

Human Centered Computing for Mars Exploration

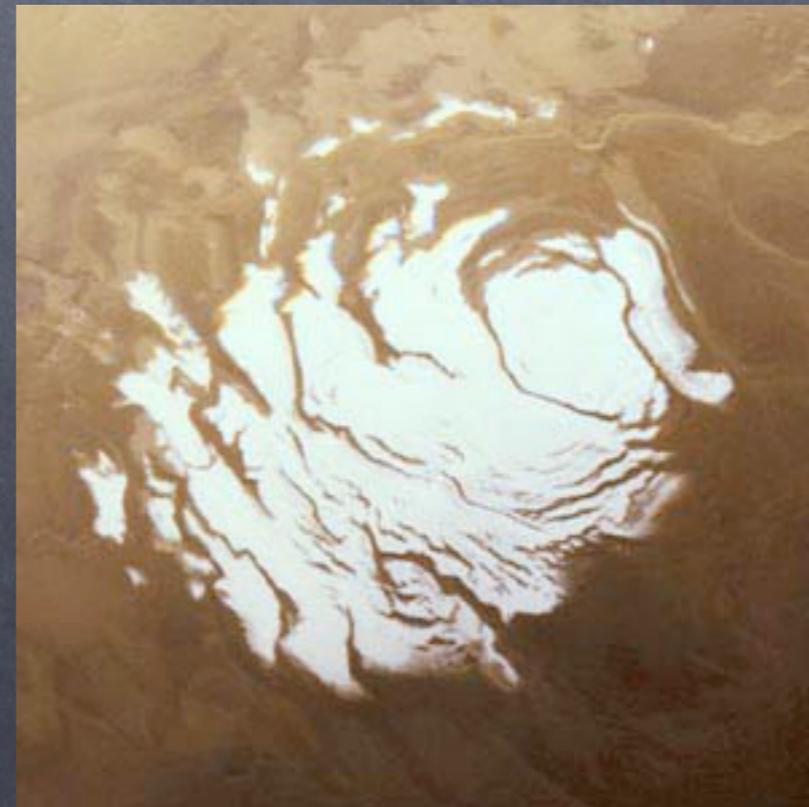
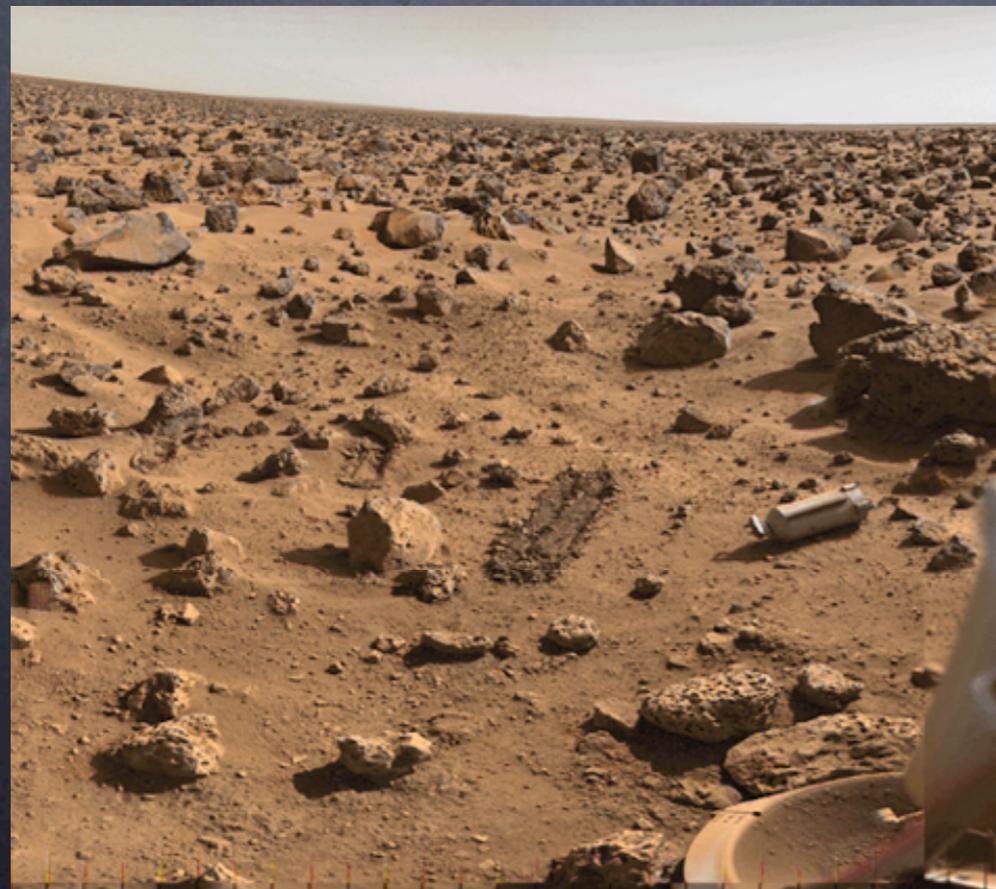
Jay Trimble

