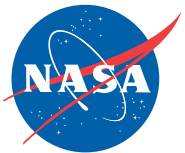


AUGUST 2, 2010 / FINAL PRESENTATION

A Mobile Execution Tool for the Exploration of Planetary Surfaces

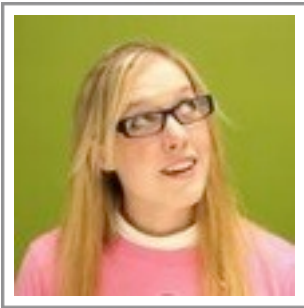


Carnegie Mellon

Team **Lumina**

Katy Linn
Christine Wu
Jesse Venticinque
Jennifer Lu
Noah Levin

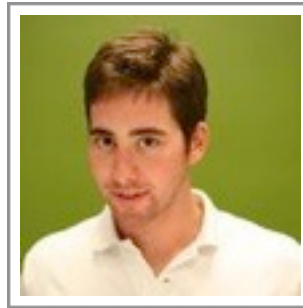
MEET THE TEAM



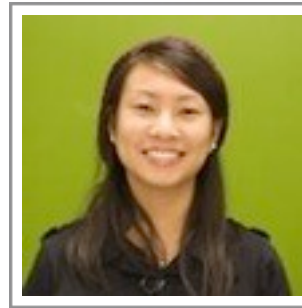
Katy Linn
Project
Coordinator



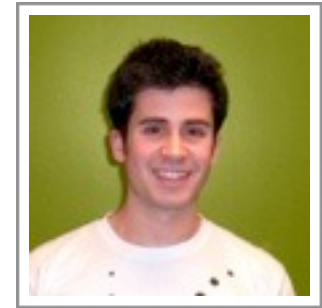
Christine Wu
Technical Lead



Jesse Venticinque
Design Lead



Jennifer Lu
User Research



Noah Levin
Web /
Documentation

MEET THE CLIENT



HCI Group
NASA Ames Research Center



BACKGROUND

DESIGN

DEMO

PROCESS

CONCLUSION

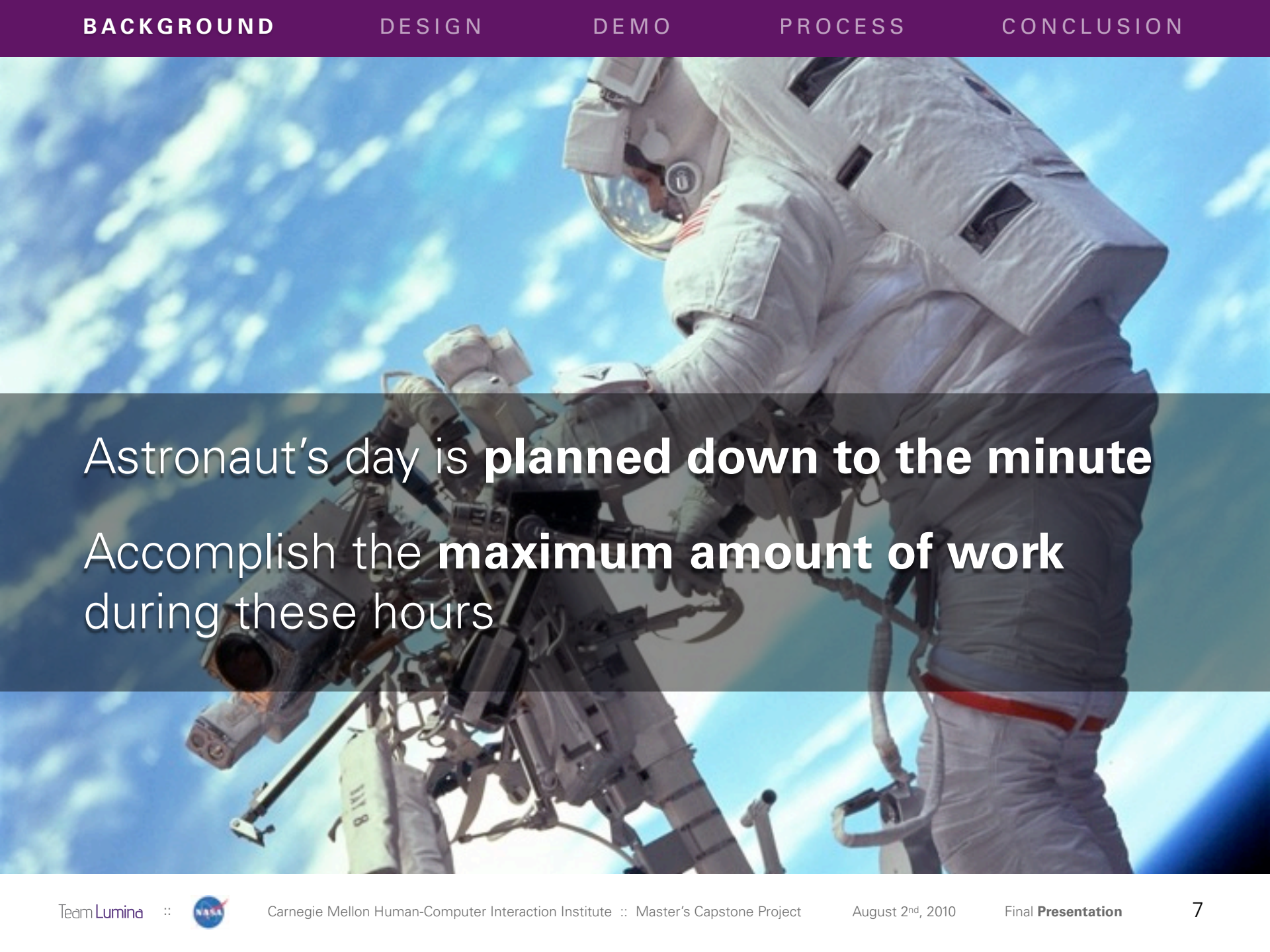


CLIENT'S CHARGE

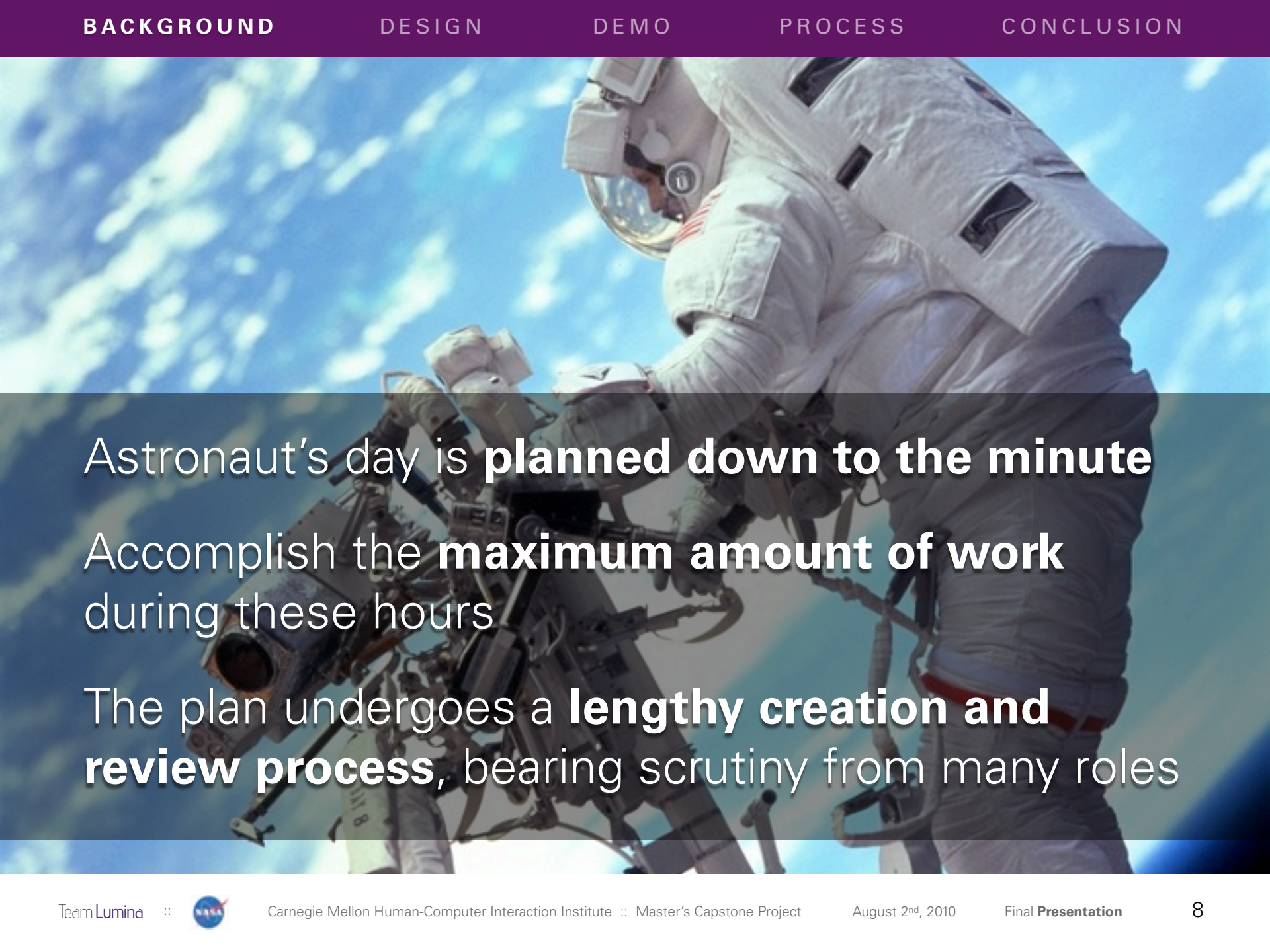
To design an **efficient plan interface** for **real-time execution** of human space missions

A photograph of an astronaut in a white spacesuit working on the exterior of a space station. The astronaut is positioned on the right side of the frame, leaning over a complex metal structure. The background shows the Earth's blue and white clouds from space. A semi-transparent dark grey horizontal bar is overlaid across the middle of the image, containing the text.

Astronaut's day is **planned down to the minute**



Astronaut's day is **planned down to the minute**
Accomplish the **maximum amount of work**
during these hours

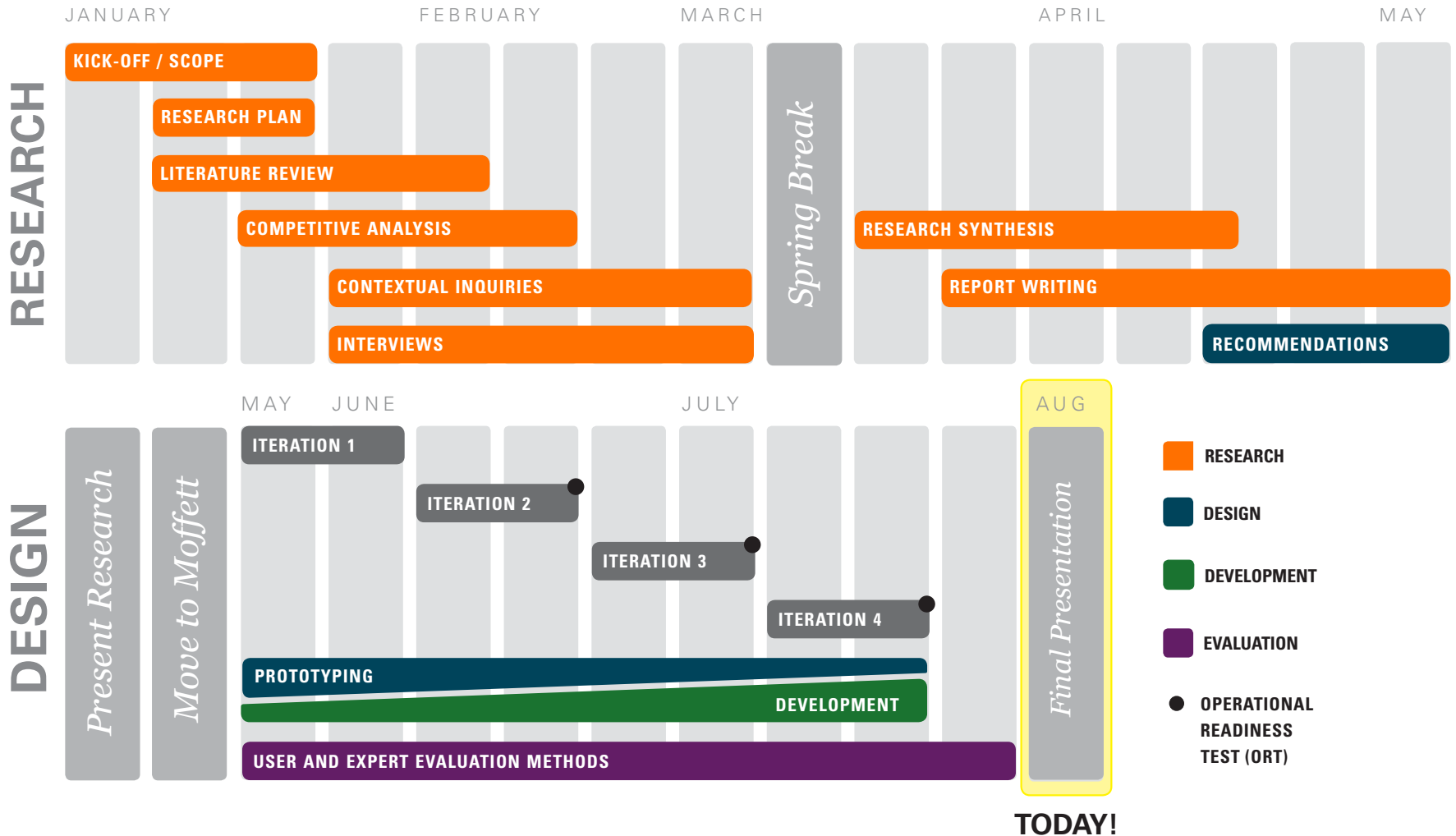
A photograph of an astronaut in a white spacesuit working on the exterior of a space station. The astronaut is positioned in the upper right, leaning over a complex structure of metal beams and equipment. The background is a clear blue sky with white clouds. The text is overlaid on a semi-transparent dark grey band across the middle of the image.

