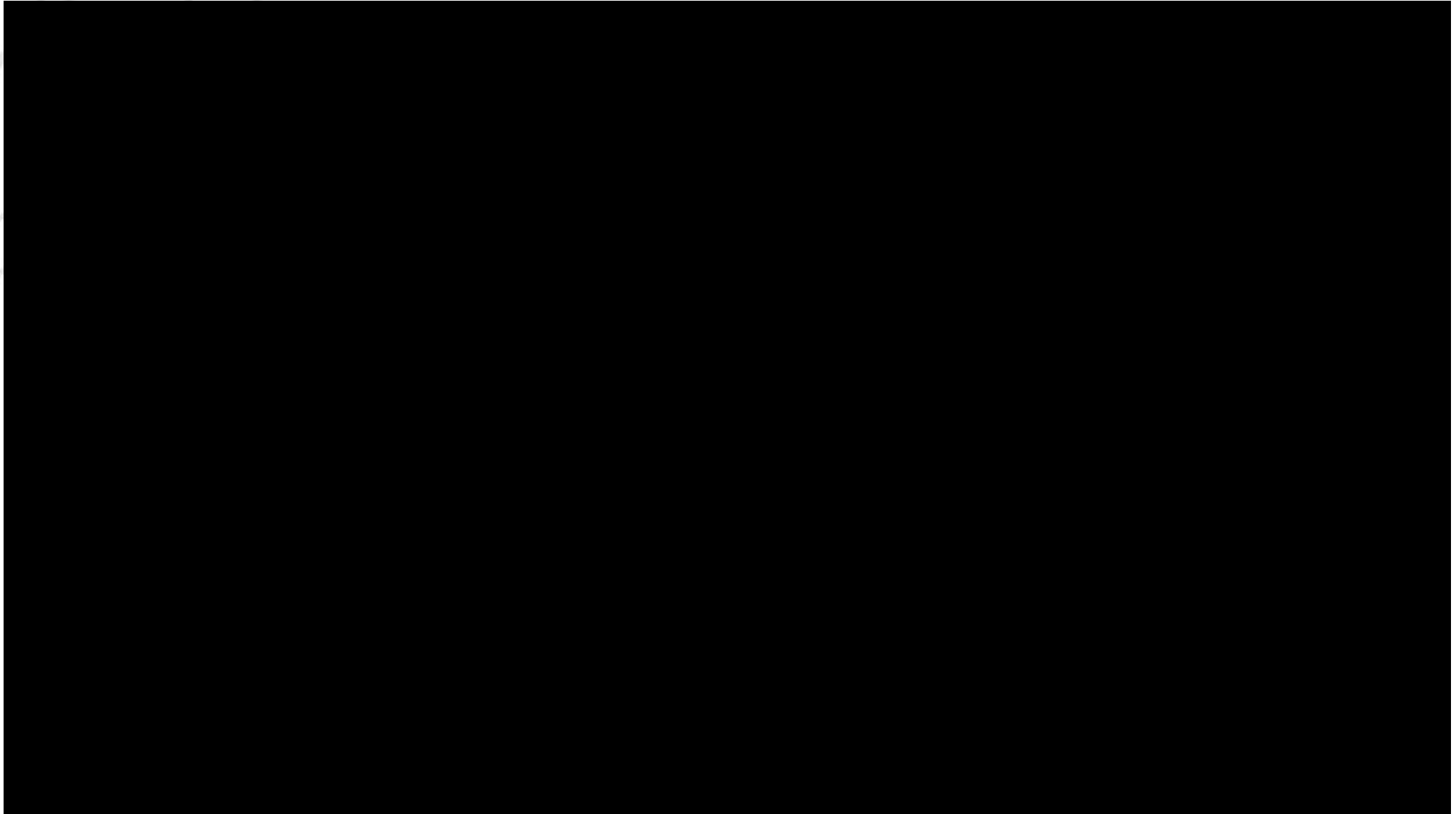
Version 2.0 (2015)
Integrated with
commercial-off-the-shelf
(COTS) sensor





Video

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The Spacecraft Carbon Dioxide (CO₂) Problem

Exposure to elevated CO₂ levels causes health problems

- Increased blood pressure, dizziness, lethargy, headache, and more severe symptoms
- Long term: intracranial pressure, vision impairment, decreased decision-making capabilities

Monitoring CO₂ in spacecraft is difficult

- Lack of natural convection limits air circulation and mixing (“CO₂ Pockets”)
- CO₂ readings from fixed sensors may not be representative of locations near the crew
- Crew group activities (e.g. meals, public events) are of particular concern

Health impact of CO₂ in spacecraft is not completely understood

- How do human adaptations to space affect sensitivity to CO₂?
- How does CO₂ influence intracranial pressure and vision impairment?
- How do individual differences affect susceptibility to elevated CO₂?