NASA Ames Research Center

People Centered Innovation Conference

9/21/05

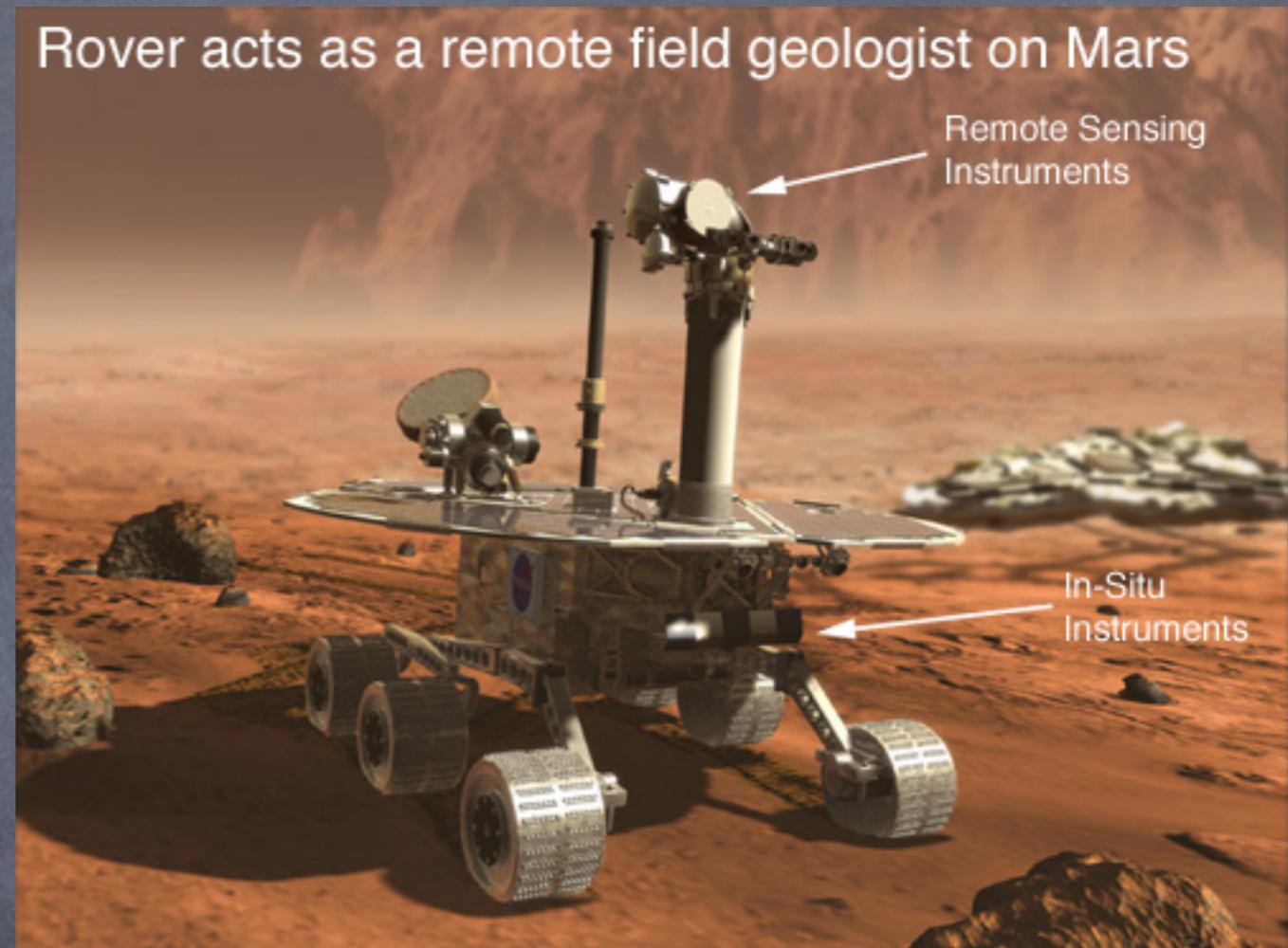
Mars Exploration



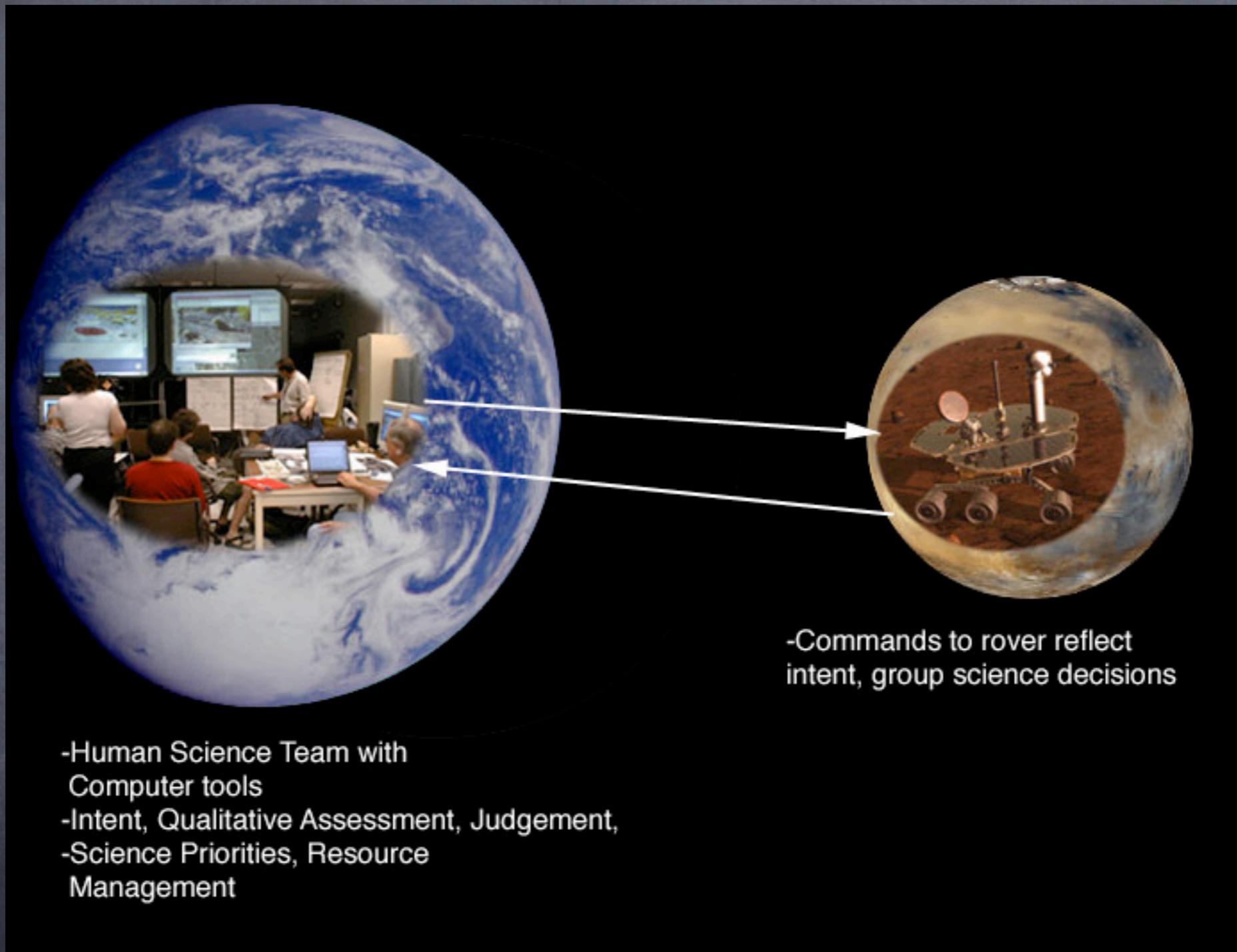
Mars Exploration Rover Mission

Science Objectives

--Determine the aqueous, climatic, and geologic history of a site on Mars where conditions may have been favorable to the preservation of evidence of pre-biotic or biotic processes



MER Operations



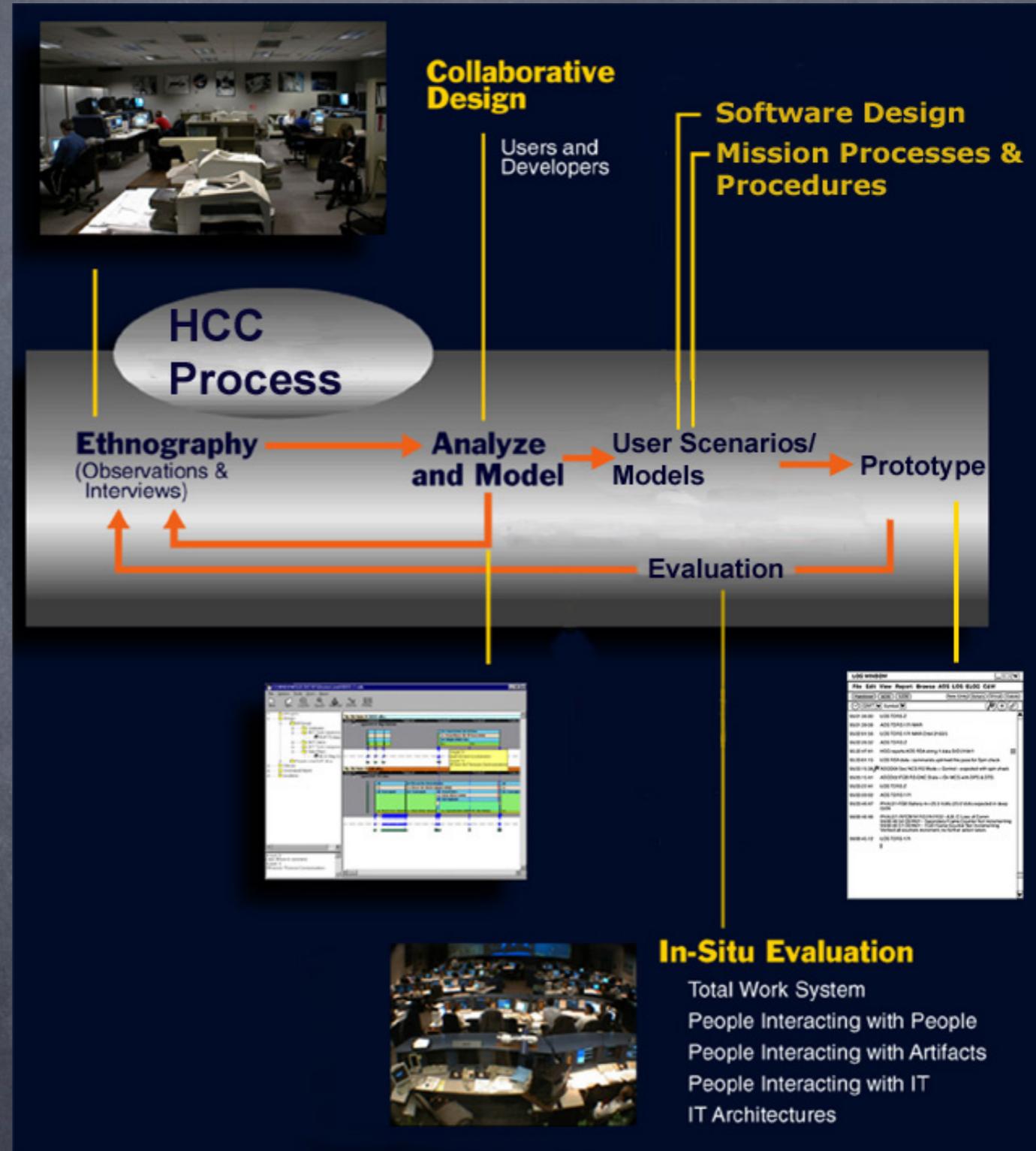
MER Human Centered Computing

- Proposed methods, not tools

- Ethnography
- Applied HCI

- Goal is mission impact on processes, procedures, tools

- Safety
- Productivity



MER HCC Overview

- What is Human Centered Computing?
 - A development process that starts with users and their needs, rather than with technology. The goal is a system design that serves the user, where the technology fits the task and the complexity is that of the task not of the tool (D. Norman)
- Why Human Centered Computing?
 - MER Surface ops time is limited and expensive
 - \$Cost for MER surface operations
 - Daily productivity of a MER rover compared to human productivity, with adjustments for rover instrument capabilities that a human does not have
 - HCC will enhance safety and productivity of surface operations

HCC Methods for MER

- Ethnography

- How do people do their work vs. how people say they do their work

- Interviews

- Observations

- Used for broader observations of work practice, impact on workpractice

- HCI

- Interface design

- Quantitative measures

Observing

- Observations often reveal vast discrepancies between what people say they do and what people actually do (D. Norman)

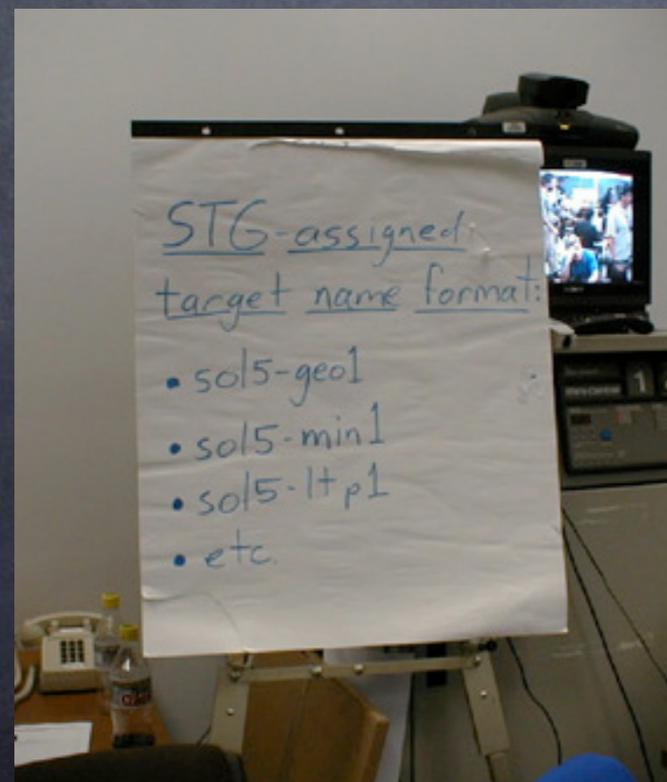
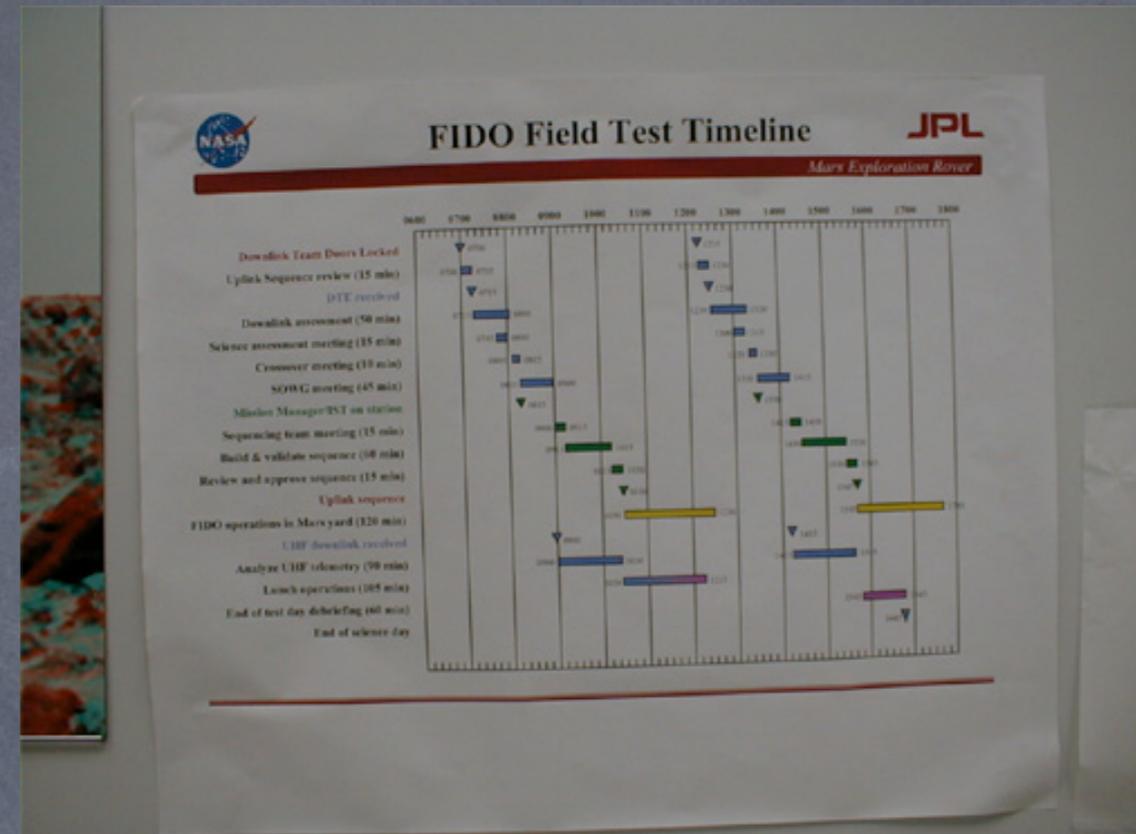
MER Ops