Astronaut's day is **planned down to the minute**

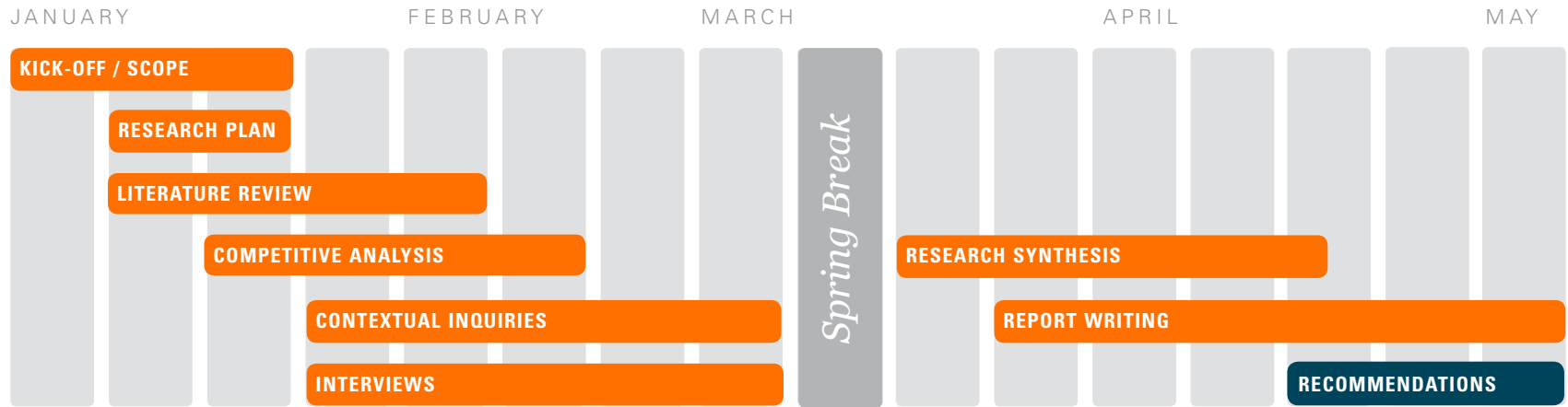
Accomplish the **maximum amount of work** during these hours

The plan undergoes a **lengthy creation and review process**, bearing scrutiny from many roles

SCHEDULE



RESEARCH



JANUARY

FEBRUARY

MARCH

RESEARCH

KICK-OFF / SCOPE

RESEARCH PLAN

LITERATURE REVIEW

COMPETITIVE ANALYSIS

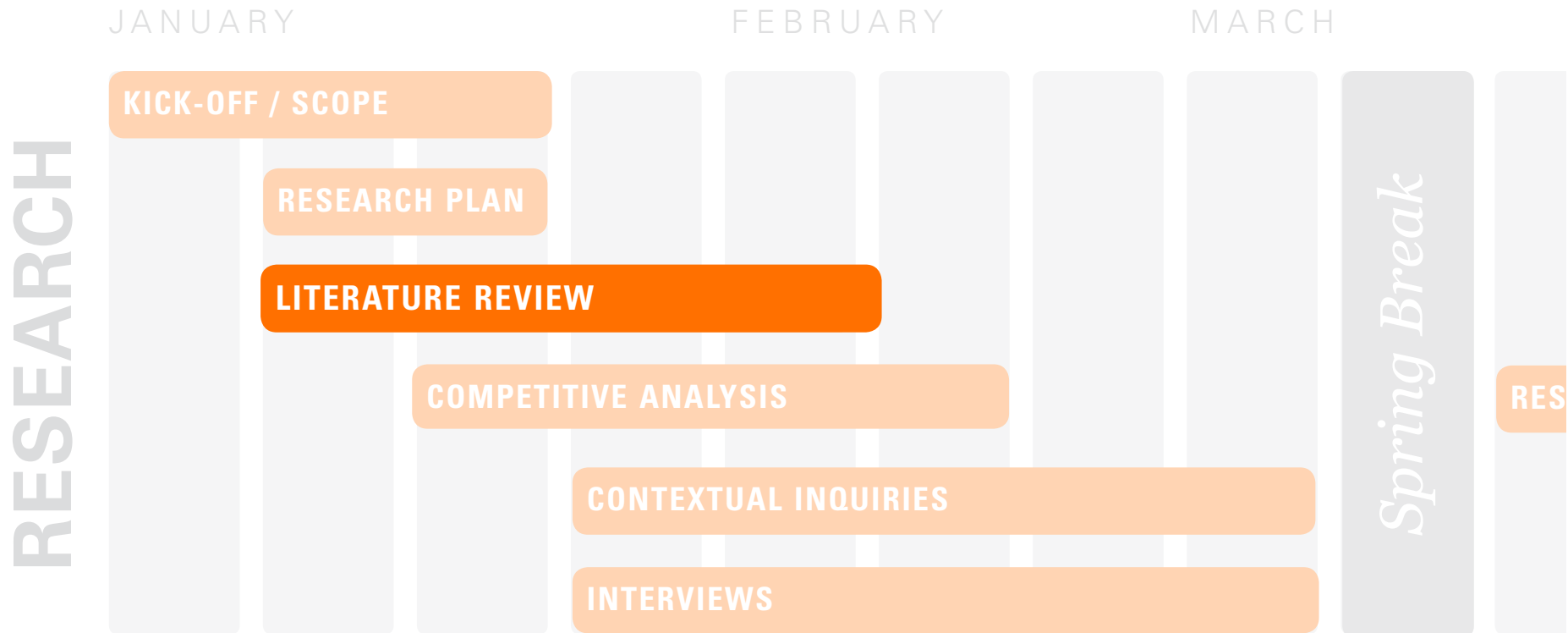
CONTEXTUAL INQUIRIES

INTERVIEWS

Spring Break

RES





20 Papers

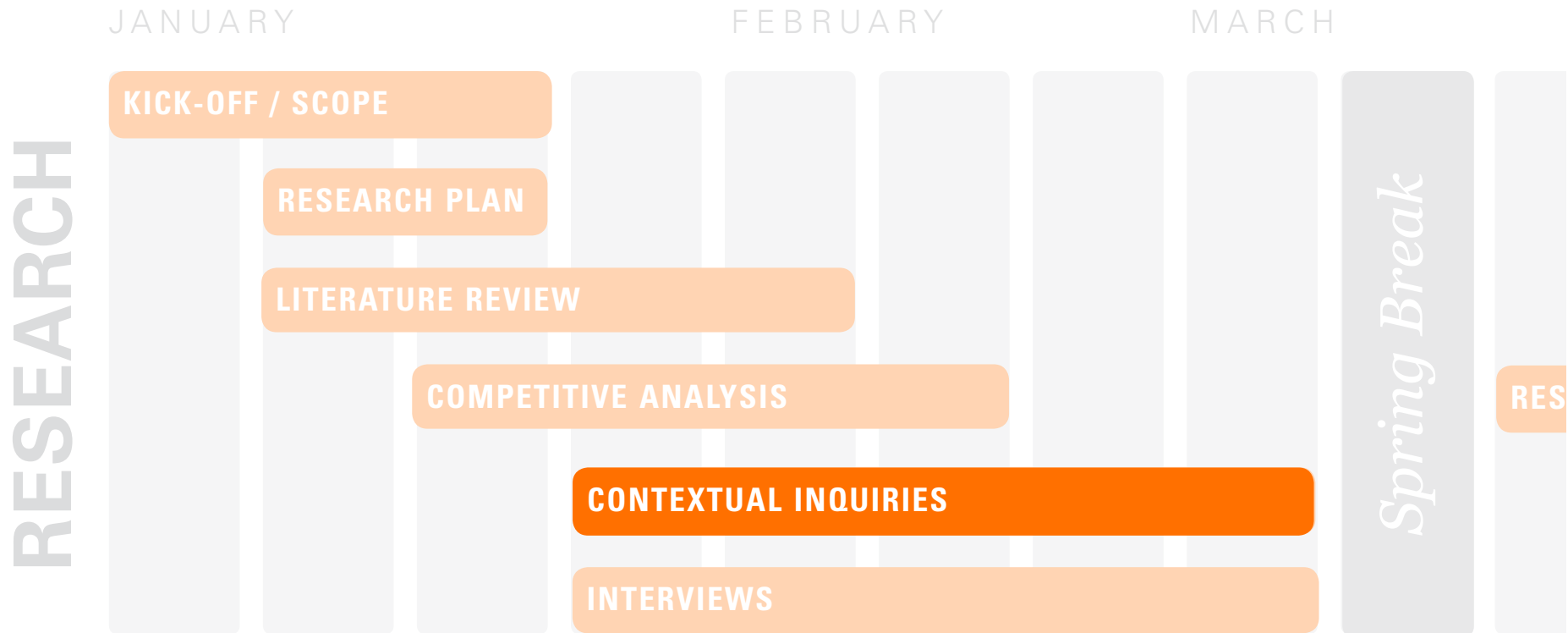
Background knowledge to **prepare for ethnographic research**



6 Planning and Execution Tools

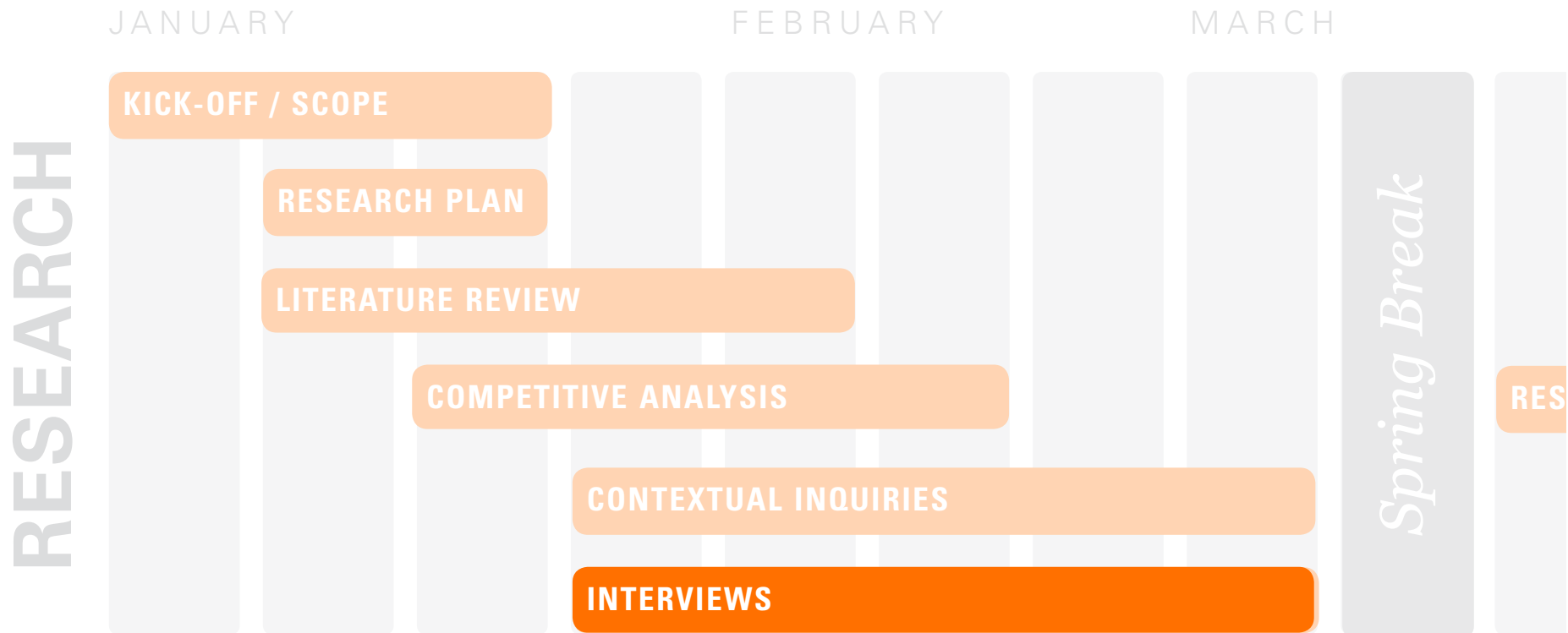
Understand **current practices**





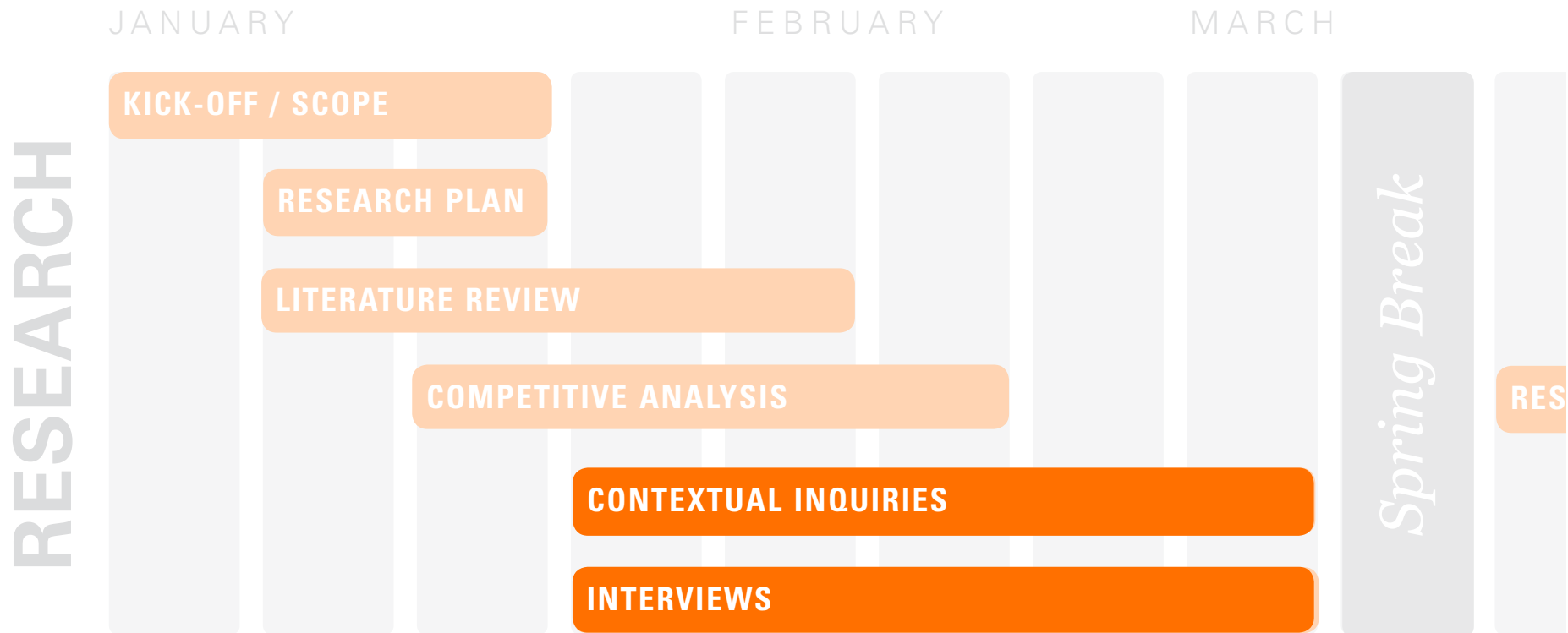
6 Contextual Inquiries (25 People)

Discover what is **actually happening at work**



3 Interviews

Reveal **retrospective accounts** of the workflow



Talked to **28 People Total**



PLANNER



ASTRONAUT



PLANNER



ASTRONAUT

PLANNER

Mission Planning is **complex**: resource, physical and sequential constraints

PLANNER

Mission Planning is **complex**: resource, physical and sequential constraints

Changing the plan is **stressful & difficult**, and requires multiple roles

PLANNER

Mission Planning is **complex**: resource, physical and sequential constraints

Changing the plan is **stressful & difficult**, and requires multiple roles

Want the **plan to be followed accurately**



PLANNER



ASTRONAUT



ASTRONAUT

A photograph of an astronaut in a blue flight suit sitting in a cluttered space station module. He is holding a white document and looking towards the camera. In the background, another person is working at a workstation. The environment is filled with equipment, cables, and various items typical of a space station interior.