Personal CO2 Monitor

Developed wearable Personal CO2 Monitor (PCO2M)

Leveraged base board and commercial-off-the-shelf (COTS) sensors



Prototype of PCO2M



First generation of PCO2M



Second Generation of PCO2M

Personal CO2 Monitor – NEEMO 18

NASA Extreme Environment Mission Operations (NEEMO)

- Operating undersea laboratory, *Aquarius*
- 62 feet underwater off Key Largo Florida



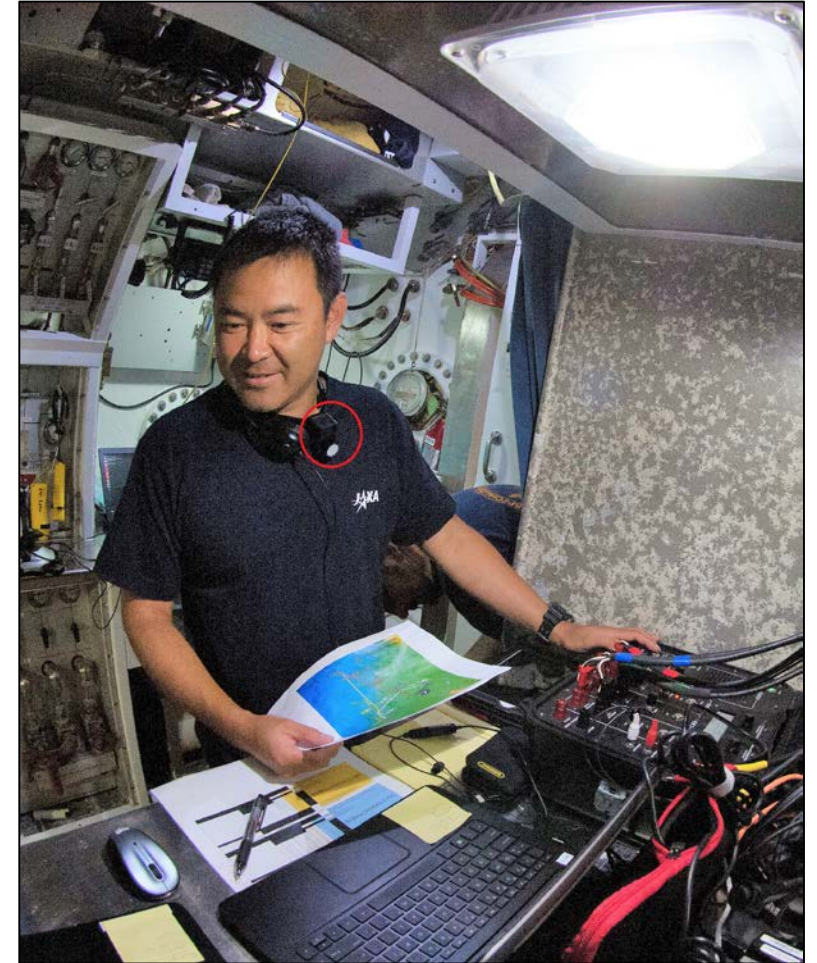
Aquanauts and waterwalks

First application of PCO2M

- Analog mission in July 2014



Mission patch and waterwalk



Aquanaut wearing PCO2M



Personal CO2 Monitor – Spaceflight

Project Start to Delivery in 12 months

Designed, built, tested, certified, and delivered:

- Base Board with COTS CO2 sensor
- 3D-printed Clip-on Housing
- iPad app, user interface, and automation
- Networked ISS data server integration

Conducted user testing and crew briefings

Created procedures, operations plans, & training videos



Launch of Orbital-ATK 6 (March 2016)



PHOTOS





PHOTOS

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Current Work

experience. discover. create.

WEAR Lab Development

Modular Bluetooth Integrator (MoBI)

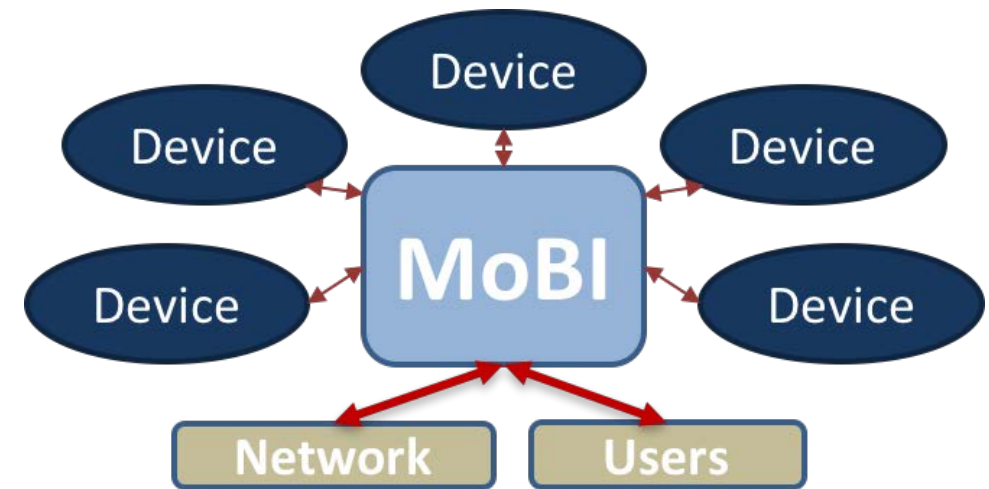
Multi-wearable, multi-sensor data hub

- Bluetooth Low Energy focus

Integrate data from many devices

- Commercial devices
- Custom NASA-developed devices
- Custom partner-developed devices

Currently at alpha internal release



MoBI Architecture

WEAR Lab Development

Chisel Software

Drag and drop, cross-platform display builder

- Rapid design (WYSIWYG), rapid reconfig

Platform interoperable

- Interfaces leverage open, modern web standards
- Out of the box integration with int'l standards

Integrated user interaction analytics

Currently at alpha internal release

- In process of being open-sourced



Screenshot of Chisel



WEAR Lab Development

Bluetooth 5

Increased bandwidth will minimize crew time spent downloading data

Increased range will minimize number of access points, launch mass

Angle of departure/arrival will result in improved crew/inventory tracking

Mesh networking could improve emergency communication

Low energy audio solutions with multiple devices are very attractive

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thank you!

