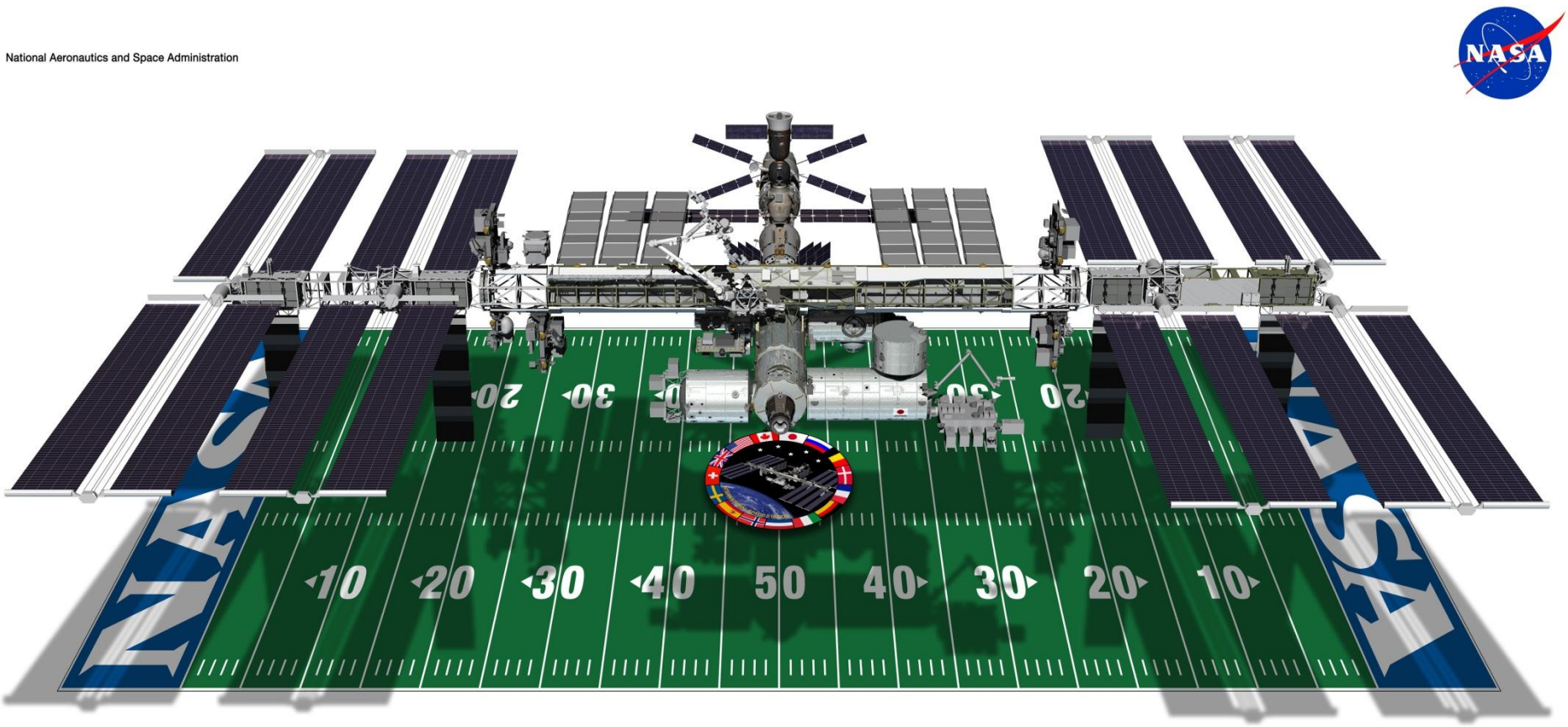
Inventive Tricks and Fixes Aboard the ISS

MacGyvering Station

International Space Station




OSO
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The Challenge

The Plan Never Survives…

- We've done a lot things that weren't planned to be done on board…
  - Upgrading computer processors
  - Removing a filter from a pump that didn't need one, and adding a filter to a different pump that needed one
  - Creating sleeping quarters until the real ones arrived
- But some fixes were more inventive than others…

A Few Examples

- Shep's Table
- The Window Box
- A Balky Tool
- Hockey Sticks and Cufflinks
- Test Twice, Cut Once
- It's Stuck
- The Frankenjumper

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Shep's Table (2001 / Inc 1)