Astronauts **cannot follow the plan exactly**

ASTRONAUT

A photograph of an astronaut in a blue polo shirt and blue pants, smiling and holding a white document. He is in a cluttered space station module with various equipment, cables, and monitors. Another person is visible in the background, working on a task.

Astronauts **cannot follow the plan exactly**
They need a **subset of information** from the plan

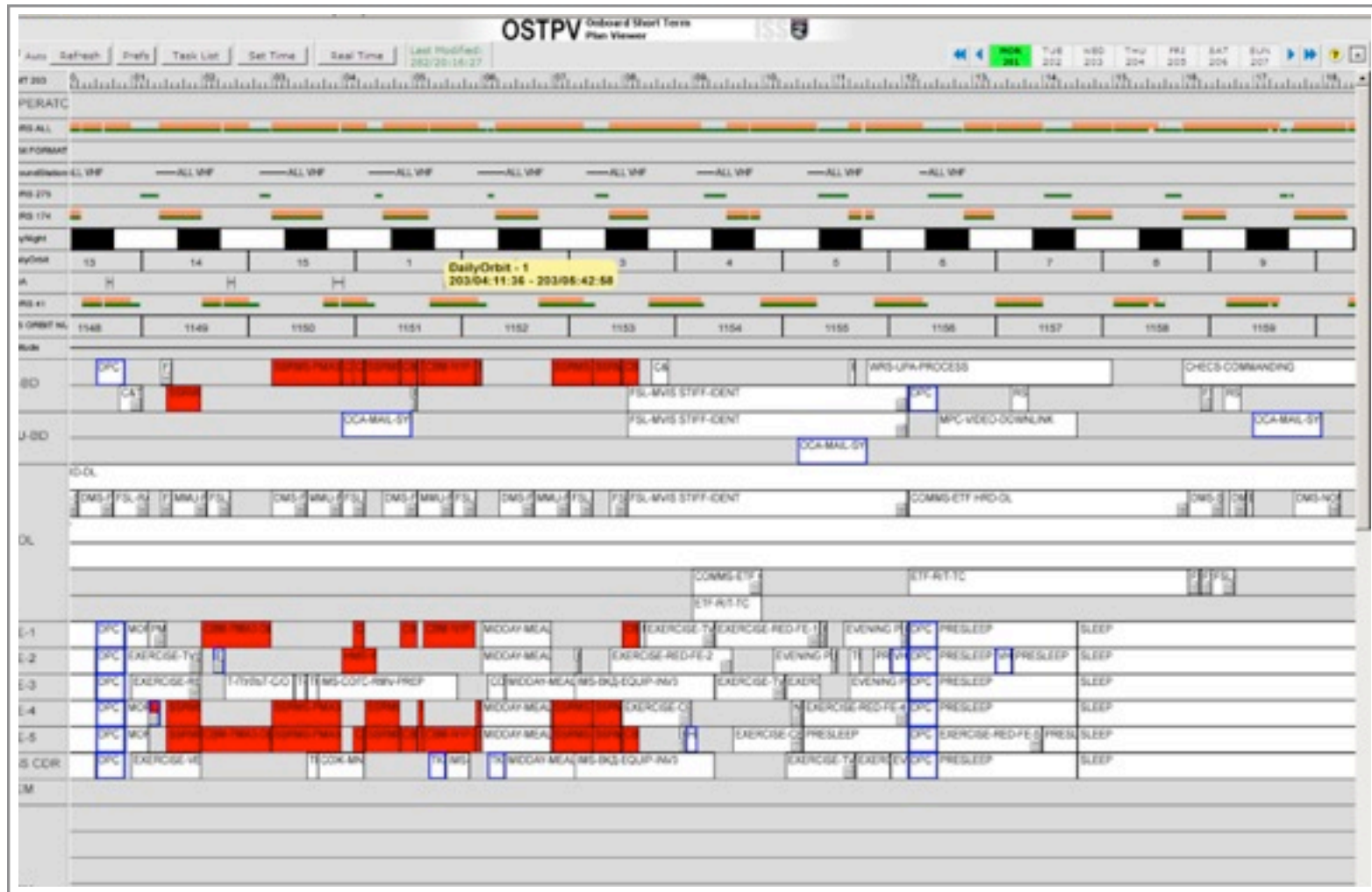


ASTRONAUT

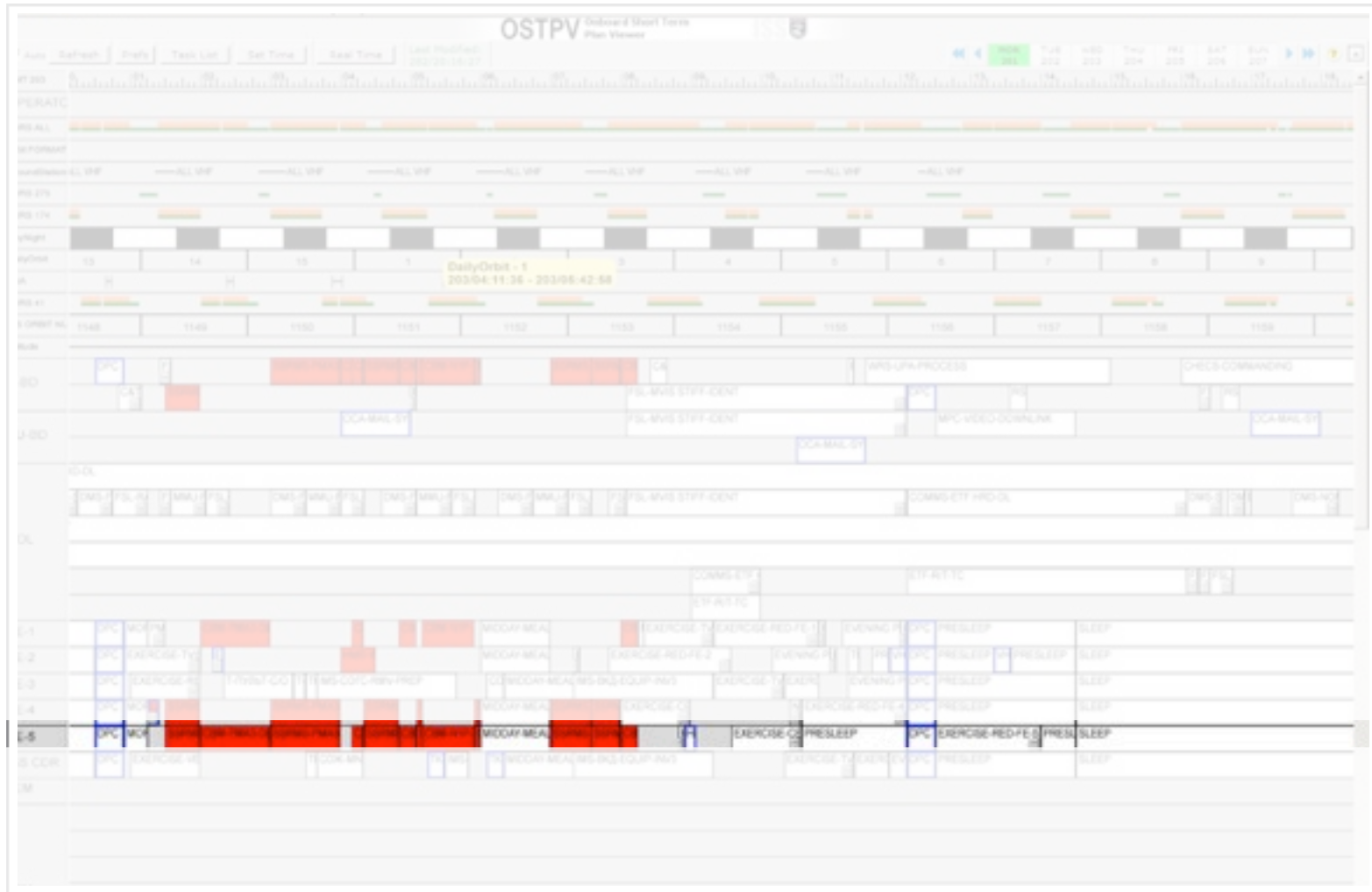


“The plan is just a suggestion...”
Former astronaut (3/1/2010)

THE PLANNERS PLAN



THE ASTRONAUTS PLAN





20 Literature Reviews
6 Competitive Analyses
6 Contextual Inquiries
3 Interviews

~300 Findings

! **Inflexible Plans** fail to capture the variable nature of execution

! Any **single representation of the plan** fails to accommodate the varying needs and responsibilities across roles utilizing the plan

! **Inflexible Plans** fail to capture the variable nature of execution

! Any **single representation of the plan** fails to accommodate the varying needs and responsibilities across roles utilizing the plan

! Inflexible Plans

Astronauts **execute the plan out of order**

! Inflexible Plans

Astronauts **execute the plan out of order**
Discrepancies arise between the
plan and actual execution

! **Inflexible Plans** fail to capture the variable nature of execution

! Any **single representation of the plan** fails to accommodate the varying needs and responsibilities across roles utilizing the plan

! Single Representation of the Plan

Planners and Astronauts need **different kinds of information from the same plan**

! **Inflexible Plans** fail to capture the variable nature of execution

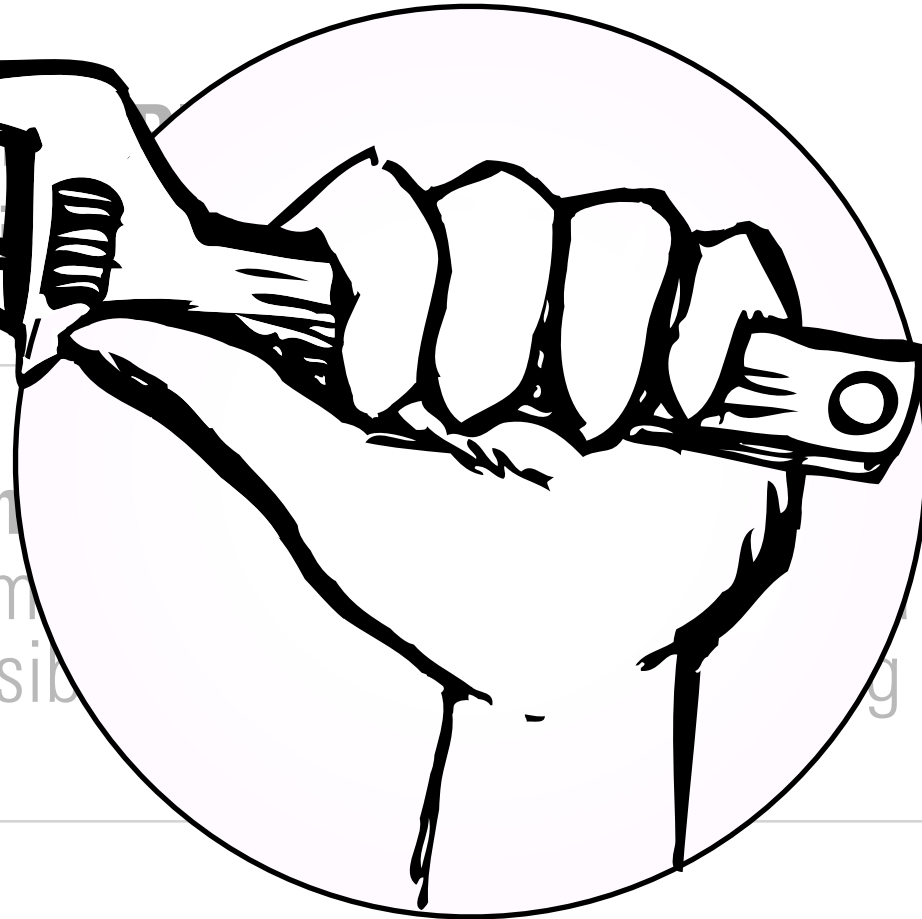
! Any **single representation of the plan** fails to accommodate the varying needs and responsibilities across roles utilizing the plan