- Some Key MER ops Challenges
 - Twin rovers
 - Daily commanding
 - 3-shifts
 - Operations on Mars Time
 - Non-deterministic environment
 - Instrument observation dependencies
 - Decision process at JPL, no remote decisions

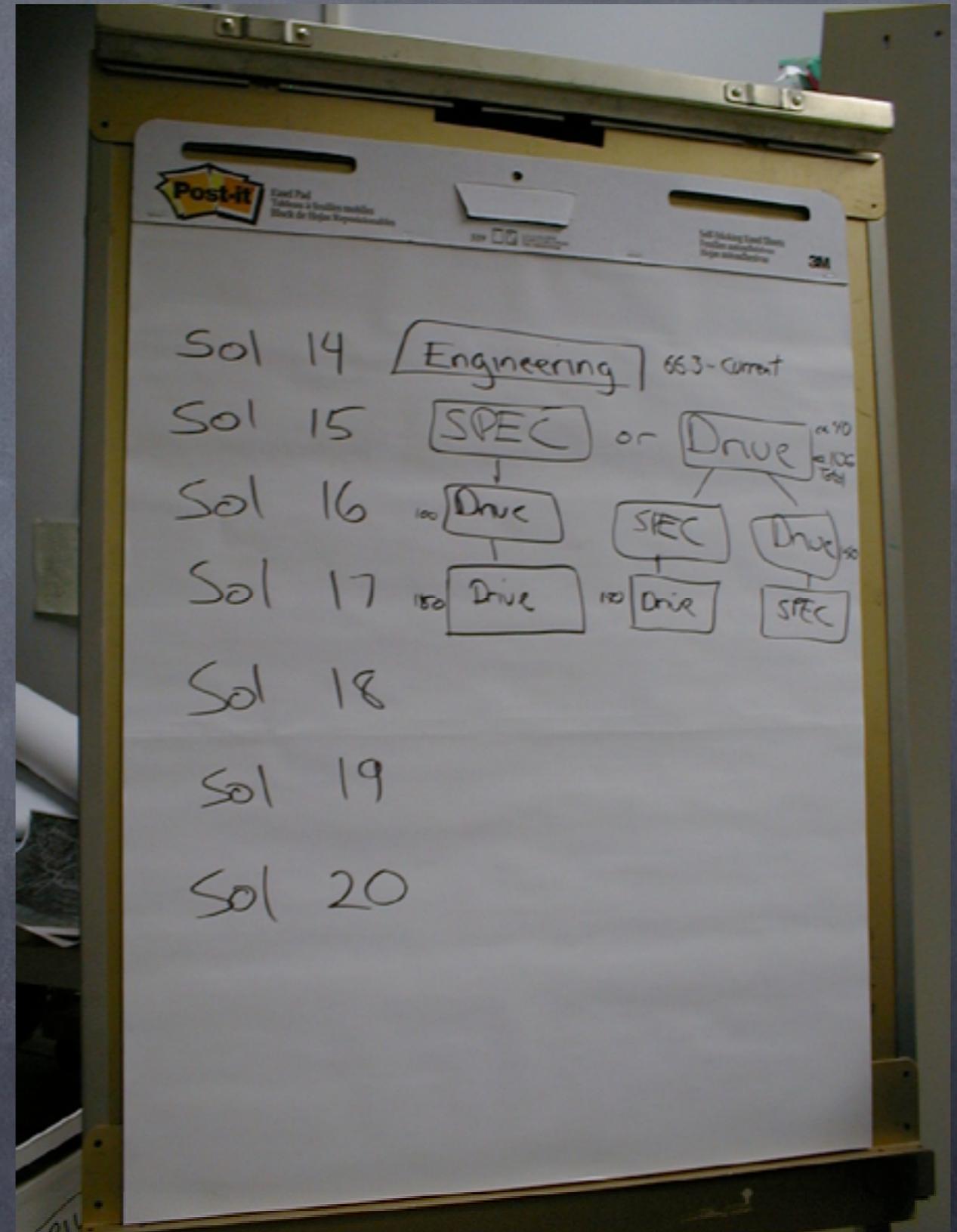
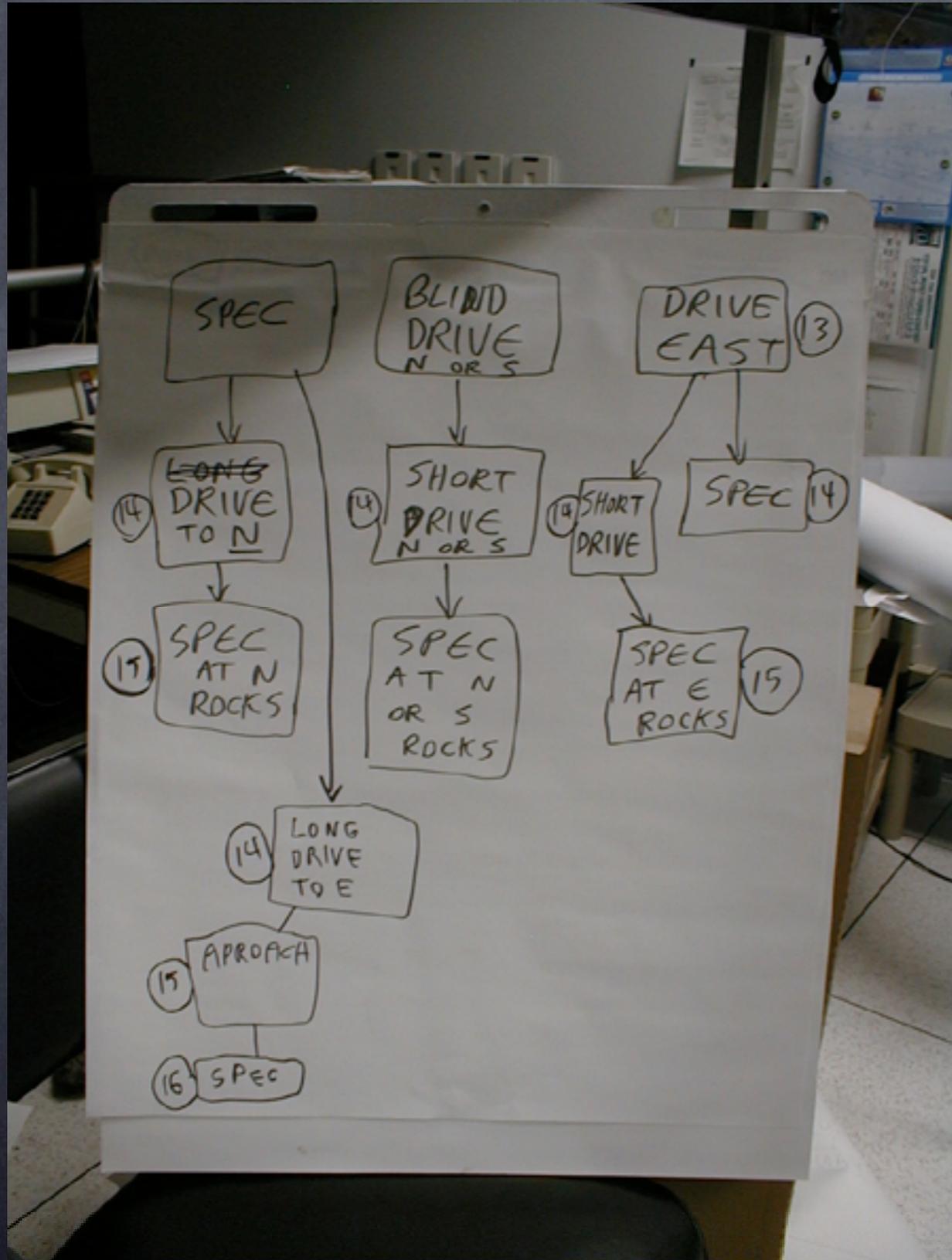
Observing Field Tests



FIDO Field Test 2001



Planning



Unstructured Representations

Hypotheses to Test

- 1) If quartz mineralogy with hematite stain and minor feldspar, then:
mTES will see $qtz \pm feldspar$, not hematite.