- Link
- NASA astronaut and International Space Station (ISS) Expedition One Commander, William "Bill" Shepherd, built this table during the first ISS mission from components that he found on board the Russian Service Module in 2001. The table is a workstation built for Shepherd's personal use during his long-duration stay on board the space station. This was the first object that NASM acquired from the ISS program. The story behind the construction of the table adds a unique dimension to the history of human space exploration. Bill Shepherd improvised the table with space parts. This improvisation demonstrates the continued need for invention in the closed environment of a space station.
- NASA transferred this table to the museum

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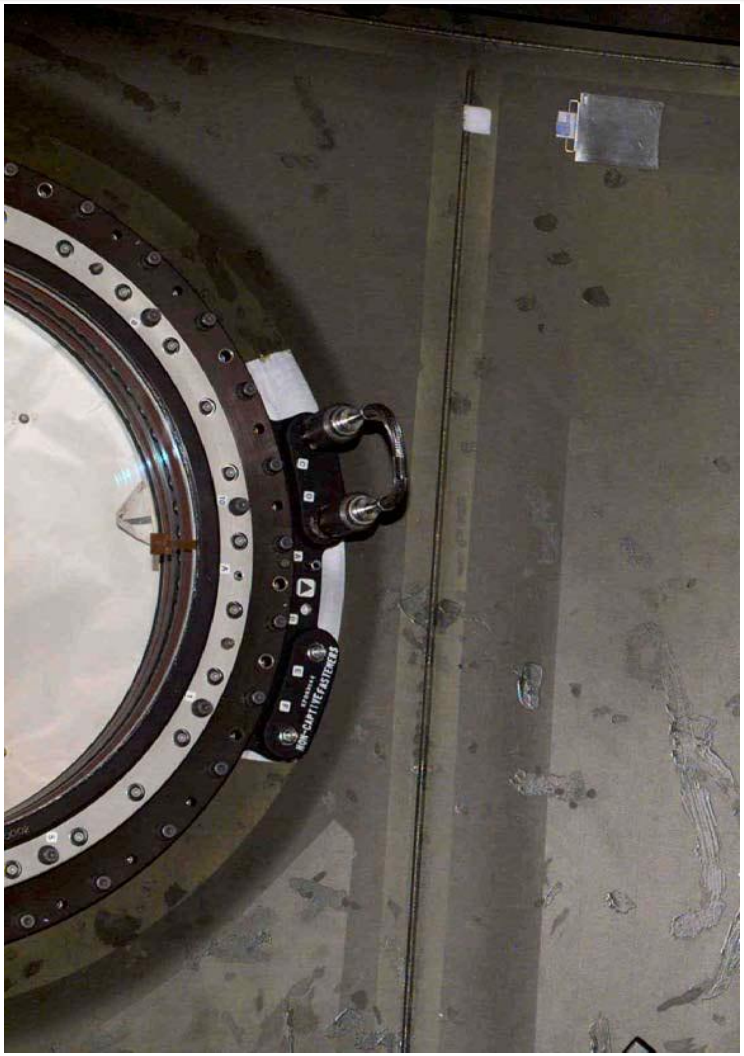
Table, International Space Station (ISS)

The Window Box (2004 / Inc 9)

- **Problem**: crew uses a hose to space as a handhold to look out the window.
- **Impact**: station leaks too much.
- **Workaround**: build a box around the hose.
  Originally it was to be built from on-orbit supplies, but eventually a kit to build the box was flown.