Inflexibility
the very

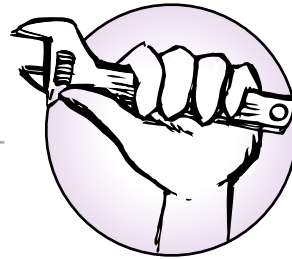


Any **single**
accommodate
responsibility



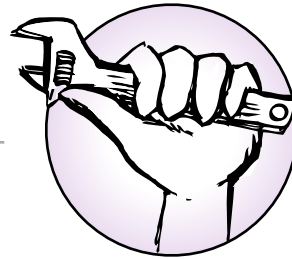
Plan fails to
the plan





Timeline optimized for execution

! Single Representation of the Plan



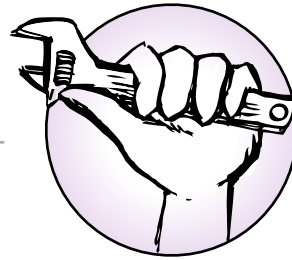
Timeline optimized for execution

! Single Representation of the Plan



Delta between plan and execution

! Inflexible Plans



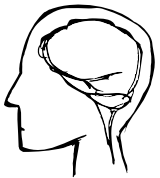
Timeline optimized for execution

! Single Representation of the Plan



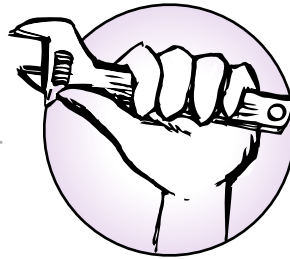
Delta between plan and execution

! Inflexible Plans



Autonomy when appropriate

! Inflexible Plans



Timeline optimized for execution

! Single Representation of the Plan



Delta between plan and execution

! Inflexible Plans



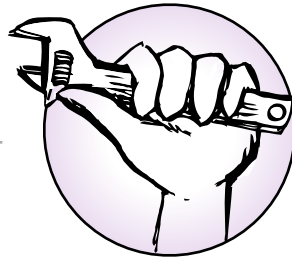
Autonomy when appropriate

! Inflexible Plans



Glanceable and unobtrusive

! Single Representation of the Plan



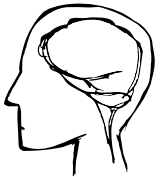
Timeline optimized for execution

! Single Representation of the Plan



Delta between plan and execution

! Inflexible Plans



Autonomy when appropriate

! Inflexible Plans



Glanceable and unobtrusive

! Single Representation of the Plan

BACKGROUND

DESIGN

DEMO

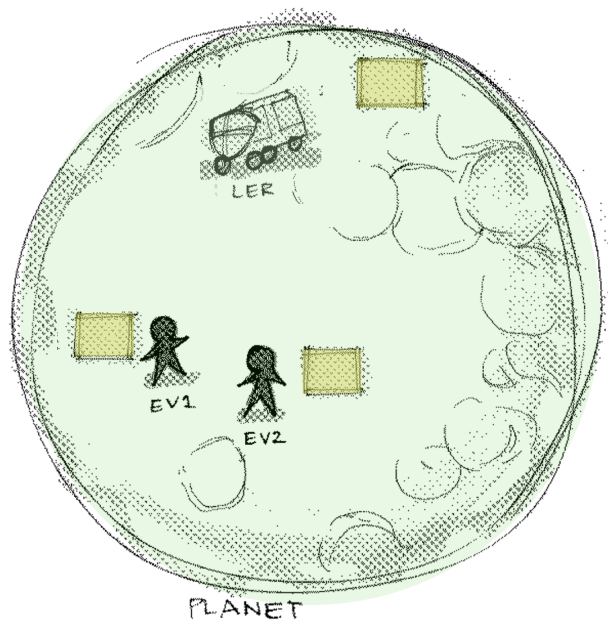
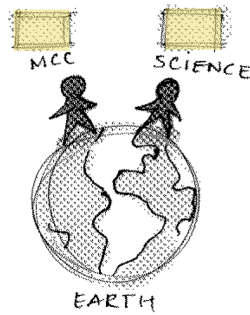
PROCESS

CONCLUSION



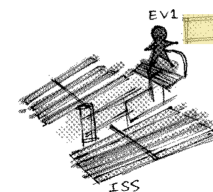
ECOSYSTEM

MISSION CONTROL



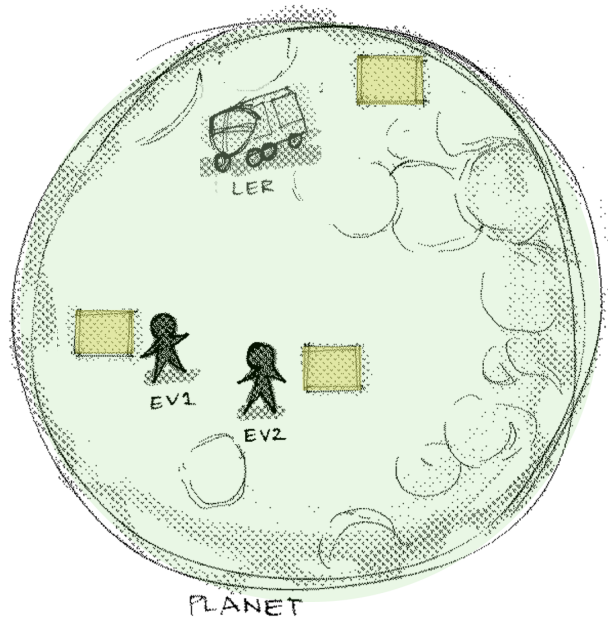
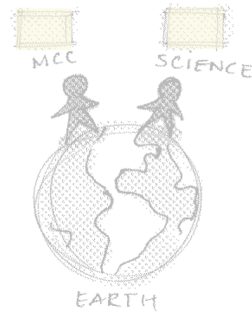
PLANETARY SURFACE

INTERNATIONAL SPACE STATION



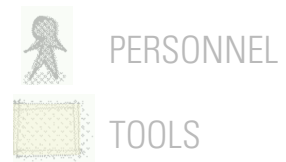
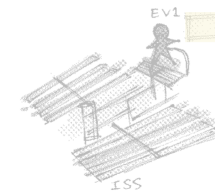
ECOSYSTEM

MISSION CONTROL



PLANETARY SURFACE

INTERNATIONAL SPACE STATION



MEET TIM

BACKGROUND:

38-year-old Astronaut (Geologist)

EXPERIENCE:

Has extensive training and experience

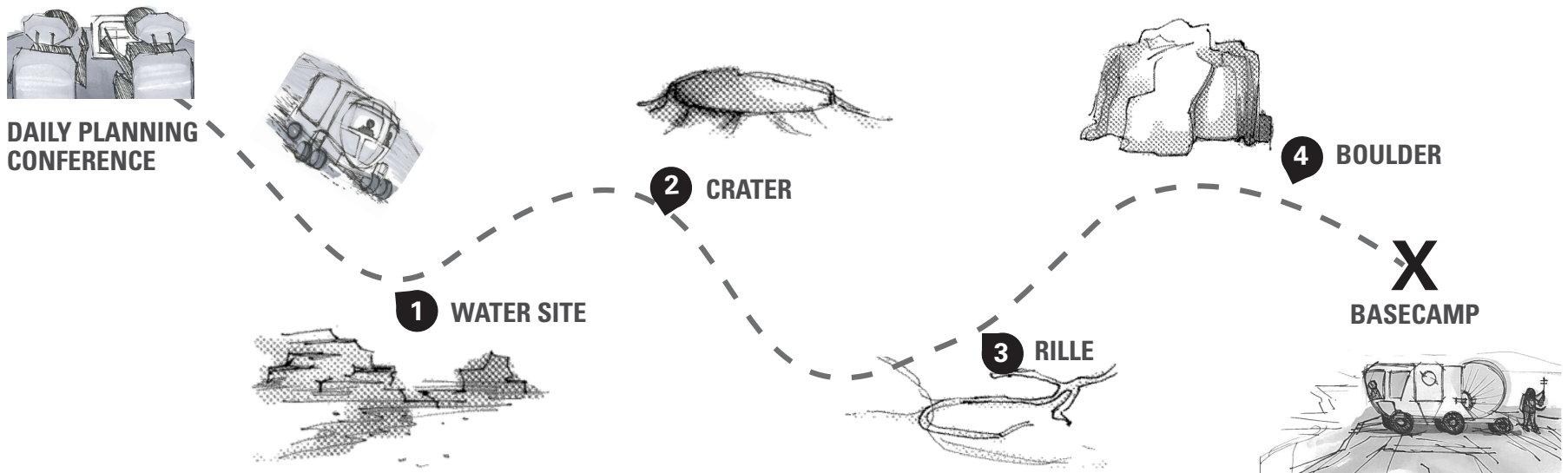
RESPONSIBILITY:

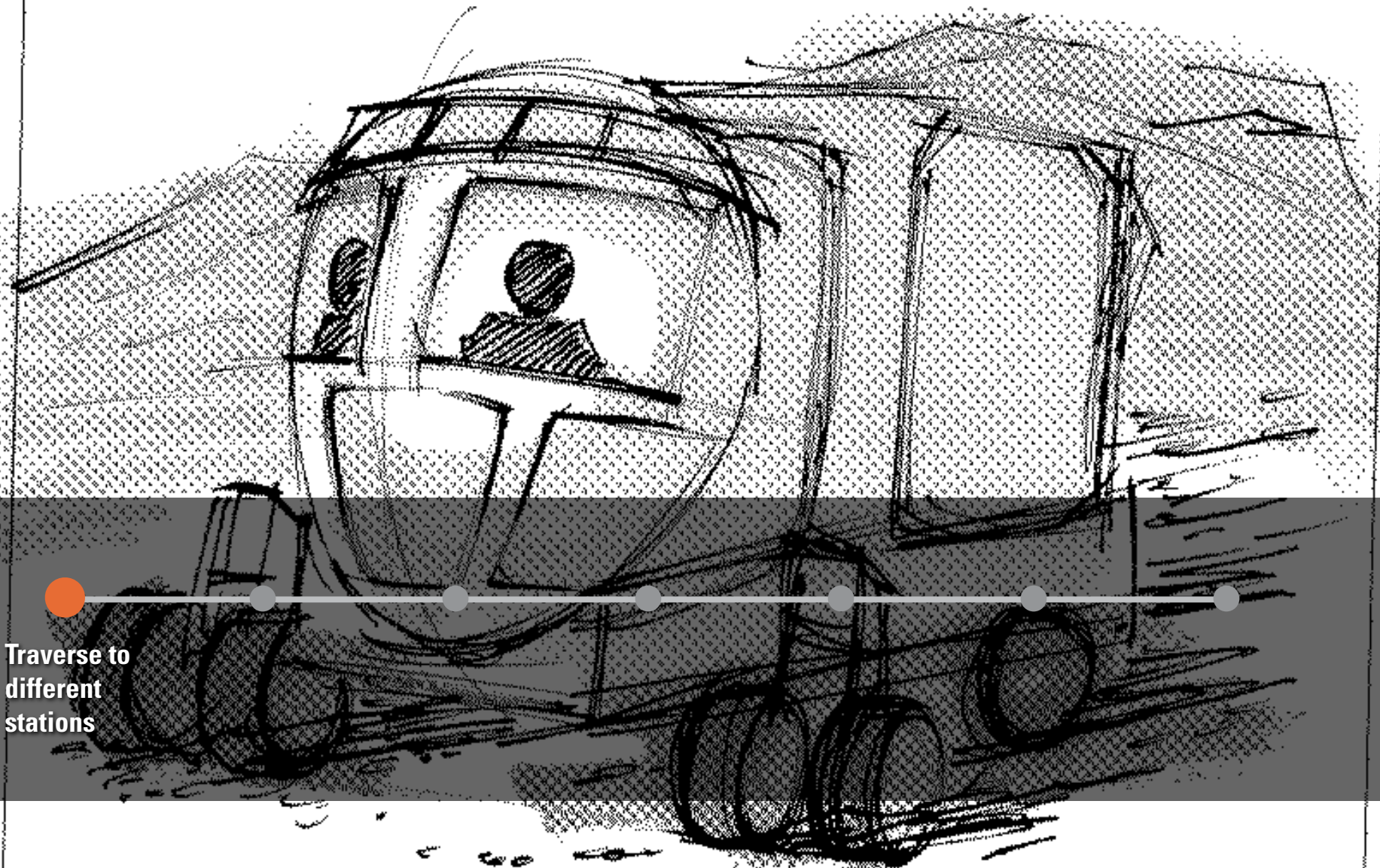
Explore planetary surfaces from vehicle

GOALS:

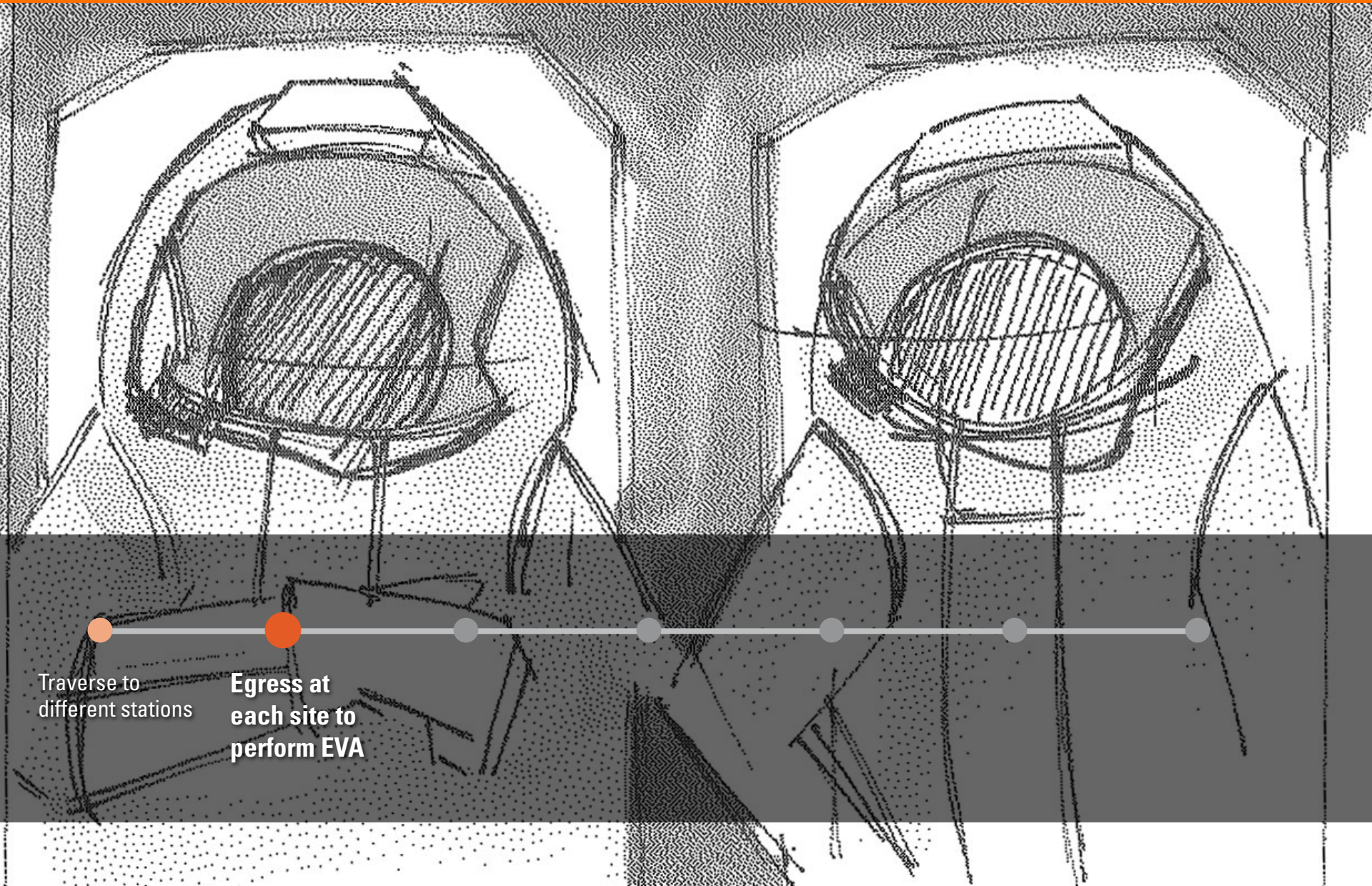
Help make new science discoveries

MISSION DAY OVERVIEW



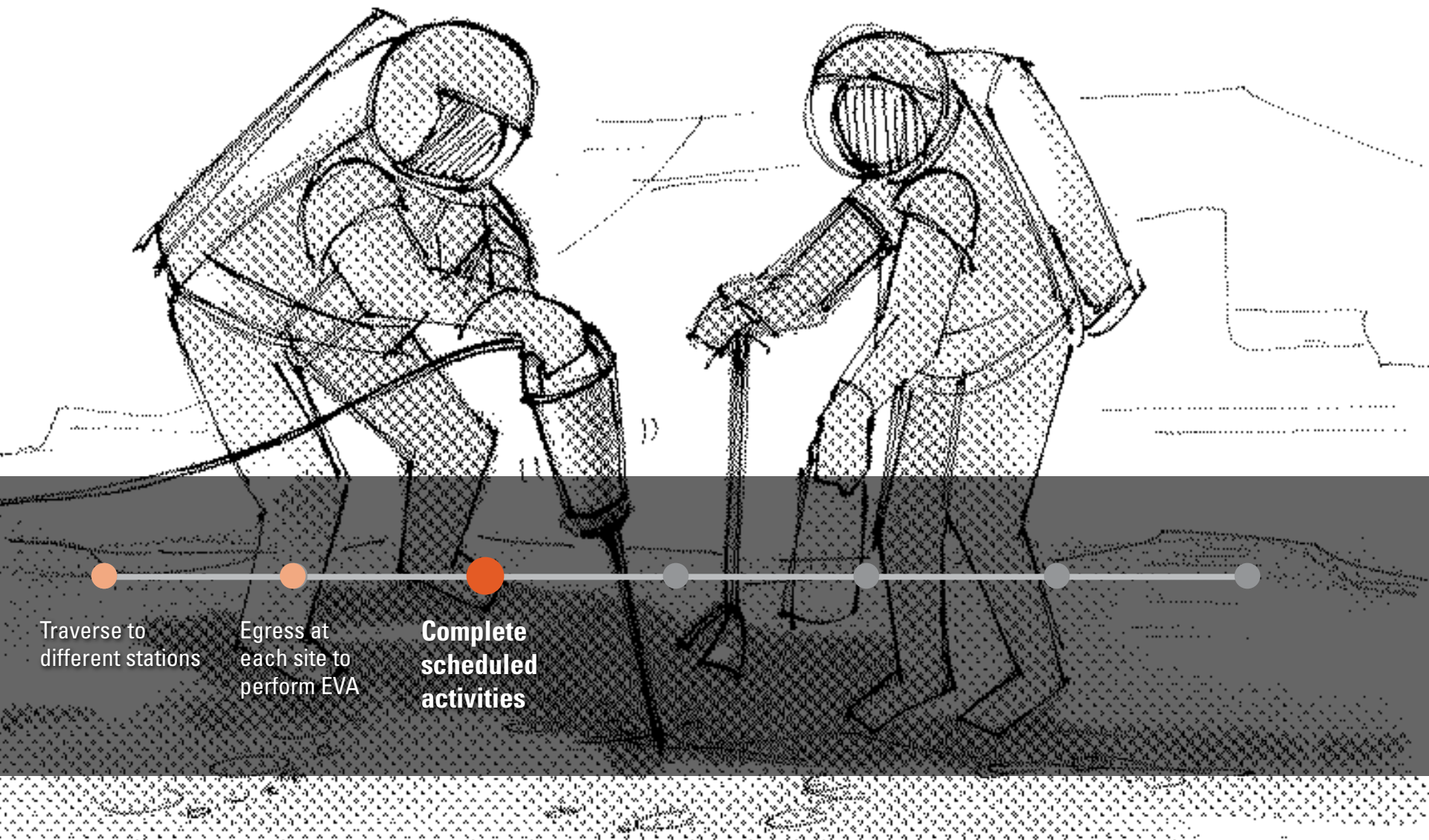


Traverse to
different
stations



● Traverse to different stations

● **Egress at each site to perform EVA**

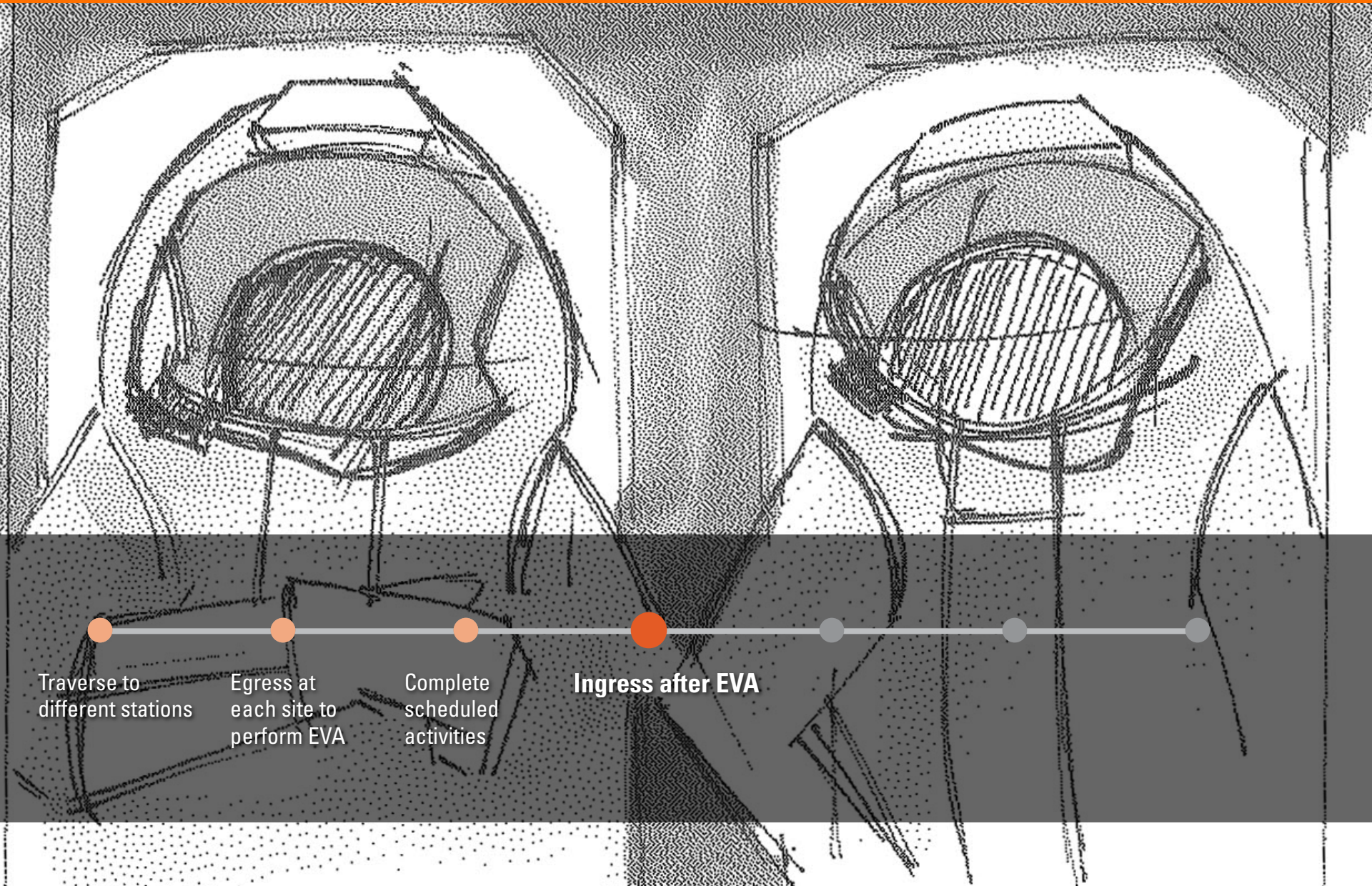


● Traverse to different stations

● Egress at each site to perform EVA

● **Complete scheduled activities**





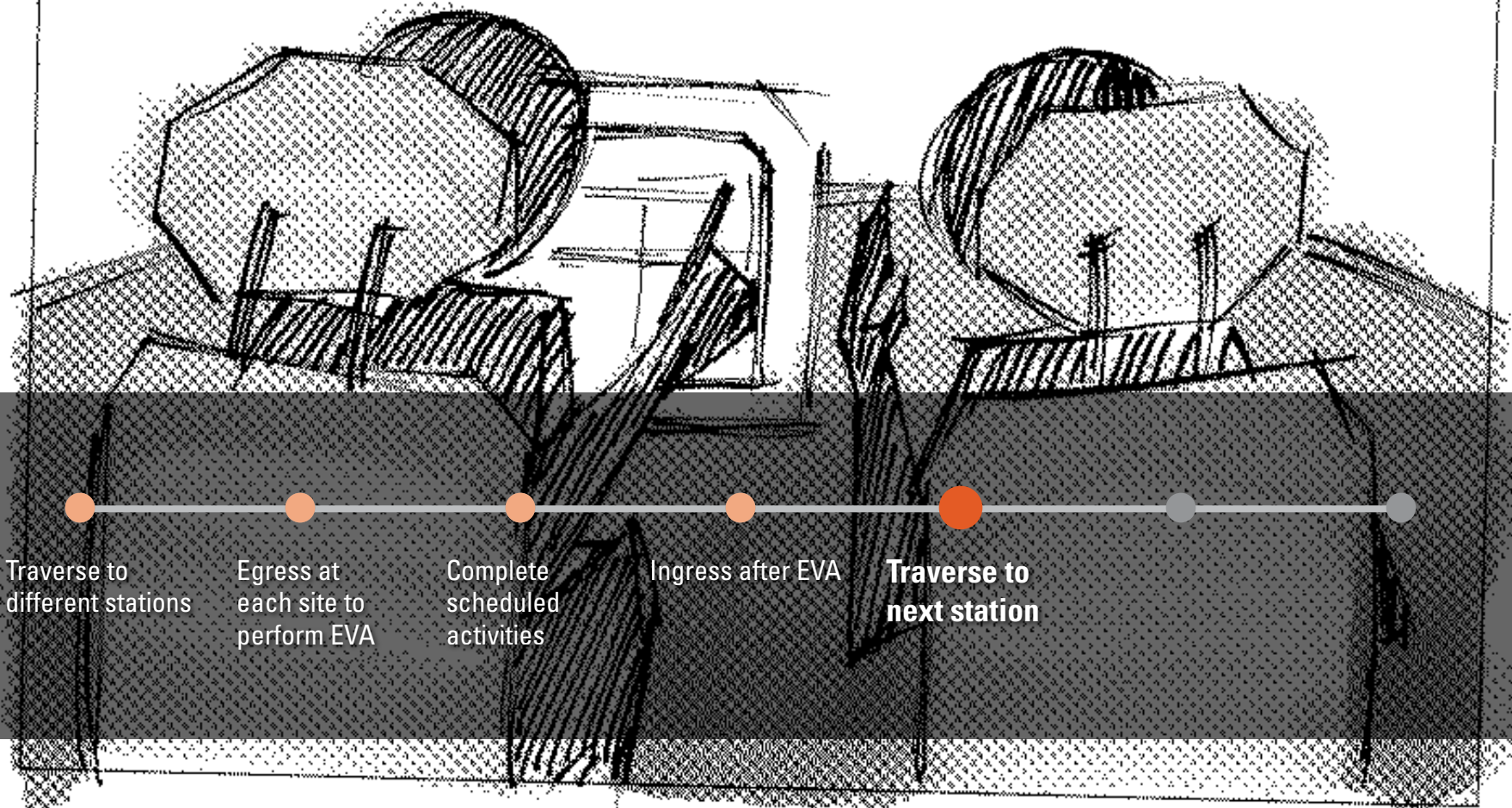
● Traverse to different stations

● Egress at each site to perform EVA

● Complete scheduled activities

● **Ingress after EVA**





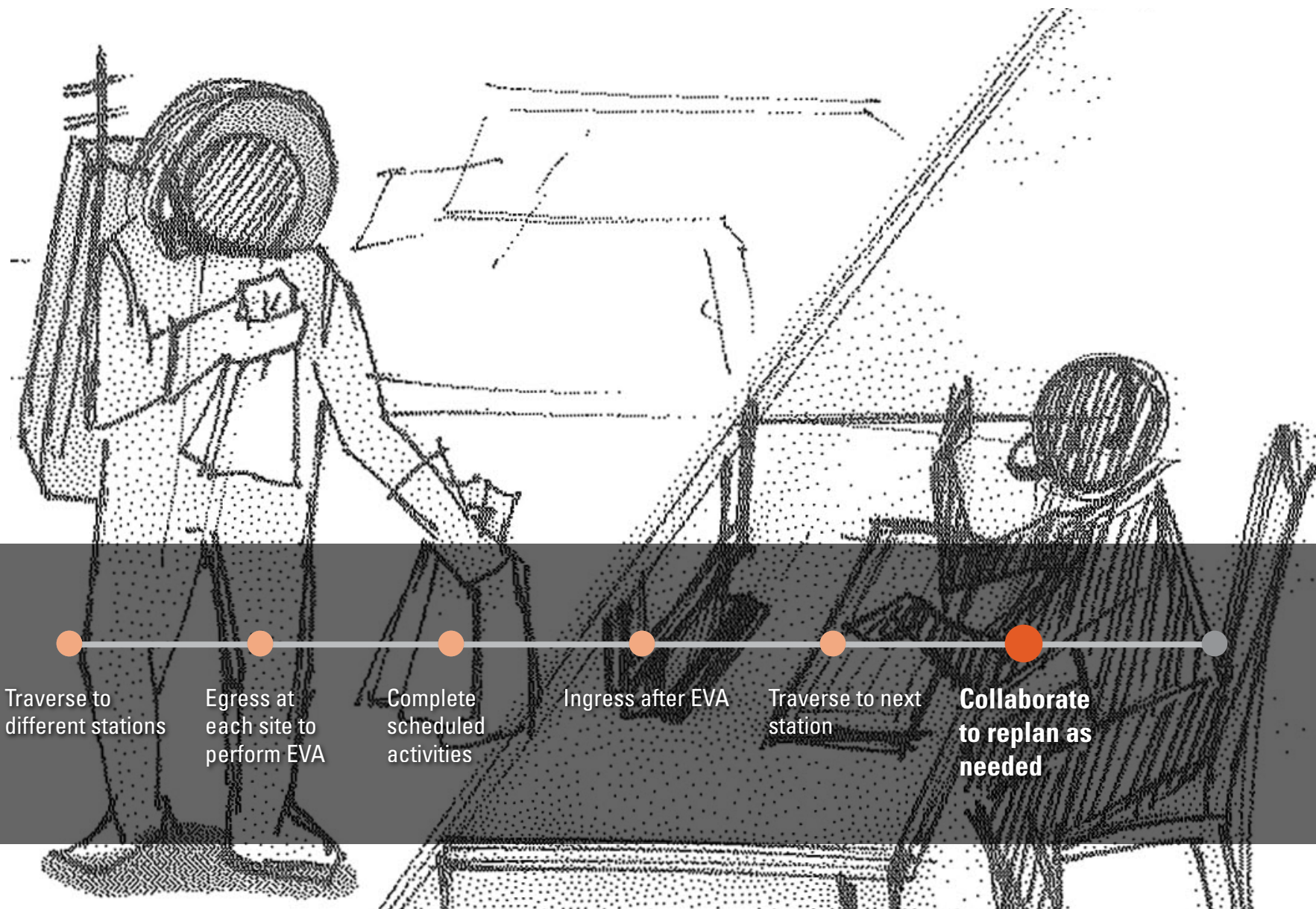
Traverse to
different stations

Egress at
each site to
perform EVA

Complete
scheduled
activities

Ingress after EVA

**Traverse to
next station**



Traverse to
different stations