(In orbital data some possible rover locations involve fans dominated by quartz, vs. carbonate-dominated hills seen, potentially, in some directions.)
- 2) Localized patches of exposed caliche in trough floor
- * 3) Caliche exposed in trough/scarps ~~walls~~ ^{NO} ~~?~~ [?]
~~_____~~
 [2+3] = What is the cementing agent? Where is the carbonate hiding?
- * 4) Are distant hills carbonate-rich?
 (Perhaps panor recon for carefully pointed IPS.) PROBABLY NOT

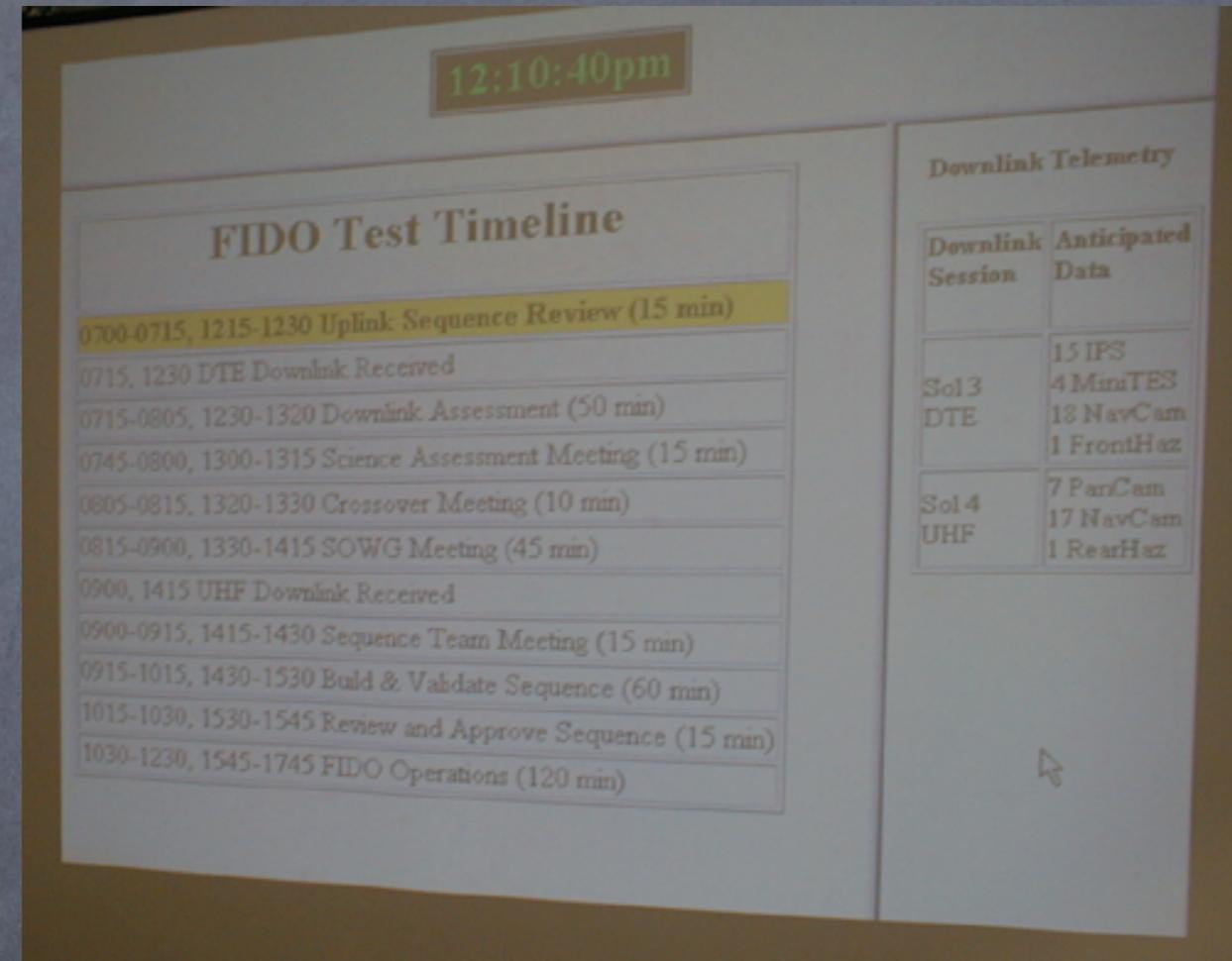
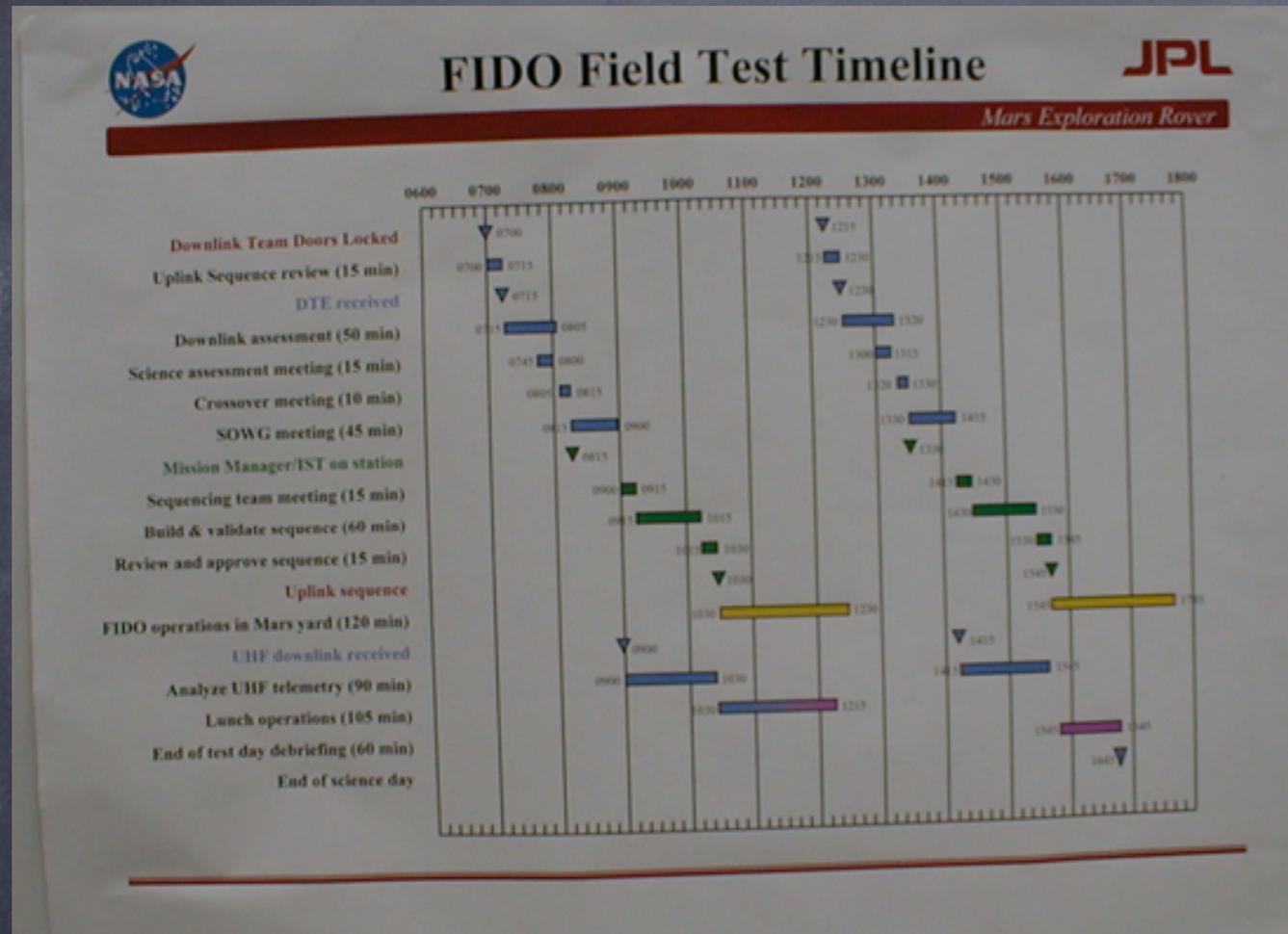
* No. ~~_____~~

* Probably not.

GUILD

MINITES	IPS
<ul style="list-style-type: none"> • UNDERLYING ROCK (1-200 μm) • 7 x 10 cm SPOT 	<ul style="list-style-type: none"> • 10 μm DEPTH • ~ 2 cm SPOT?
SILICIC NO QZ PHYLOSILICATES AND/OR GLASS	Mg- [?] Mn PHYLO NOT AL-FE PHYLO
CARBONATE FEATURE	?? NO CARBONATES
↓ ?	↓ ?
CARBONATE RIND ON SILICIC VOLCANIC ROCK +/- DESERT VARNISH	DESERT VARNISH - APPROX FOL/PORT RAT SAME

Time



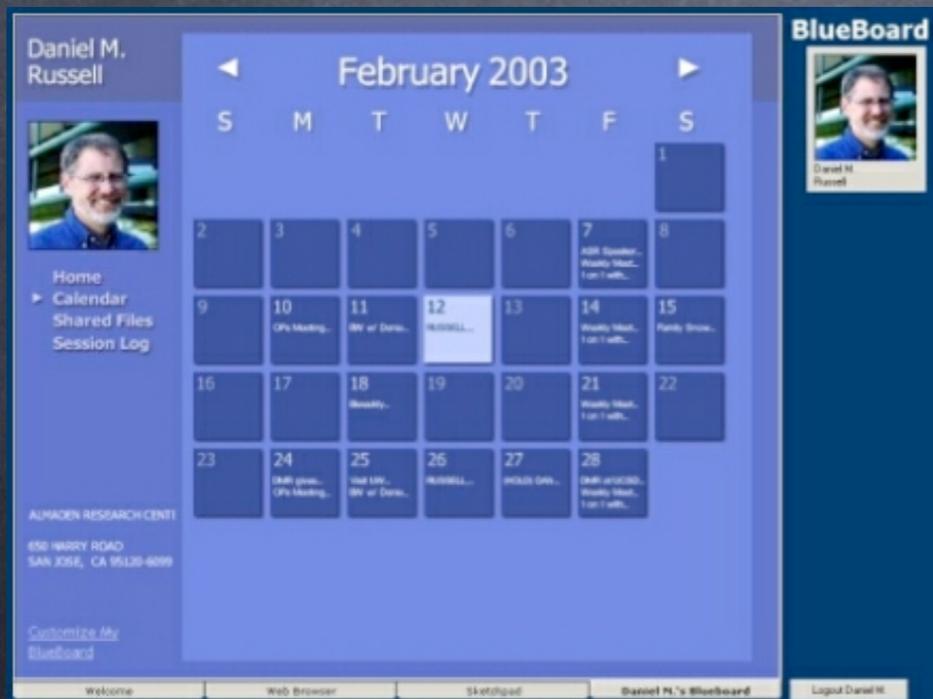
IBM Blueboard + FIDO = MERBoard



+



=



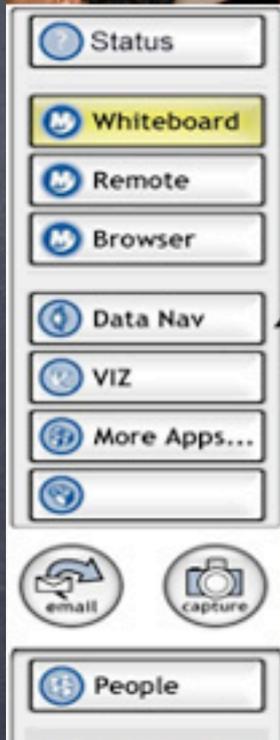
MERBoard

- MERBoard proposed improvements in the following areas
 - Communication and sharing
 - Data display
 - Strategic planning
 - Visibility of presented material across the facility
 - Storage and retrieval of informal data representations and strategic plans
 - Information access