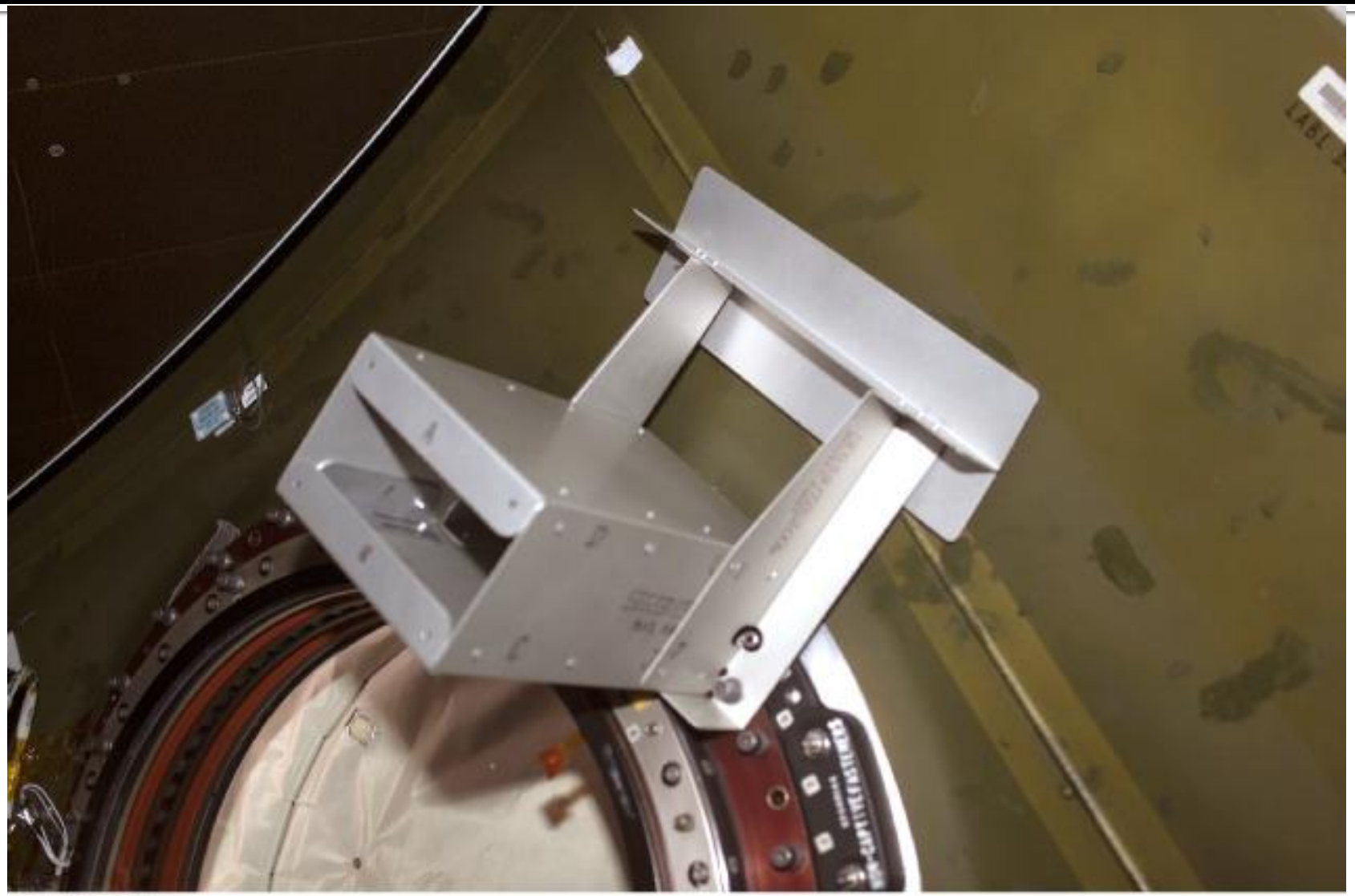


Window Box Parts List

Table 1 - Lab Window Flex Hose Cover Kit contents

Item #	Part Name		Quantity
1	Top Plate		1
2	Bottom Plate		1
3	Right Plate		1
4	Left Plate		1
5	Front Plate		1
6	Right Bracket		1
7	Left Bracket		1
8	Attachment Bracket, 74º		1
9	Attachment Bracket, 100º		1
10	Angle Bracket (M&C)		1
11	Angle Bracket (K&J)		1
12	Angle Bracket (L&R)		1
13	Angle Bracket (N&P)		1
14	Angle Bracket (E&D)		1
15	Angle Bracket (H&U)		1
16	Angle Bracket (F&O)		1
17	Angle Bracket (G&Q)		1
18	Velcro Loop, 11.0 x 1.0		2
19	1/8" Dia. Pop Rivet, 1/4" Length		60 rivets
20	Lab Window Bolt		2
21	Lab Window Washer		2
22	Keep Out Zone Decal		1

The Window Box



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A Balky Tool (2010 / Inc 22 / 20A)

- Crew calls down that the super-fancy self-reacting torque device got stuck.
- Just the previous day an OSO teaching a class had the same thing happen and told me how to fix it.
- I got to tell the crew: "Go get the center punch and a hammer and give it a good, sharp, whack." Crew: "Really? Cool."
- Nothing quite like percussive maintenance.