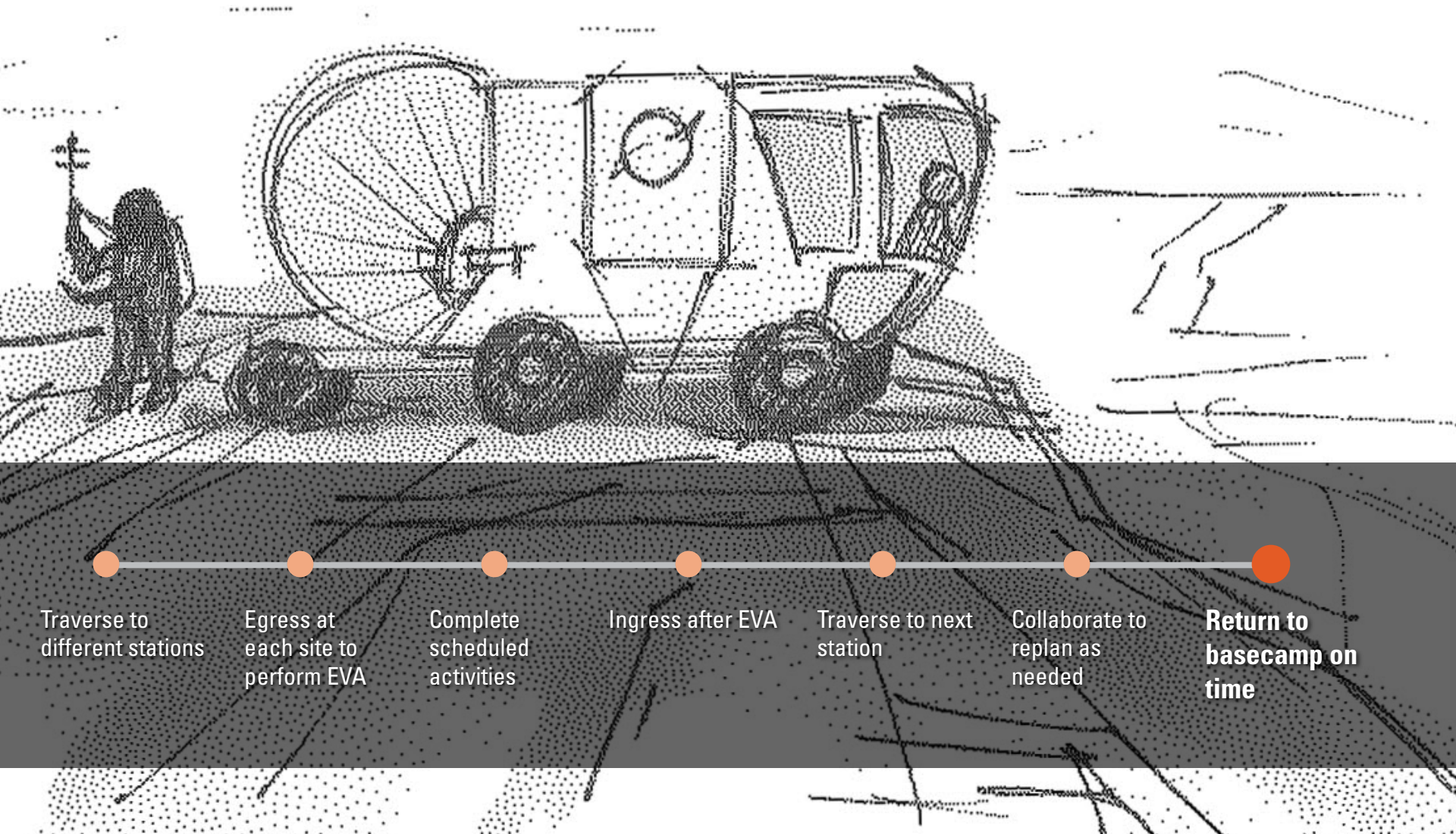
Egress at
each site to
perform EVA

Complete
scheduled
activities

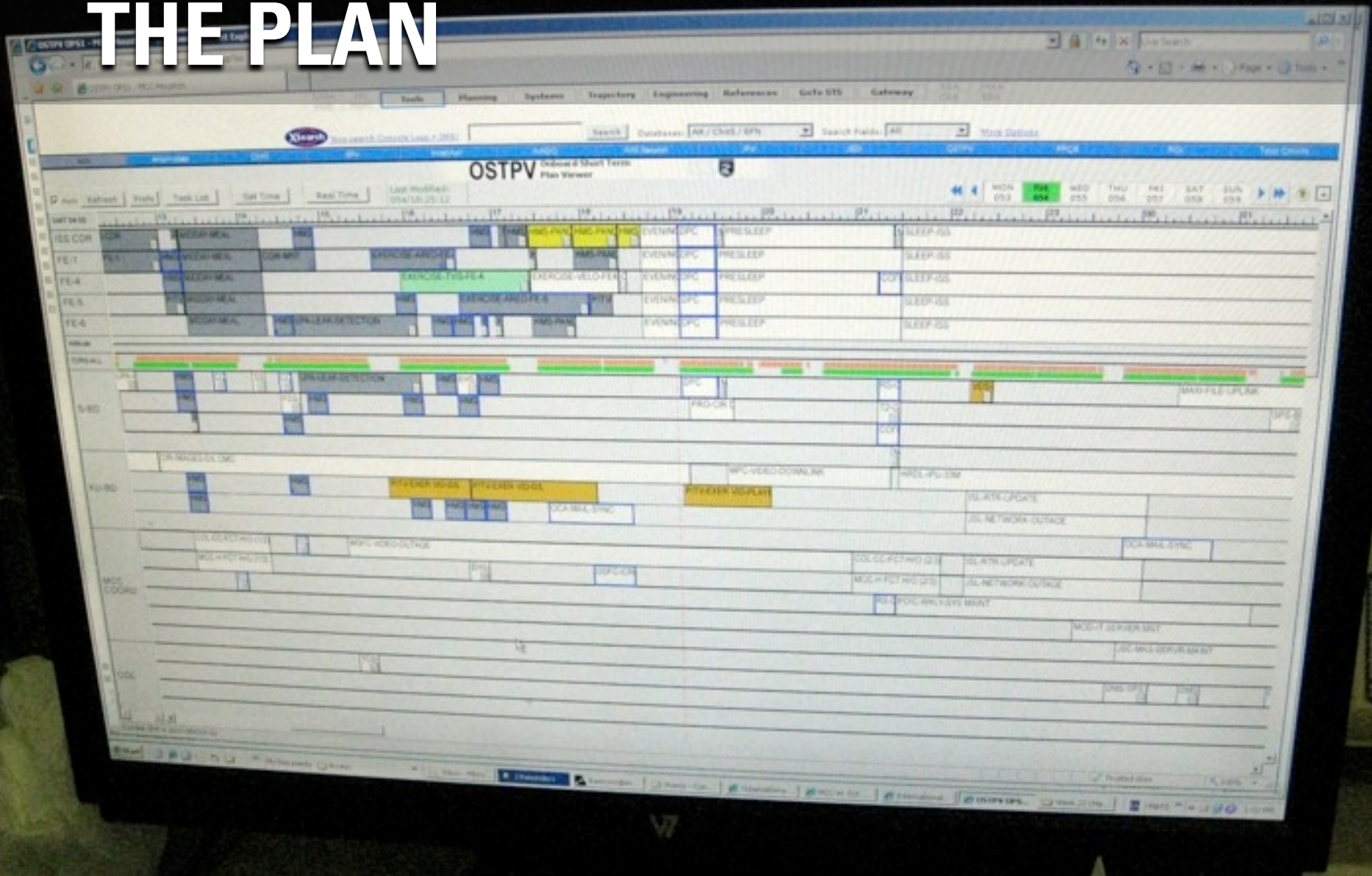
Ingress after EVA

Traverse to next
station

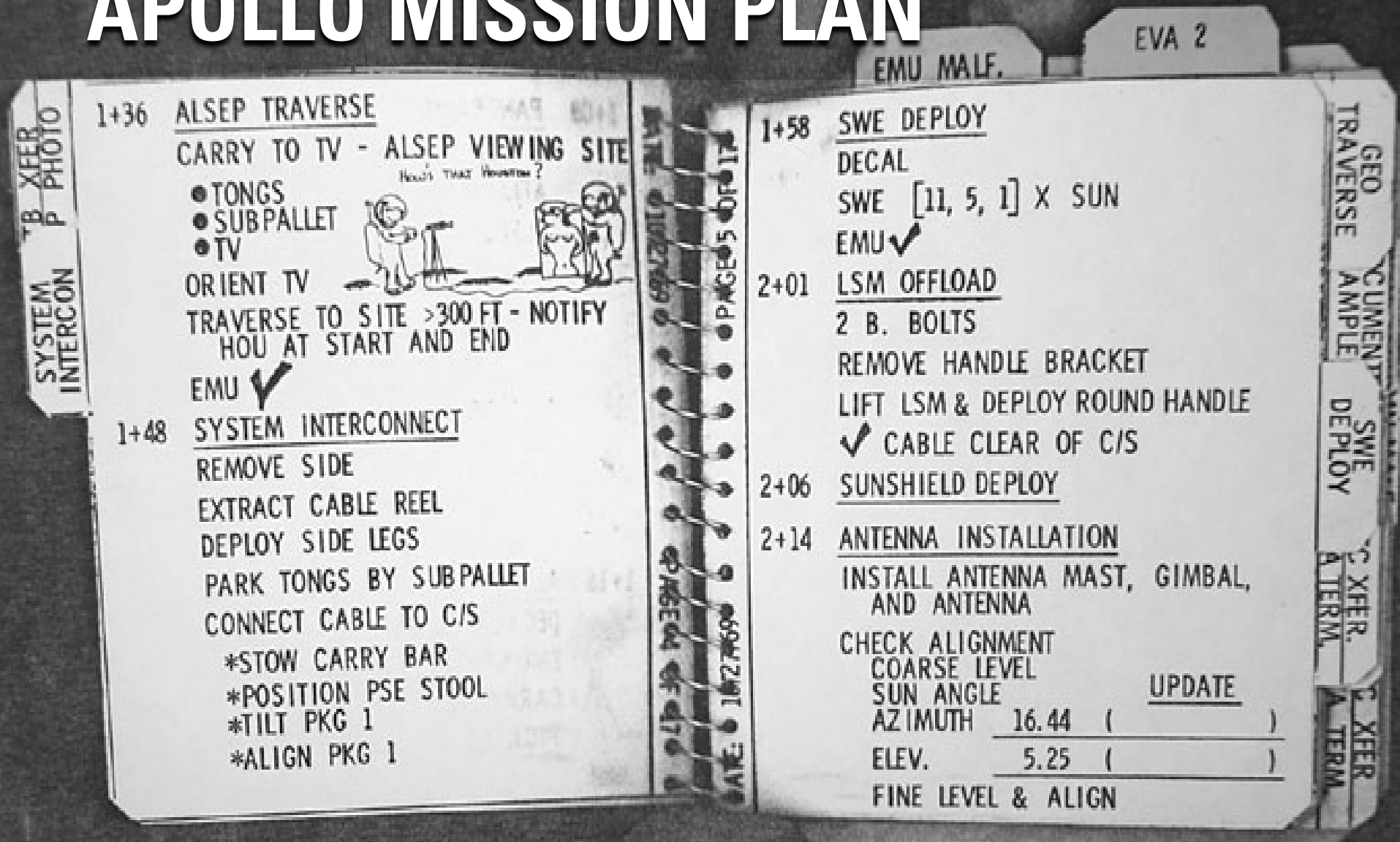
**Collaborate
to replan as
needed**

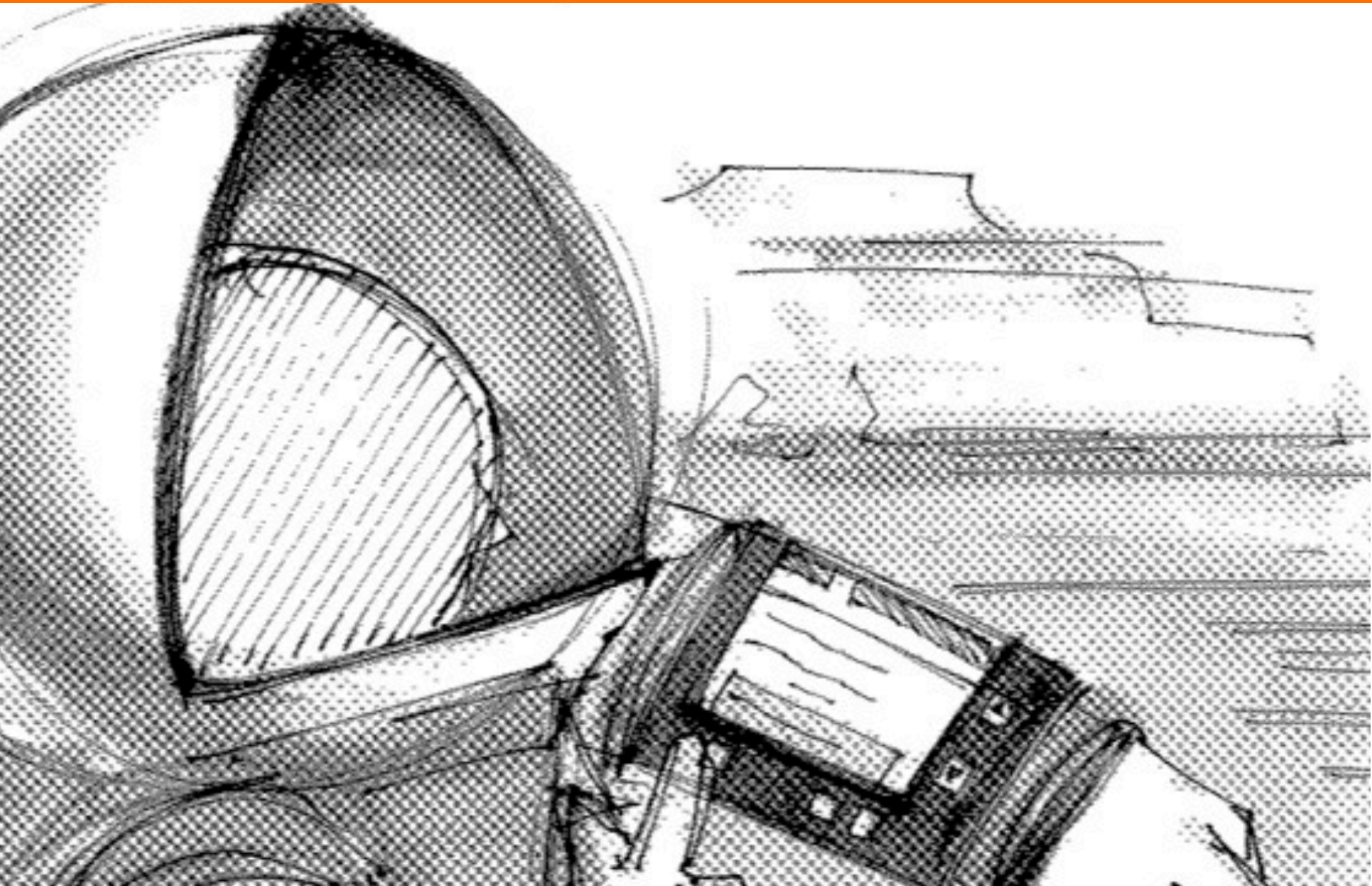


THE PLAN



APOLLO MISSION PLAN

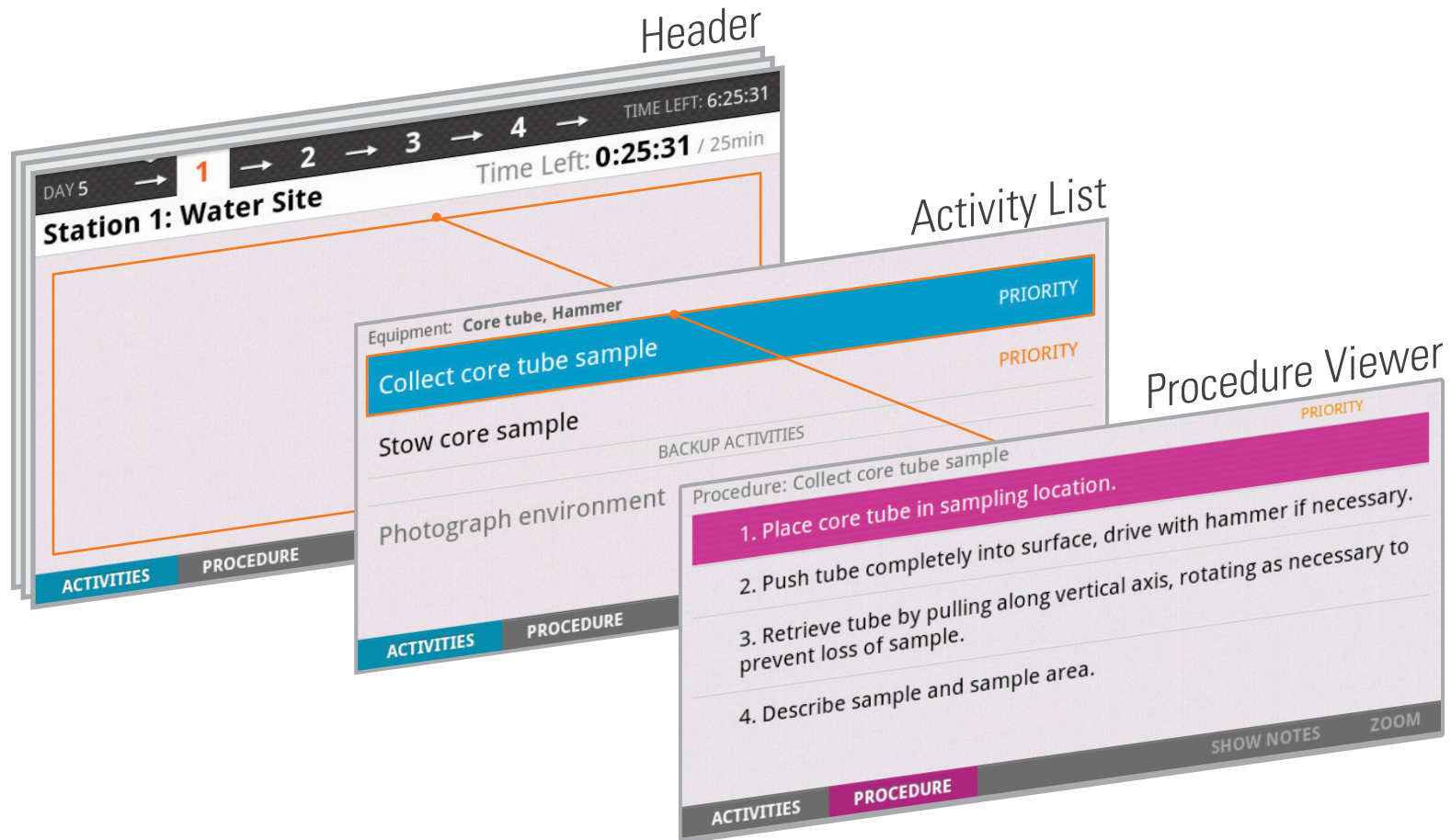


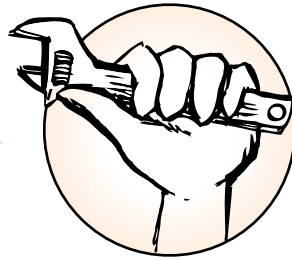




LuMo
Lumina MOBILE

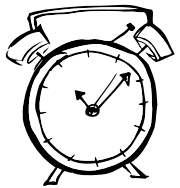
INFORMATION HIERARCHY





Timeline optimized for execution

! Single Representation of the Plan



Delta between plan and execution

! Inflexible Plans



Autonomy when appropriate

! Inflexible Plans



Glanceable and unobtrusive

! Single Representation of the Plan



Timeline optimized for execution