MERBoard



Collaborative content creation for mission planning

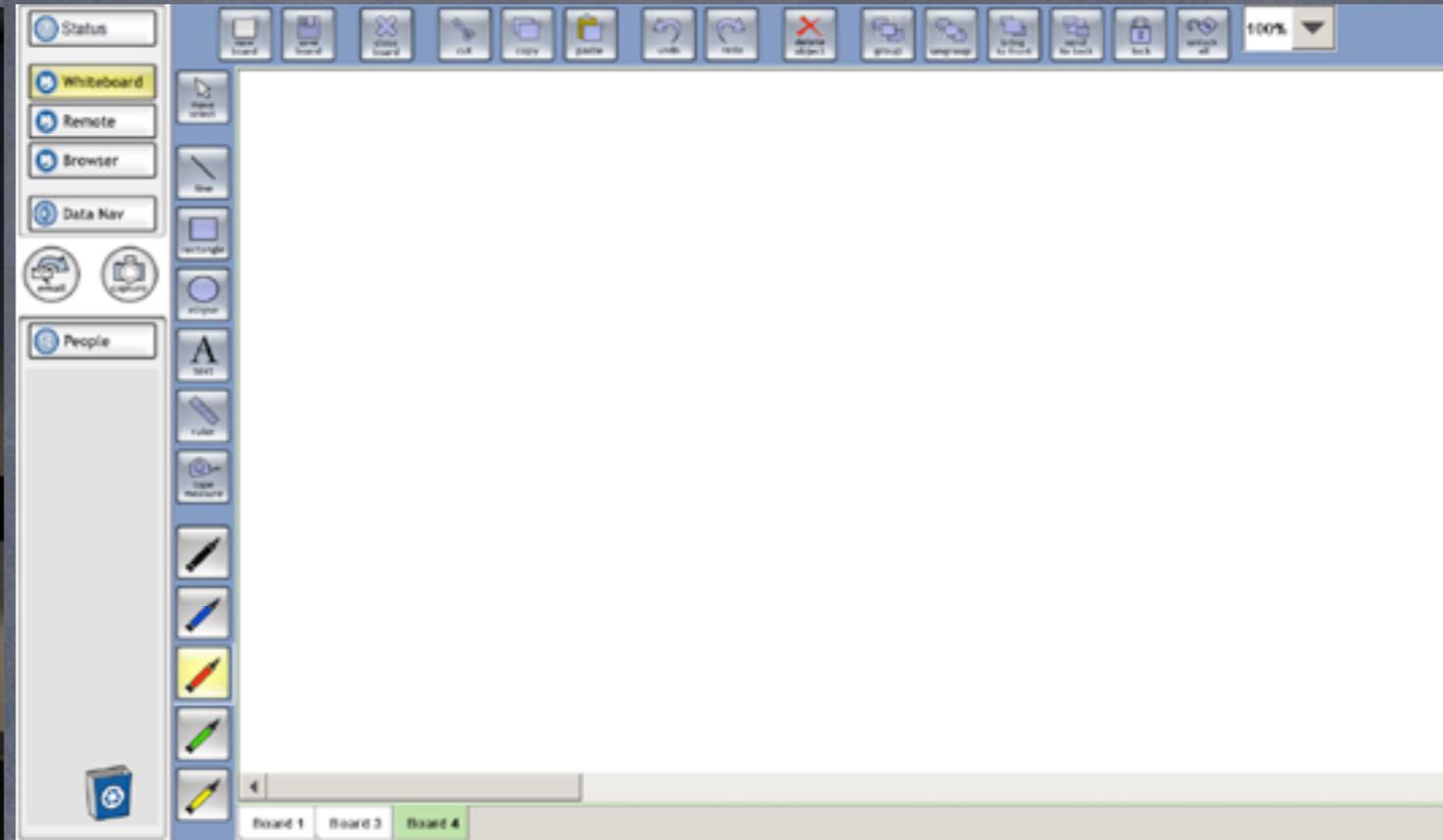
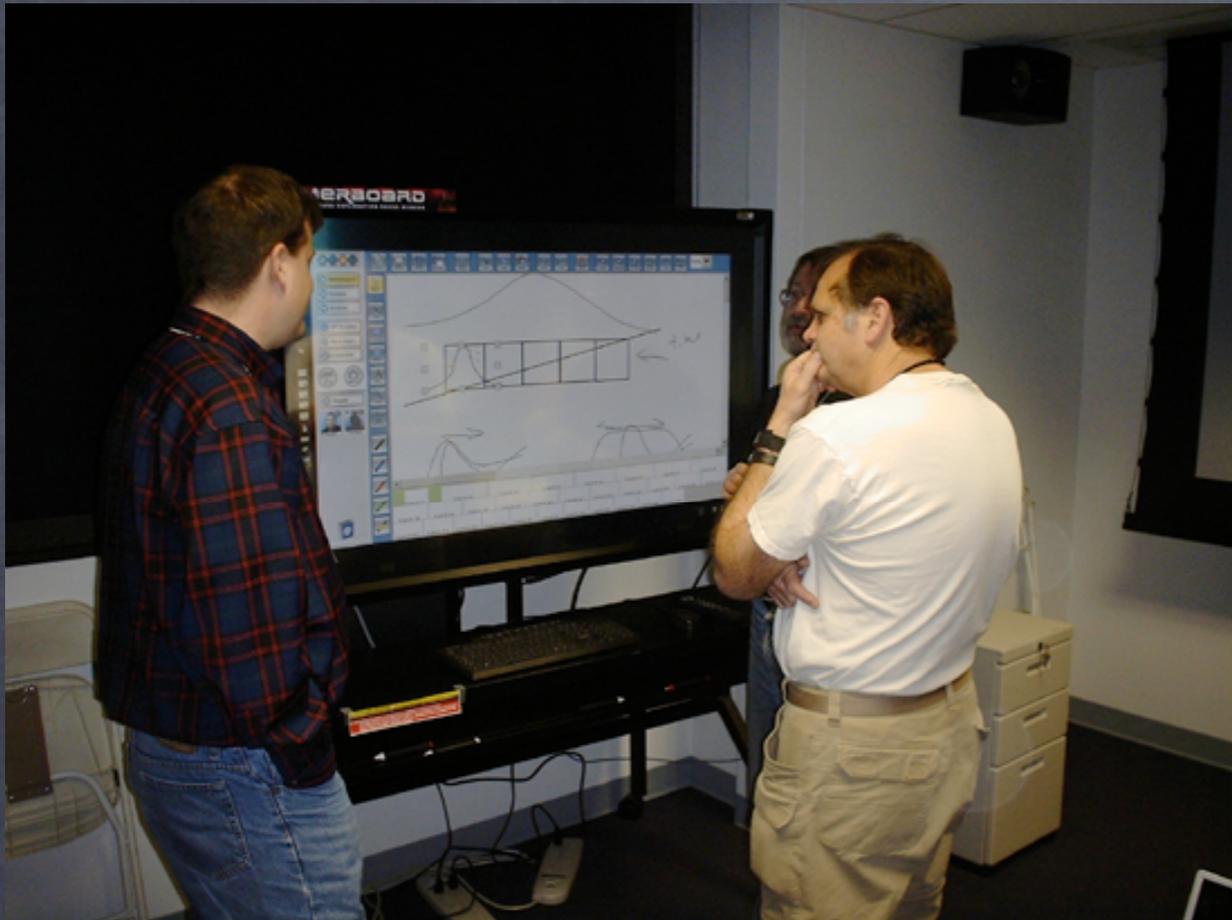


Ubiquitous access to information allows presentation from any board, viewing from multiple boards

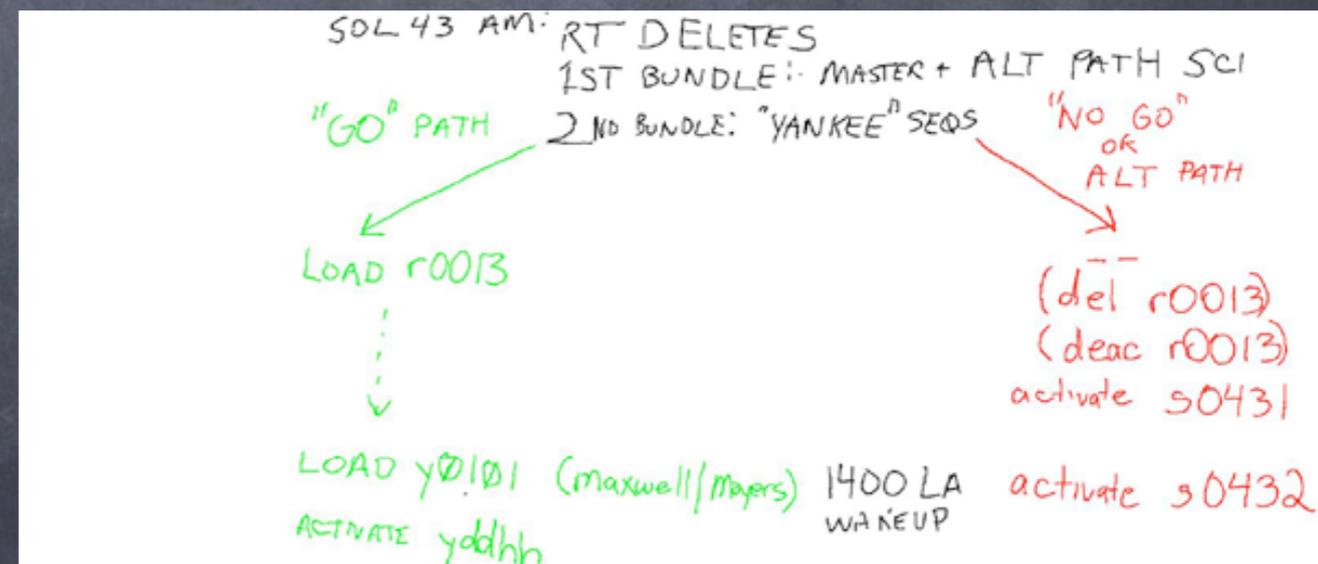
MERBoard Whiteboard

- Support informal representations as seen at the field tests
- Informal representations without fixed structures
- Structured tools create thinking inside that structure
 - Research has suggested that prolonging sketching, and therefore the ambiguous representations that are produced by sketching, will result in a broader exploration of the design space (Goel, 1995)
- Provide an electronic tool to facilitate unstructured representations, add save, share, retrieve
- Observe --> Unstructured Tools --> Structured Tools