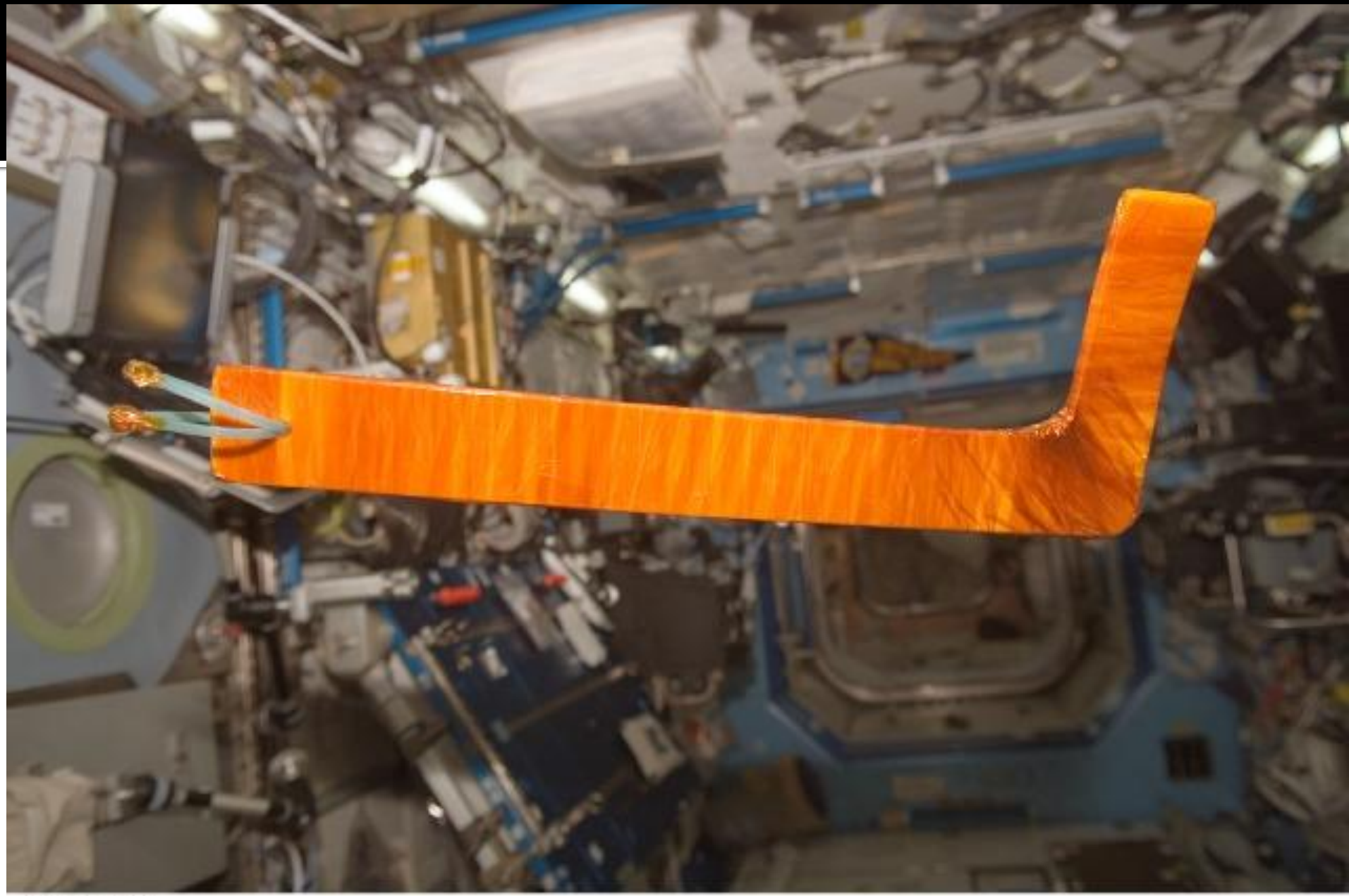
A Balky Tool: Percussive Maintenance

Solar Array Hijinks (2007/Inc 15-16)

- Summary:
  SAW damage noticed during P6 deploy, 4B - right blanket. Large hinge separation between panels 35 and 36, small damage between 37 and 38. OSOs created SOLAR ARRAY HINGE STABILIZER CONSTRUCTION. IV crew constructed 5 "cuff-links". Cuff-link installation on 10A EVA 4, FD 12. Cuff-links span separated panels, relieving tension from hinges.

Solar Array Hockey Stick

- Construct a tool from one sheet of Coldplate/Wireway Cover material (Teflon) to enable an EVA crew member to safely touch the Flat Conductor Cable (FCC) portion of the Solar Array blanket in order to help it to fold properly during retraction. All four 13A EVA crewmembers participated in the design and prototype construction of the tool.