Timeline optimized for execution

Segmentation of day's plan

DAY 5 → 1 → 2 → 3 → 4 → TIME LEFT: 4:08:23

Station 2: Crater Time Left: **-0:01:37** / 30min

Equipment: Camera, Sample Collection Kit

Sample crater rim

Pan crater rim

Collect rock samples

BACKUP ACTIVITIES

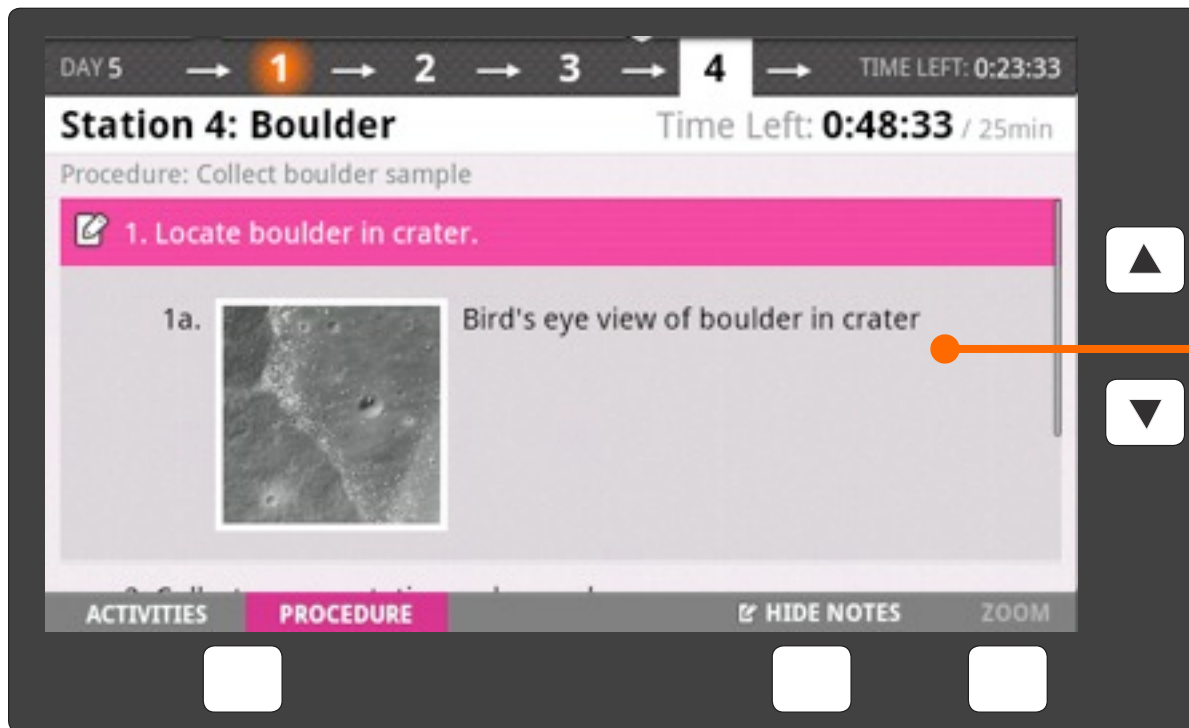
Trench 10min

ACTIVITIES PROCEDURE < PREV NEXT >



Timeline optimized for execution

Segmentation of day's plan



**Integrated
workflow**

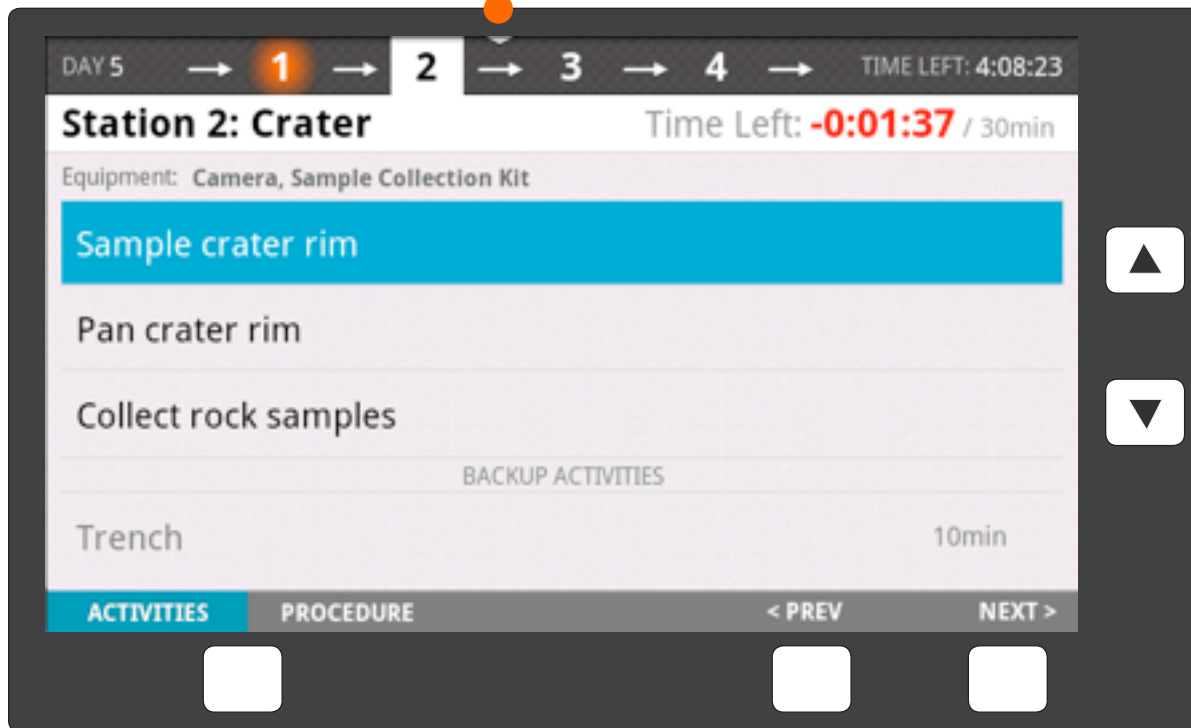


Delta between plan and execution



Delta between plan and execution

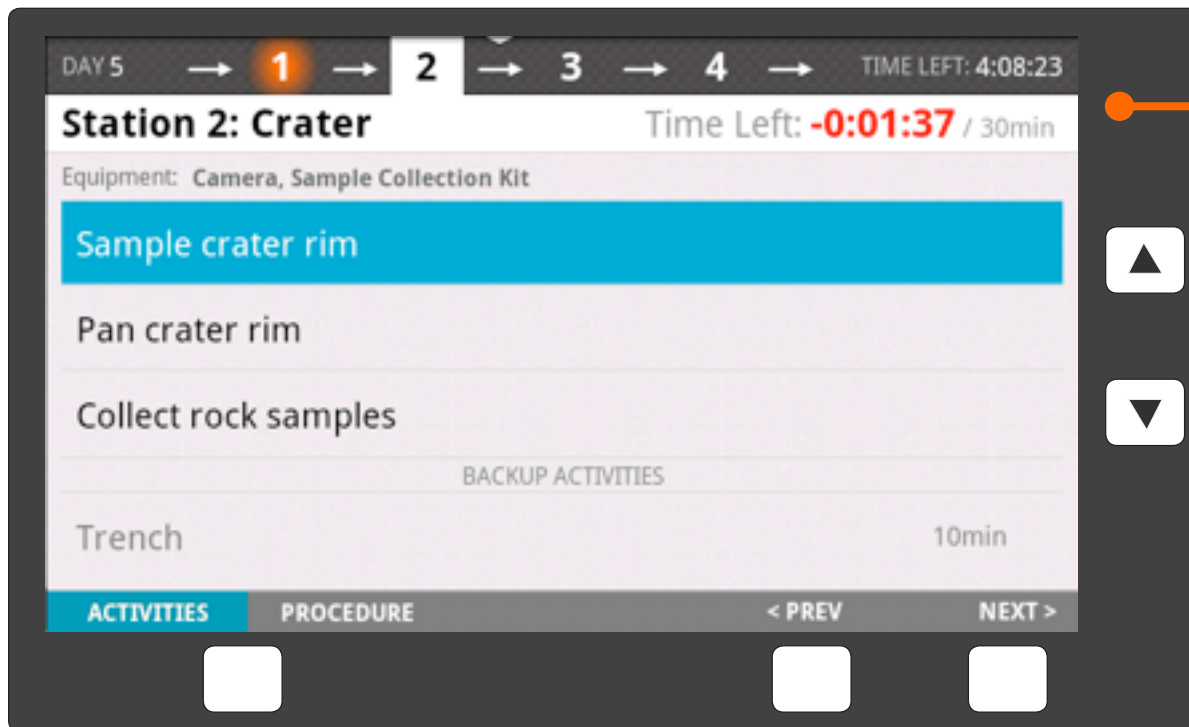
Marcus Bains Notch



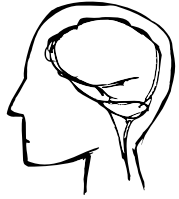


Delta between plan and execution

Marcus Bains Notch

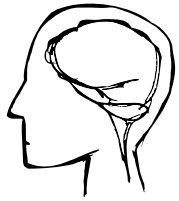


**Time Left:
Mission & Station**