MERBoard Whiteboard



Present, Save, retrieve,
ubiquitous access, owners,
versions



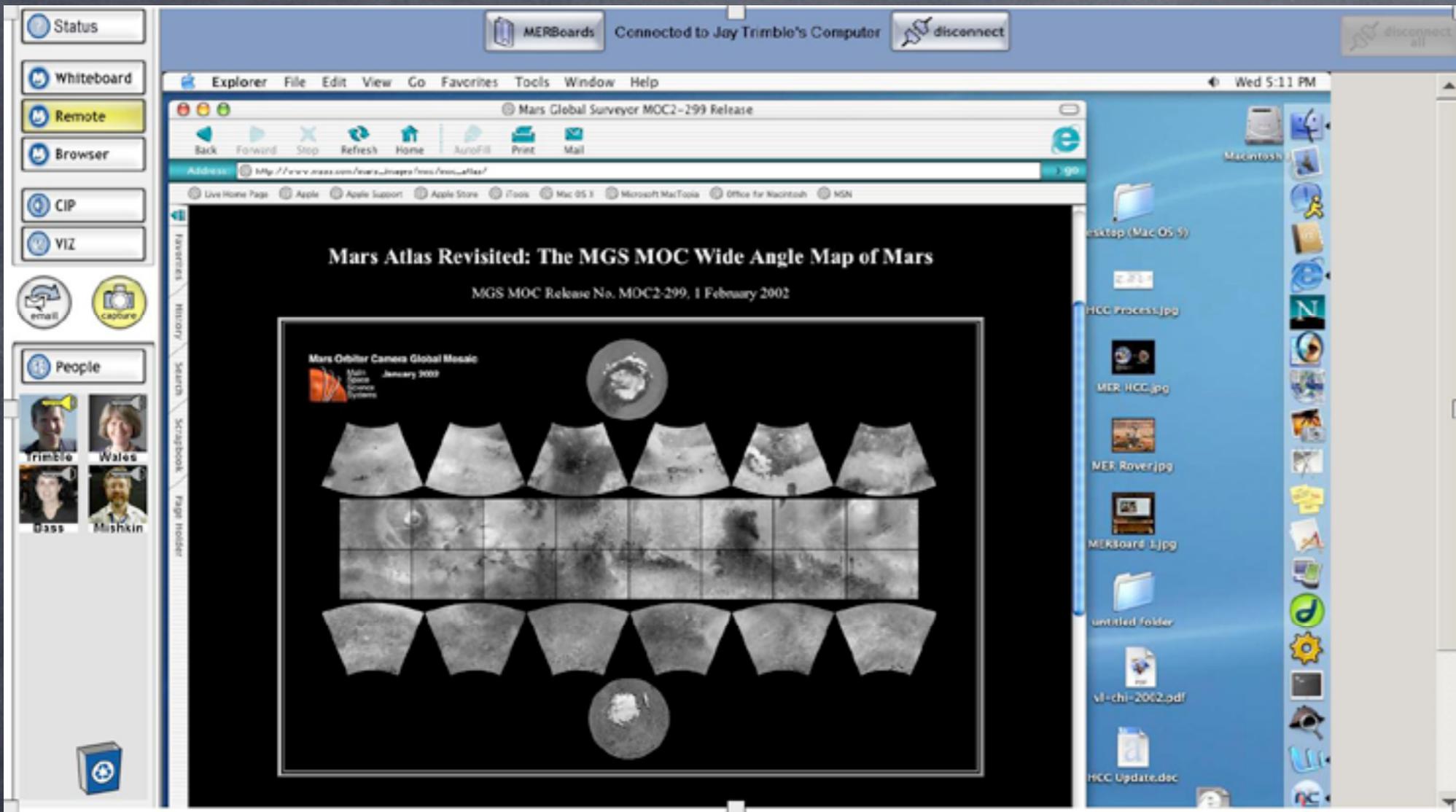
MERSpace Design

- Personal data in a collaborative space
- A consistent model for storing and retrieving data

The screenshot displays the MERSpace web interface for 'Jay Trimble's MERSpace'. The interface includes a top navigation bar with 'Status', 'Whiteboard', 'Remote', 'Browser', 'Data Nav', and 'VIZ' buttons. A 'De-Authenticate' button is also present. The main content area is titled 'Files' and contains a table of files. The table has columns for 'Name', 'Created', 'Modified', and 'Type'. The files listed are 'Board 1' through 'Board 13', all of type 'svg'. The 'Modified' column is currently selected. To the left of the table is a 'Folders' sidebar with options like 'Documents', 'Inbox', 'Images', 'Saved Whiteboards', 'Private', and 'MER'. To the right is a 'Bookmarks' sidebar with a list of URLs, including 'http://mars.jpl.nasa.gov/mission...', 'http://mars.jpl.nasa.gov/', and 'http://athena.cornell.edu/'. Below the bookmarks is a 'Remote Computer' section with a list of computers, including 'My Computer (3/12@3PM)'. At the bottom of the interface are buttons for 'Delete', 'New', 'Delete', and 'Open'. A 'People' sidebar on the left shows avatars for 'Trimble', 'Wales', 'Ecco', and 'Makler'.

Name	Created	Modified	Type
Board 12	4:40 PM 03/12/03	4:40 PM 03/12/03	svg
Board 12	4:39 PM 03/12/03	4:39 PM 03/12/03	svg
Board 13	4:37 PM 03/12/03	4:37 PM 03/12/03	svg
Board 11	4:08 PM 03/12/03	4:08 PM 03/12/03	svg
Board 10	3:18 PM 03/12/03	3:18 PM 03/12/03	svg
Board 9	3:16 PM 03/12/03	3:16 PM 03/12/03	svg
Board 4	8:12 PM 03/10/03	8:12 PM 03/10/03	svg
Board 1	4:36 PM 03/10/03	4:36 PM 03/10/03	svg

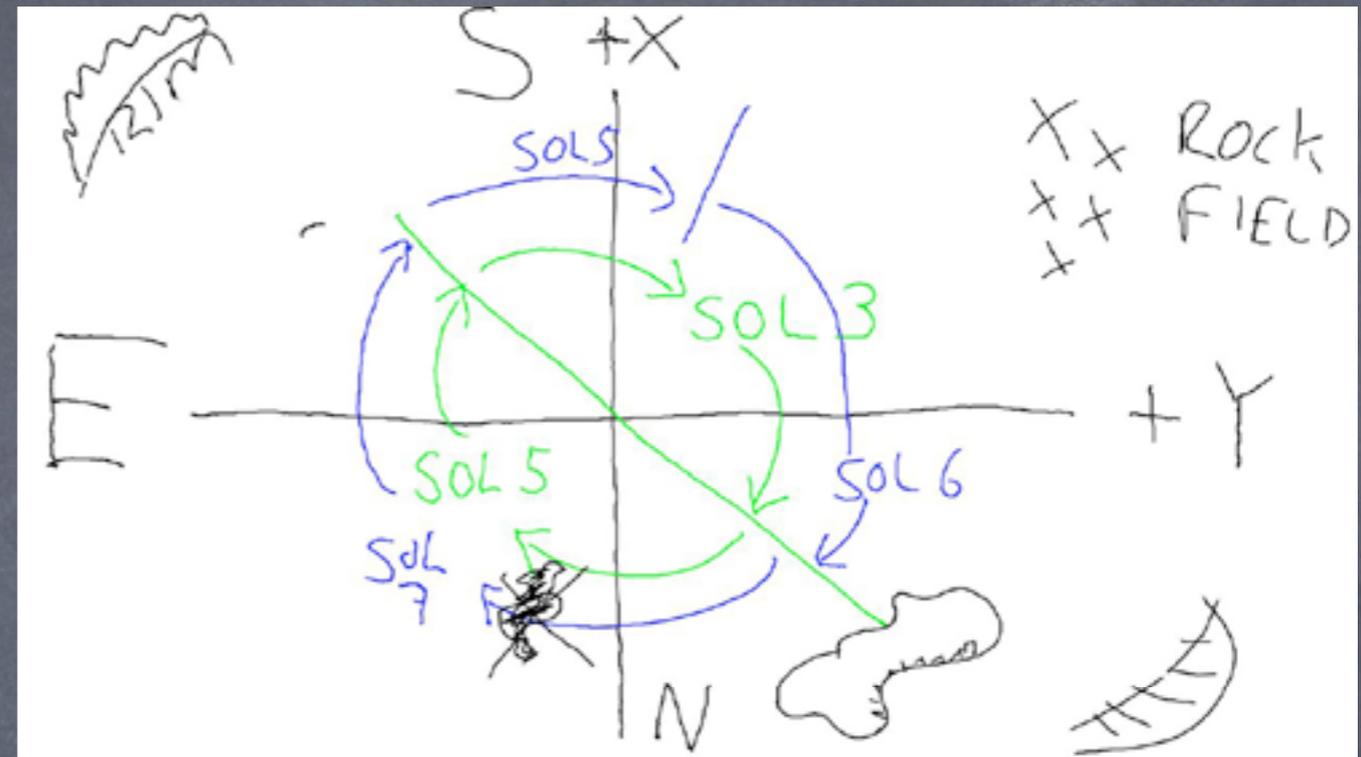
Remote Access



View, control,
capture, save

- Board to Board
- PC to Board

Whiteboard Use in Surface Ops



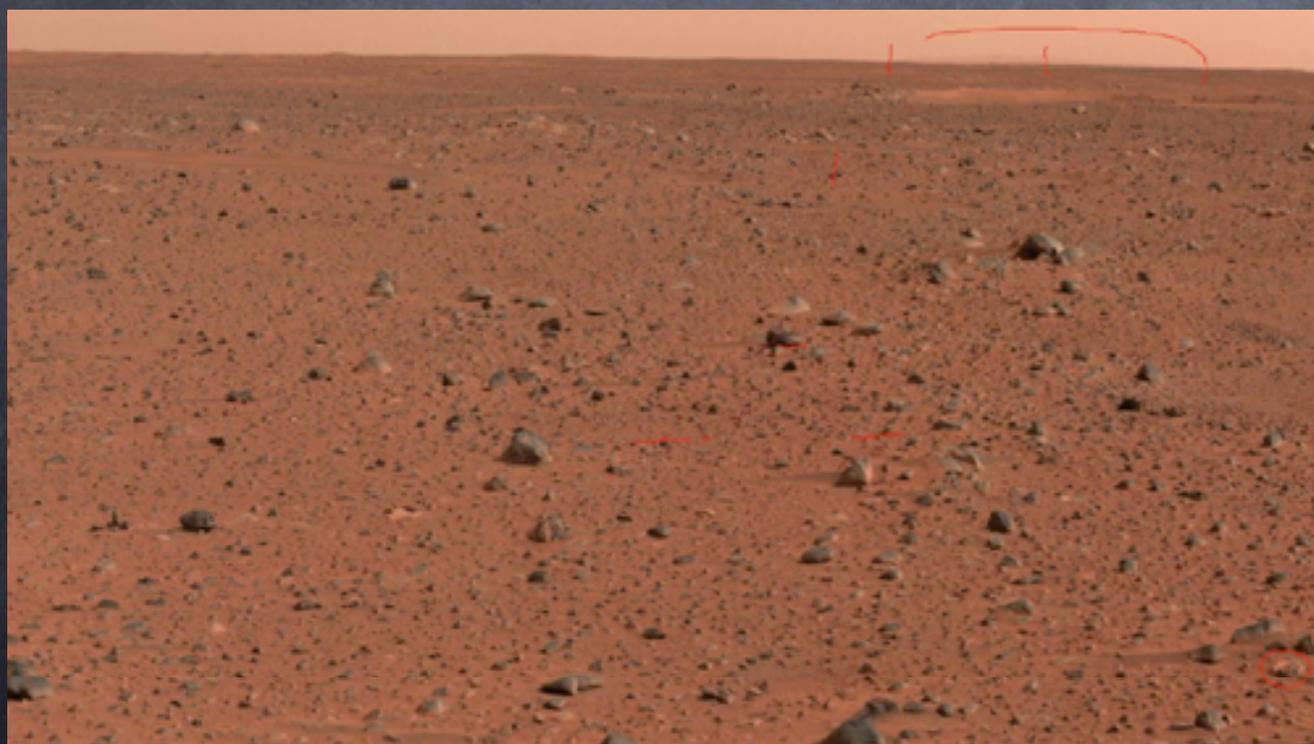
Write, broadcast,
present, save, recall



Looking at Images



Images



Content

Traverse path to Bonneville Crater, created in personal environment, uploaded and displayed on MERBoard