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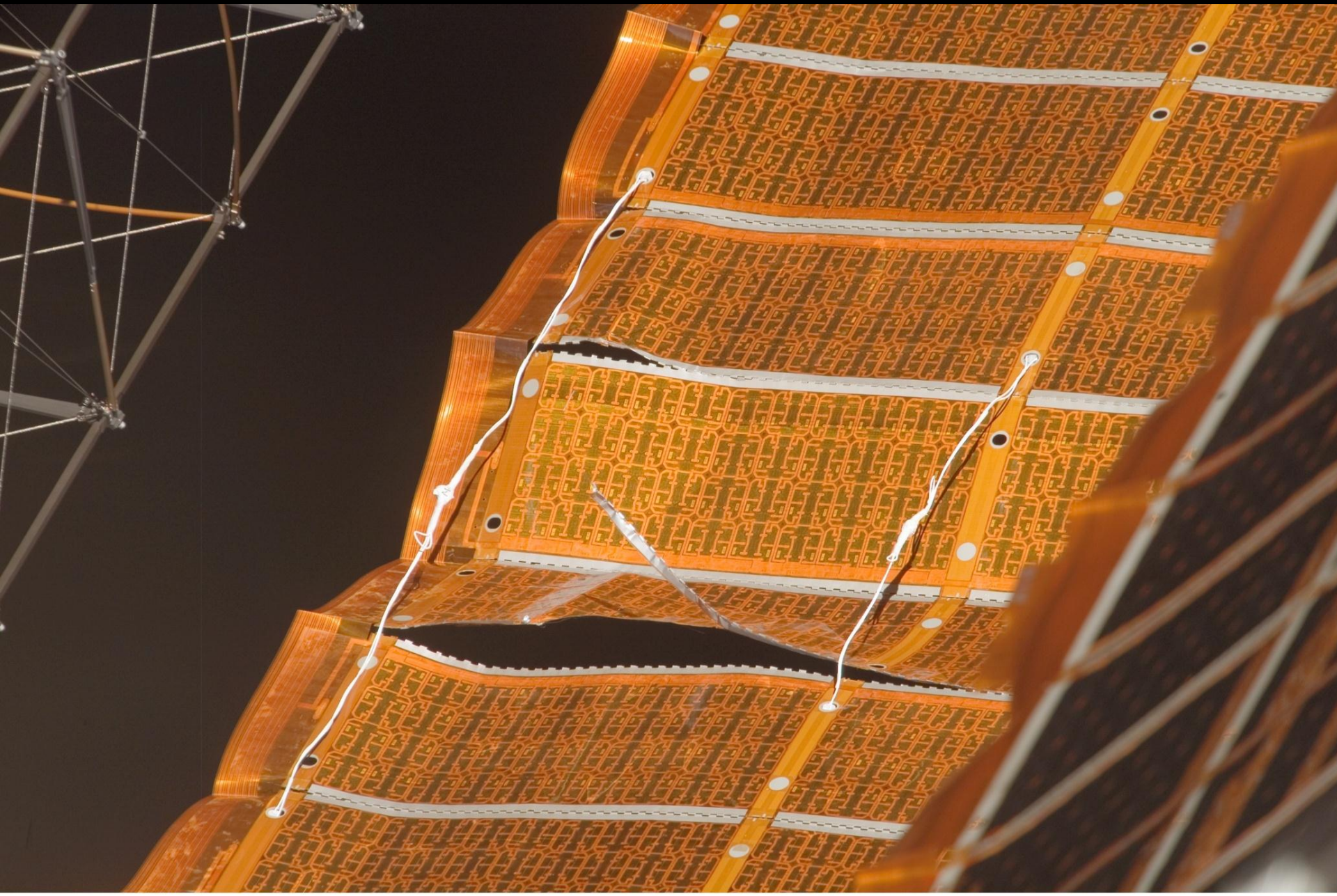
Solar Array Cufflinks Parts List