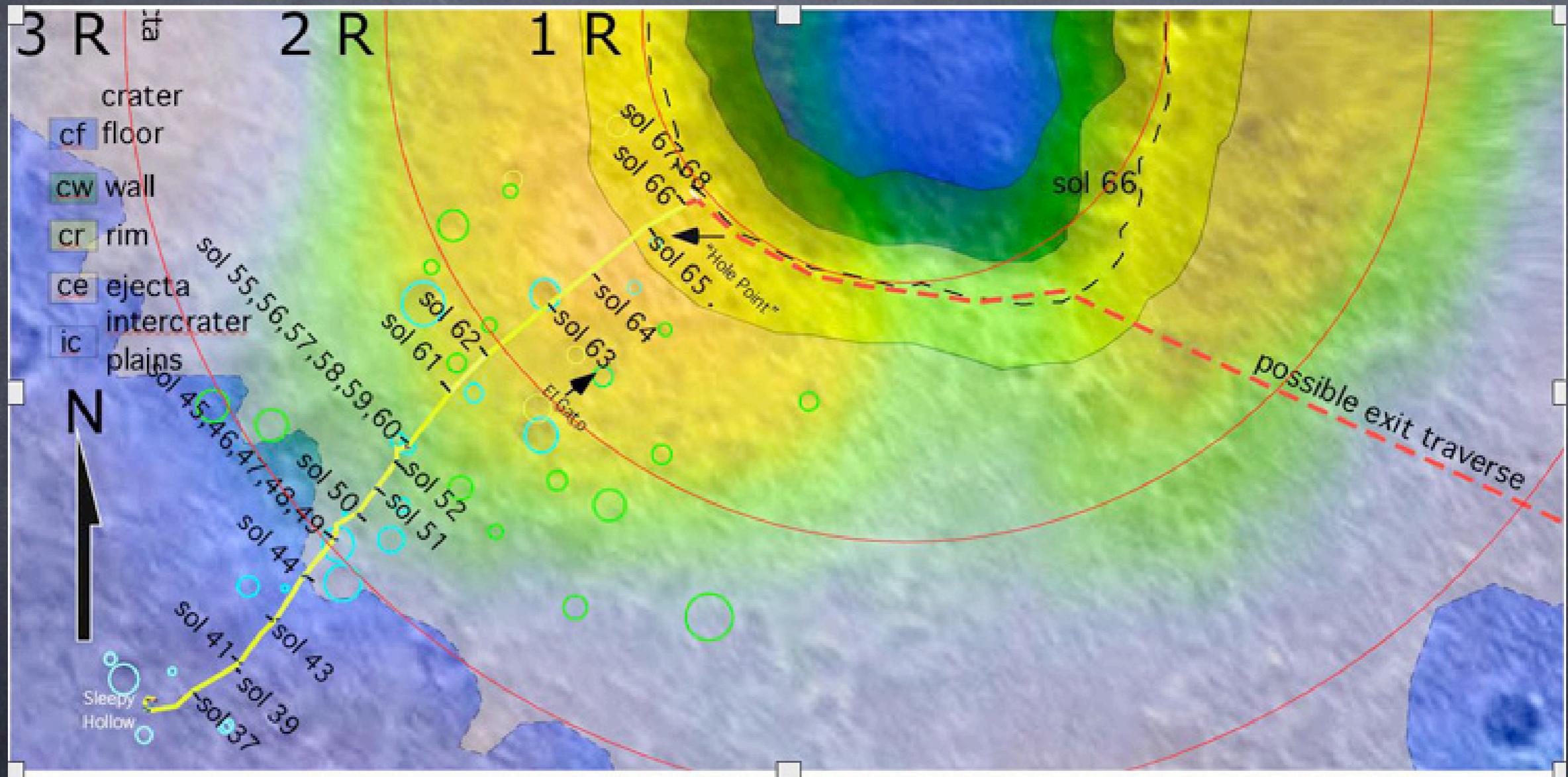
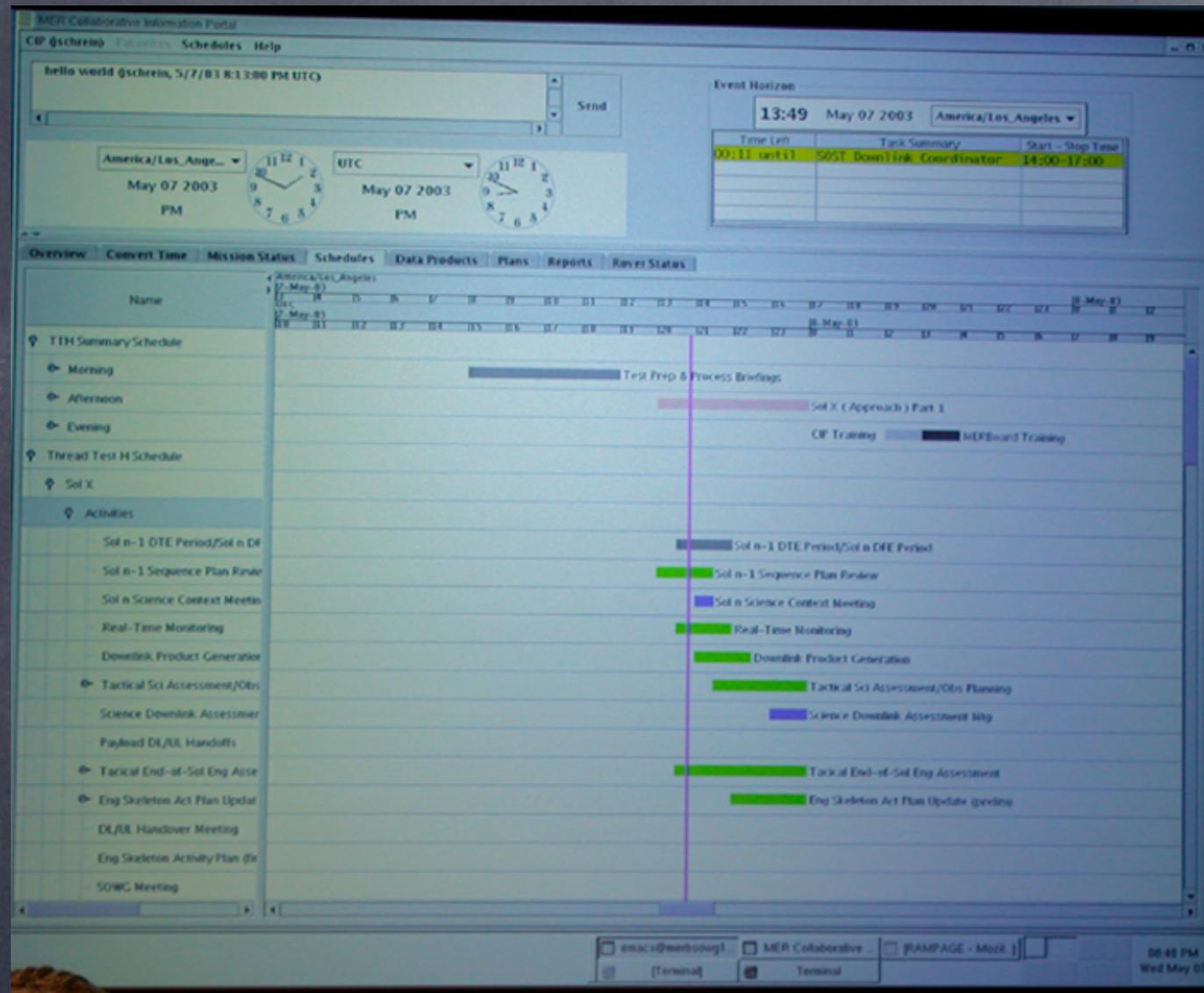


Image courtesy of Larry Crumpler

Presenting Sol Trees



Time & Schedules



Collaborative Information Portal for MER

The screenshot shows the CIP (Ikeely) software interface. At the top, there are menu options: CIP (Ikeely), File, Messages, Clocks, Events, Schedules, and Help. Below the menu is a message log table with columns for Mission, Sender, Message, and Sent (UTC). The main area is divided into several sections: a 'Clocks' section with two rows (SOL 51, 18:07, LST-A and SOL 31, 06:06, LST-B), an 'Events' section with a table of tasks, and a 'Schedule Viewer' section with a Gantt chart. The Gantt chart shows various activities over time, with a vertical pink line indicating the current time. The 'Schedule Viewer' section has tabs for Overview, Time Converter, Schedules, Browse Files, Find Files, New Files, and Observations. Below the tabs are buttons for GO TO NOW, SHOW/HIDE SCHEDULES, PRINT GANTT CHART, and GET INFO. The Gantt chart shows activities like Engineering Leads Tagup, DL/UL Handover Meeting, SOWG Meeting, End-of-Sol Science Discussion, Sci Product EPO Caption Interview, Activity Refinement/Sequence Assign, and Activity Carving.