- MATERIALS:
  - Sharpie
  - Ziplock Bag (two)
  - Kapton Tape
  - EVA Tape
  - ISS Pin Kit: (two)
  - Page 3
    - 12 Ga Wire (50 feet) (need approximately 66 feet total)
  - Clamp and Bracket Kit:
    - 0.03" x 4" x 12" Aluminum (two)
  - Large Gauge Pin Kit:
    - Small Split Bolt Connector P/N S-4
- TOOLS:
  - Eye Protection
  - DCS 760 Camera
  - ISS Vacuum Cleaner
  - MWA Utility Kit:
    - Track Restraint (two)
    - PC Circuit Board Clamp (two)
  - Clamp and Bracket Kit:
    - Tin Snips
    - Hand Punch
    - Hand Punch Key
    - 9/32" Punch Insert (engraved "281")
    - 9/32" Punch Die (engraved "281")
  - ISS IVA Toolbox:
  - Drawer 2:
    - 9/16" Socket, 3/8" Drive
    - 11/16" Socket, 3/8" Drive
    - Ratchet, 3/8" Drive
    - (40-200 in-lbs) Trq Wrench, 3/8" Drive
  - Drawer 4:
    - Wire Cutters
  - Drawer 5:
    - Tape Measure
    - Steel Rule
    - Breaker Bar, 3/8" Drive
    - File Set, Small
    - Small Round File
    - Red File Handle
    - File Set, Large
    - Large Hand File
    - Black File Handle

Solar Array Hinge Stabilizers … a.k.a. Cufflinks



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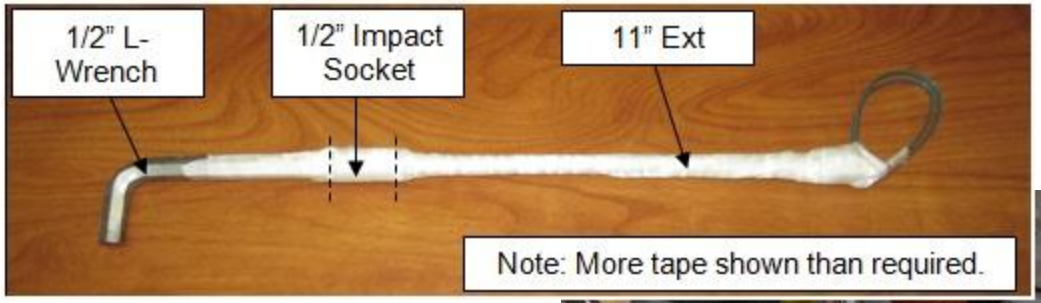
Test Twice, Cut Once (2009/Inc 20)

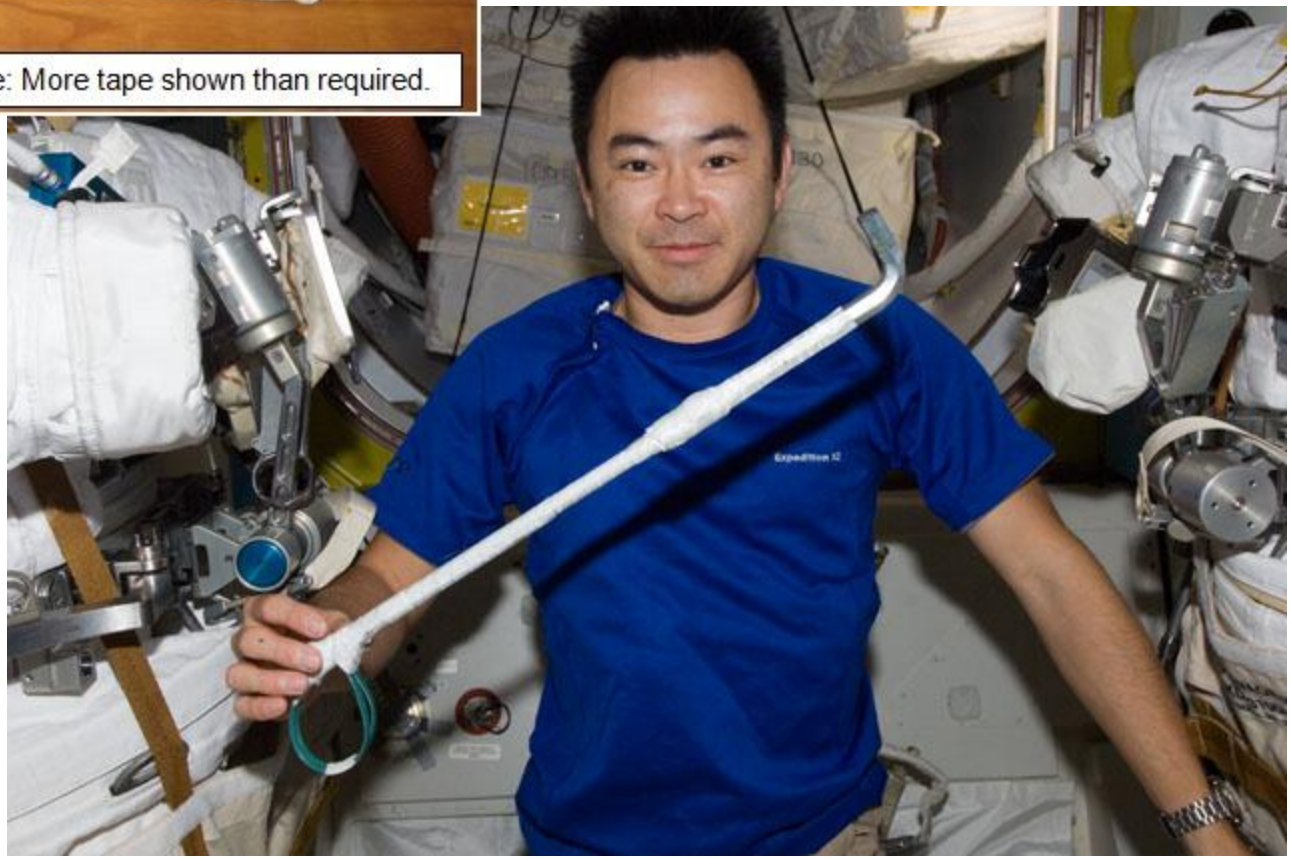
It's Stuck (2012 / Inc 32)