Time Left	Task Summary	Start	Stop
00:52 left	Tactical End-of-Sol Engr. Assessm...	06:00	10:06
01:54 left	SOWG Meeting	09:05	11:08
01:54 until	End-of-Sol Science Discussion	11:08	11:39
01:54 until	Sci Product EPO Caption Interview	11:08	12:10

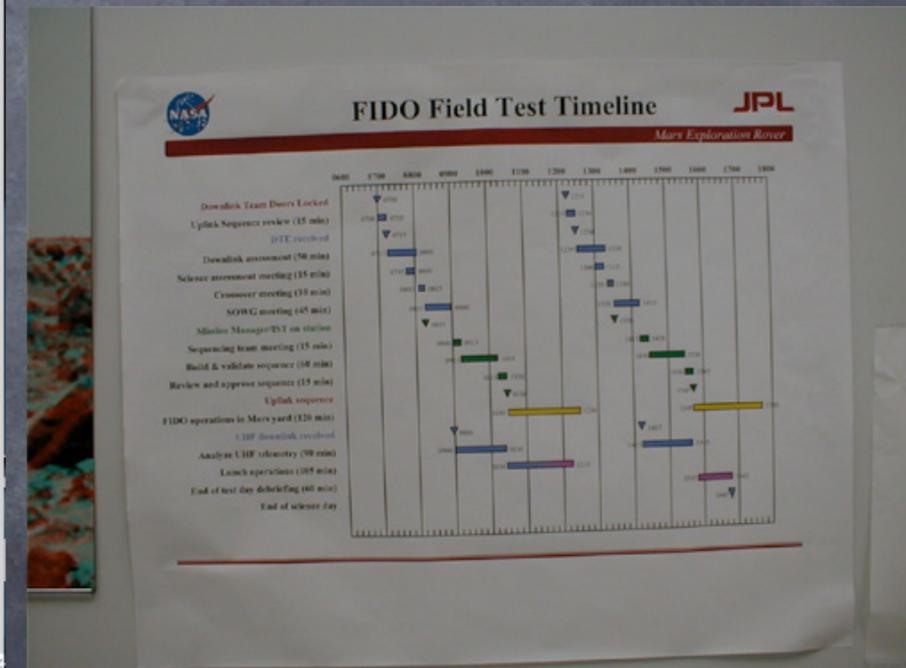
Broadcast Messages

Event Countdown Timer

Clocks

Tabs for time conversion and data navigation tools

Schedule Viewer

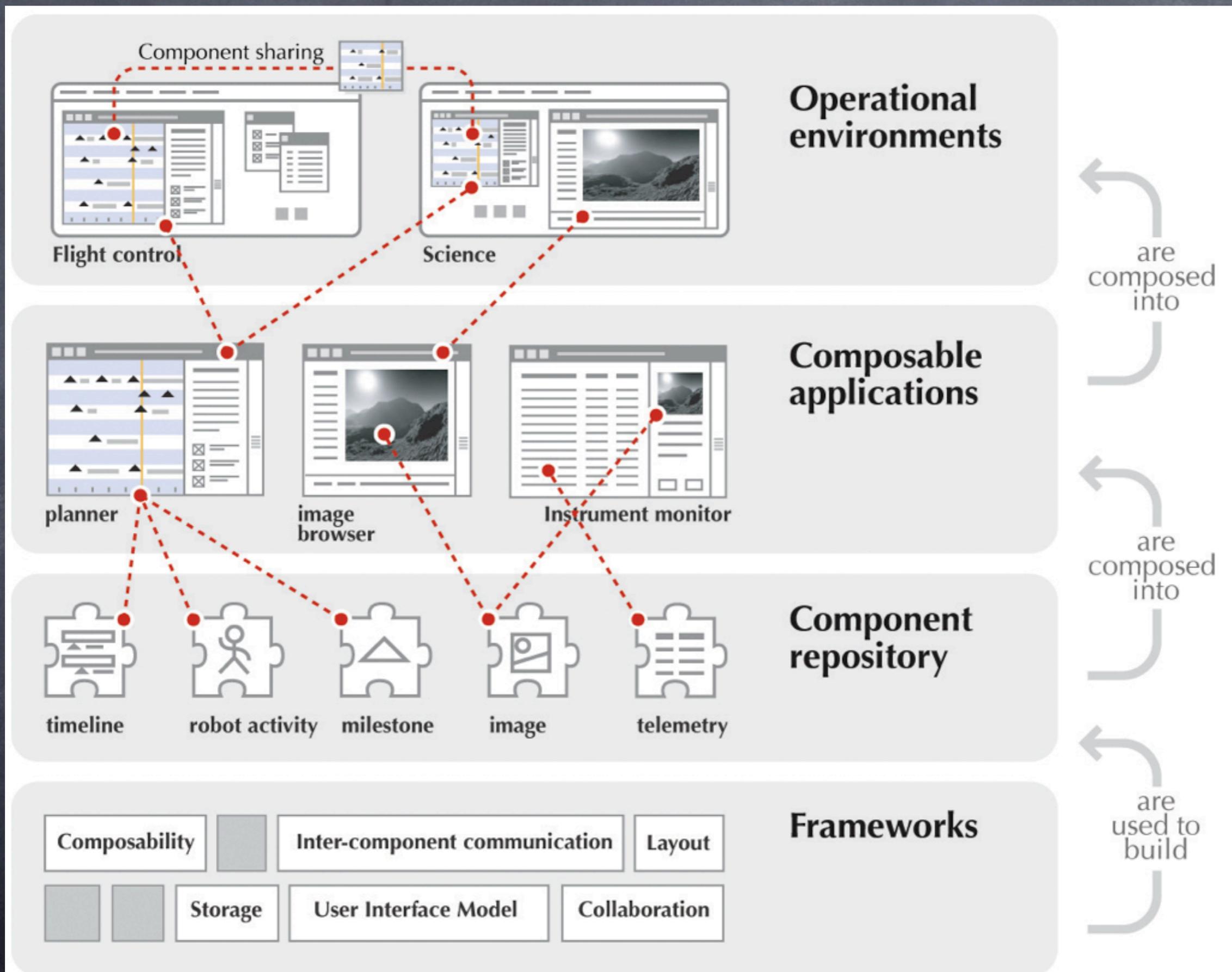


Personal tools

- Initial MER observations suggest that scientists default to their own tools
- Use mission tools when they fill a desired niche, or when required, future mission systems will benefit from interoperability



Future Plans



Future Plans

George's Mission Collection

My inbox

- Data products received 12Dec11
- Data products received 13Dec11
- Activity change needed 16Dec11

Working plans

- 451-01a Tomorrow's soil plan
- 32-00-02 Soils group campaign S291
- 32-00-03 Temp soil plan

Working activities

- 32-00-01 A simple activity
- 32-00-02 Micro-image of rock "Spud"
- 32-00-03 Essential activity

Working targets

- 121-01 untitled target
- 123-02 Narrow angle, slide on east hill
- 123-03 Center of Spud
- 123-04 Medium-wide pano, east hill slope A

Working data products

Mission data products

Pancam

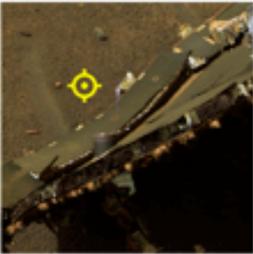
- D0321-00 West Elysium #2
- D0311-07 Heatshield separation fitting**
- D0402-05 Pano east rise, Filberg complex
- D0371-21 Pano west rise, Filberg complex

APXS

- D0321-00 MBF-0 spectra, band 1
- D0321-01 MBF-0 spectra, band 2
- D0321-02 MBF-0 spectra, band 3
- D0321-03 Min exposure 10nm side
- D0321-04 Min exposure 10nm front

Preview: **D0311-07 Pancam of heat ...**

Dataproduct | Accountability | Component



ID: D0311-07
Name: Pancam of heatshield separation fitting
Captured: mmddyy hhmmss
Status: MIPS-3 (mmddyy)

Open as

- Image editor
- Target / activity editor**

Xxxxx

Dataproduct



Targets

- 123-01 untitled target
- 121-02 heatshield edge

X:Y [] [] [] Delete

Target 123-01 : untitled

Name: [] Center point:

X: 4.0923032
Y: 4.0923032
Z: 4.0923032

ID: D0311-07
Name: Pancam of heatshield separation fitting
Captured: mmddyy hhmmss
Status: MIPS-3 (mmddyy)

Create new activity...

Activities

- 032-A12 Power cycle
- 123-A45 Microimage**

Activity 123-A45 : Microimage

Name: [] ID: []

Latest start time: Unspec. []

Uplink priority: []

Uplink priority rationale: []

Downlink priority rationale: []

Notes: []

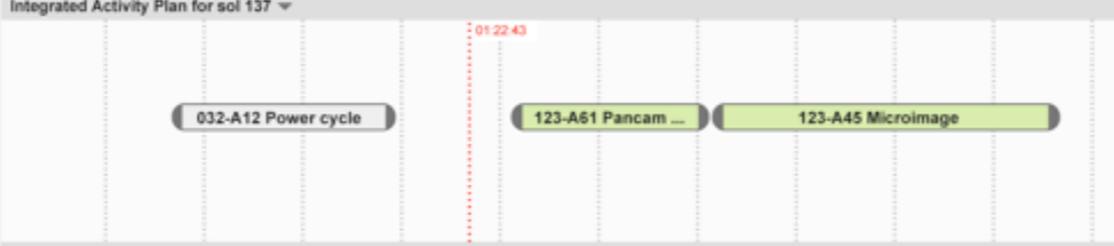
Requested data products

- D0311-07 Microimage, heatshield surface condition

Daily Soils Science Planning Timeline

01:00:00 01:05:00 01:10:00 01:15:00 01:20:00 01:25:00 01:30:00 01:35:00 01:40:00 01:45:00 01:50:00

Integrated Activity Plan for sol 137



Soils science plan 12Dec09

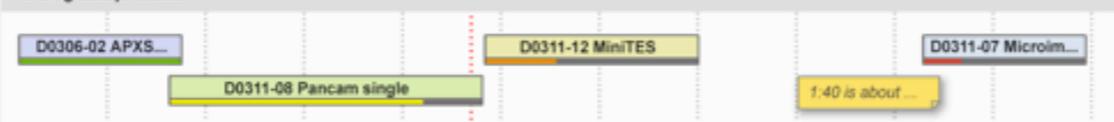
Soils science plan 14Dec09



Ephemeris



Pending data products



Scale [] Show **Current soils activity** Find []

Soils science plan 12Dec09

ID	Name	Power	Memory	Priority	Order	Start time
A 32-00-01	A simple activity	2.5	128	1	1	00:00:00.00
A 32-00-02	Micro-image of rock "Spud"	4.1	190	1	2	00:00:00.00
A 32-00-03	Essential activity	1.3	74	2	3	00:00:00.00
A 32-00-04	Some other activity	7.1	110	2	4	00:00:00.00
A 32-00-05	Yet another activity	7.1	110	3	5	00:00:00.00

Show **Current soils activity** Find []

Note

1:40 is about the earliest we can expect to start the 2nd MiniTES today because of the recent power draw-down.

GRF : S137 : 00:09:15:37