- During Increment 32, just before Labor Day weekend, crew went out to change a power switching unit that had stopped communicating.
- The EVA went great until they tried to install the spare and couldn't get it to bolt down.
- Since it seemed like the nut was the problem, EVA needed some tools to clean it, test it, and lubricate it for the next (unplanned) spacewalk.

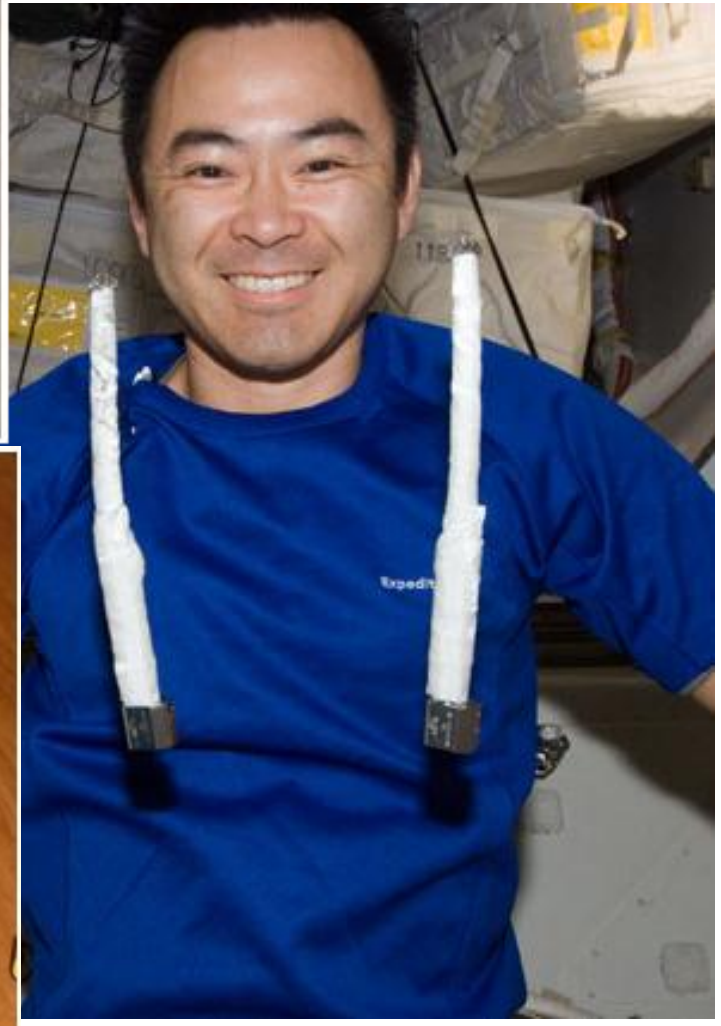
Tethered ACME Bolt

ACME Bolt Interface Tool





Tethered Chimney Sweeps



Tethered Lube (tooth)Brush

The Frankenjumper (2011/Inc 26)

- Power and data jumpers (cables) needed to put the HTV on Node 2 Zenith were in a cargo module that hadn't launched yet…and needed HTV at Zenith in order to launch.
- We could build entirely new jumpers using wire, pins, and sockets on board, but when you deal with bare contacts instead of standard connectors, you have to power down a lot more upstream. So instead…we scavenge.

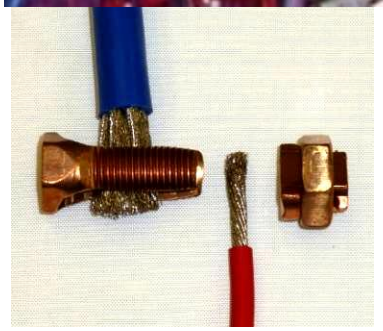
The Frankenjumper: 8 hours

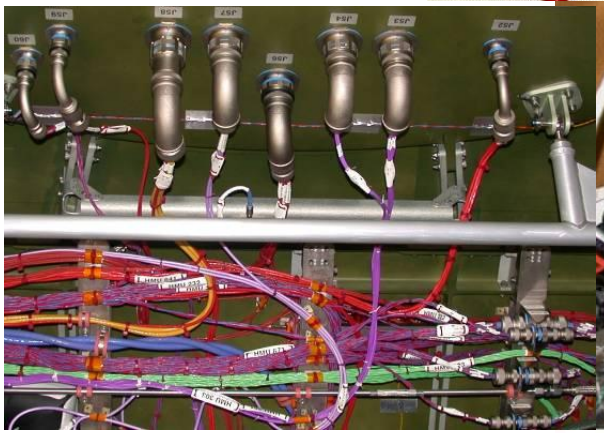
- PART 1: CONNECTOR SCAVENGE
  - Scavenge three connectors from wire harnesses located at the Node 2 Overhead Starboard and Port Bulkheads.
- *PART 2: JUMPER BUILD*
  - This is the longest and most tedious part of the procedure. There are two types of cable connections to build: 1) pin/socket and 2) spliced. The pin/socket mating is simple, but because of the large gauge, strain relief is put in place using wire ties. The spliced connections for large gauge wire is similar to a crimp on small gauge wire, but instead of a crimp we are using a hefty bolt that will need to be torqued.
- *PART 3: JUMPER TEST*
  - The jumper continuity test is to verify a successful build of the jumpers.
- *PART 4: JUMPER ROUTE*
  - The jumper will be routed from Node 2 Zenith to Node 2 Forward. Post-routing, a final continuity and isolation test will be performed to verify the jumper was not damaged during routing.

The Frankenjumper Parts List

- MATERIALS:
  - Ziplock
  - Velcro Straps
  - Kapton Tape
  - Gray Tape
  - Sharpie
  - Wire Ties, 7 in [Qty = 12]
- PARTS:
  - CTB Divider
  - 1.0 CTB "Large Gauge Pin Kit S/N 1001"
- TOOLS:
  - Digital Camera
  - Leatherman
  - Vacuum Cleaner
  - Deer Skin Gloves
  - Multimeter Kit
  - Multimeter
  - Red Multimeter Lead
  - Black Multimeter Lead
  - Red Multimeter Probe
  - Black Multimeter Probe
  - Scopemeter and Accessories Kit
  - Industrial Alligator Clip
  - Black Test Lead
  - Black Banana Adapter
  - ISS IVA Toolbox:
  - Drawer 2:
    - 5/32" Hex Head, 1/4" Drive
    - 3/8" Socket, 1/4" Drive
    - 3/4" Socket, 3/8" Drive
    - 7/8" Socket, 3/8" Drive
    - 9/16" Socket, 3/8" Drive
    - 11/16" Socket, 3/8" Drive
    - Driver Handle, 1/4" Drive
    - Ratchet, 3/8" Drive
    - (40-200 in-lbs) Trq Wrench, 3/8" Drive
  - Drawer 4:
    - Adjustable Joint Pliers, Straight Jaw
    - Wire Cutters
  - Drawer 5:
    - Tape Measure
    - 8-1/4" Long, 2" Cut Scissors
    - Breaker Bar, 3/8" Drive

Bits and Builds of the Frankenjumper





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More Resources

- http://www.nasa.gov/offices/oce/appel/ask/issues/49/49s_toothbrush_prt.htm
- http://www.nasa.gov/multimedia/index.html