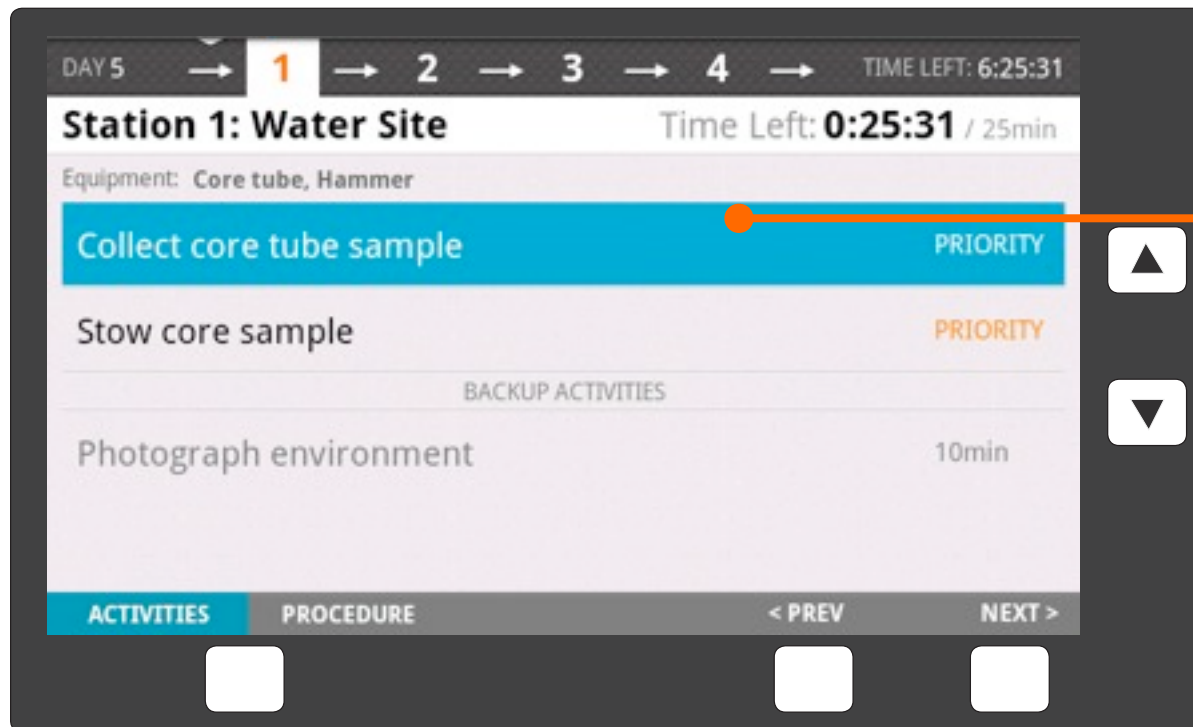


Autonomy when appropriate

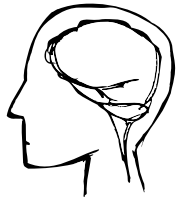




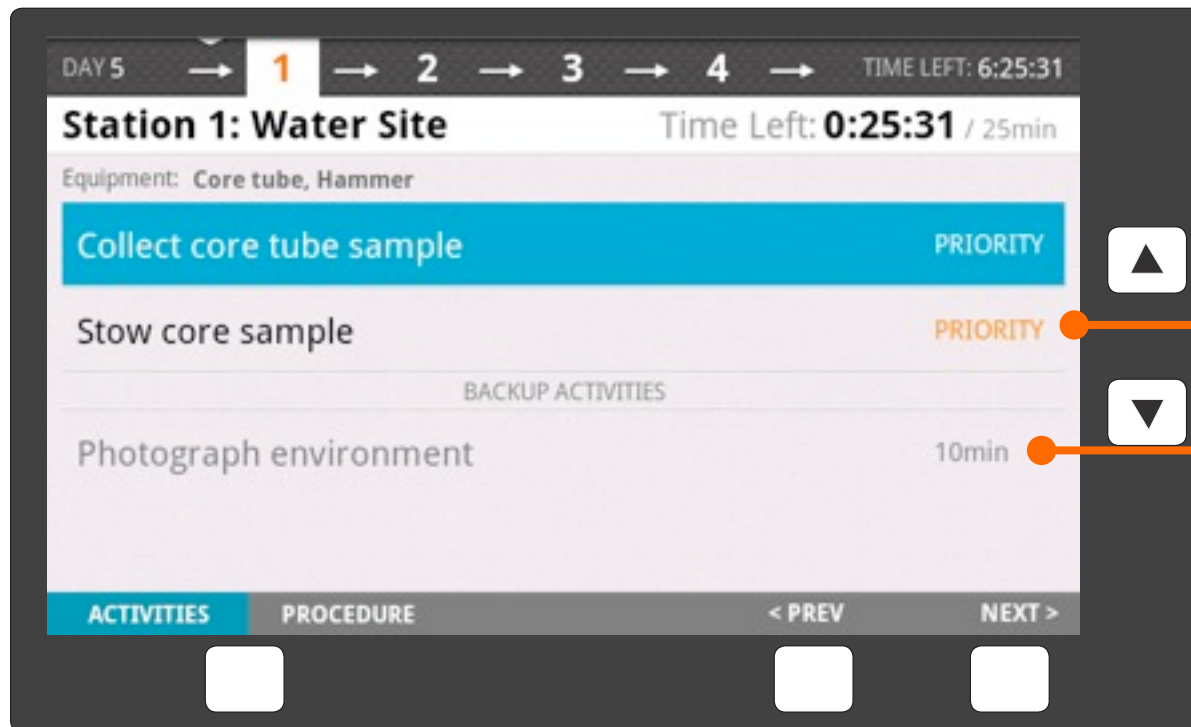
Autonomy when appropriate



**Not time
constrained**



Autonomy when appropriate



Not time
constrained

Prioritization

Backup Activities



Glanceable and unobtrusive





Glanceable and unobtrusive



**Large Text,
High Contrast**



Glanceable and unobtrusive



Large Text,
High Contrast

**No unnecessary
interactions**

BACKGROUND

DESIGN

DEMO

PROCESS

CONCLUSION

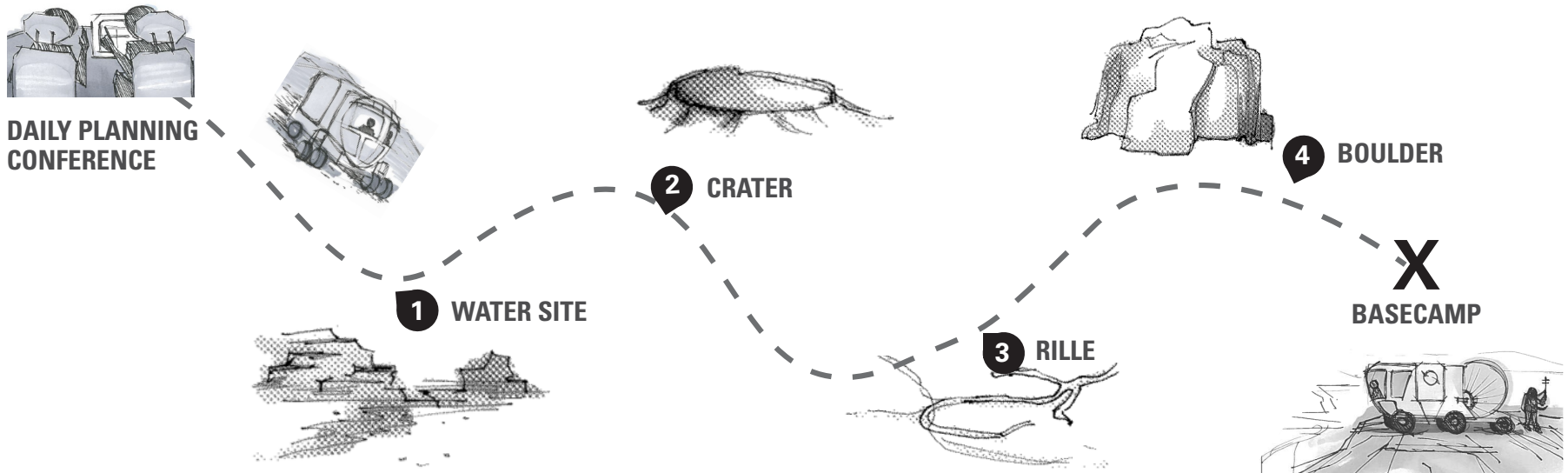


LUMo

Lumina MOBILE



MISSION DAY 5



Tim: Geologist Astronaut

Goal: Investigate water site

BACKGROUND

DESIGN

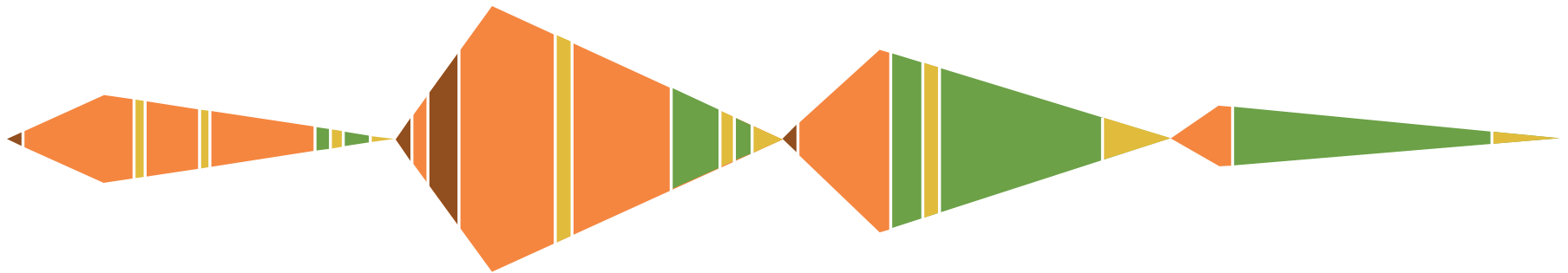
DEMO

PROCESS

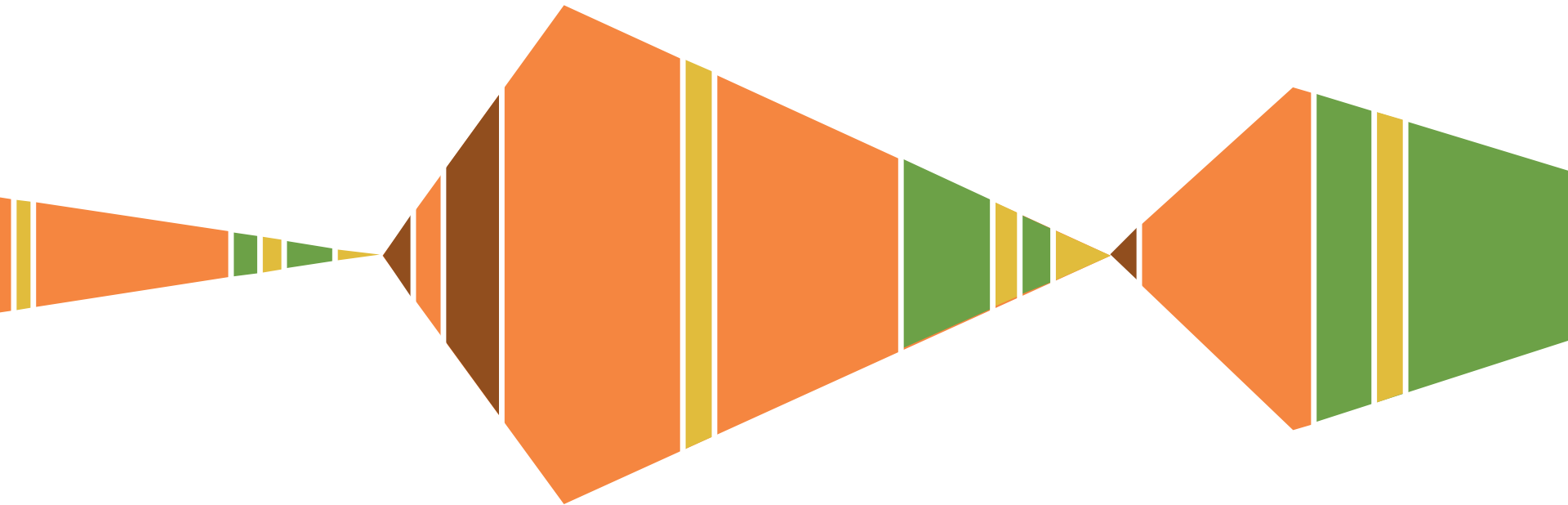
CONCLUSION



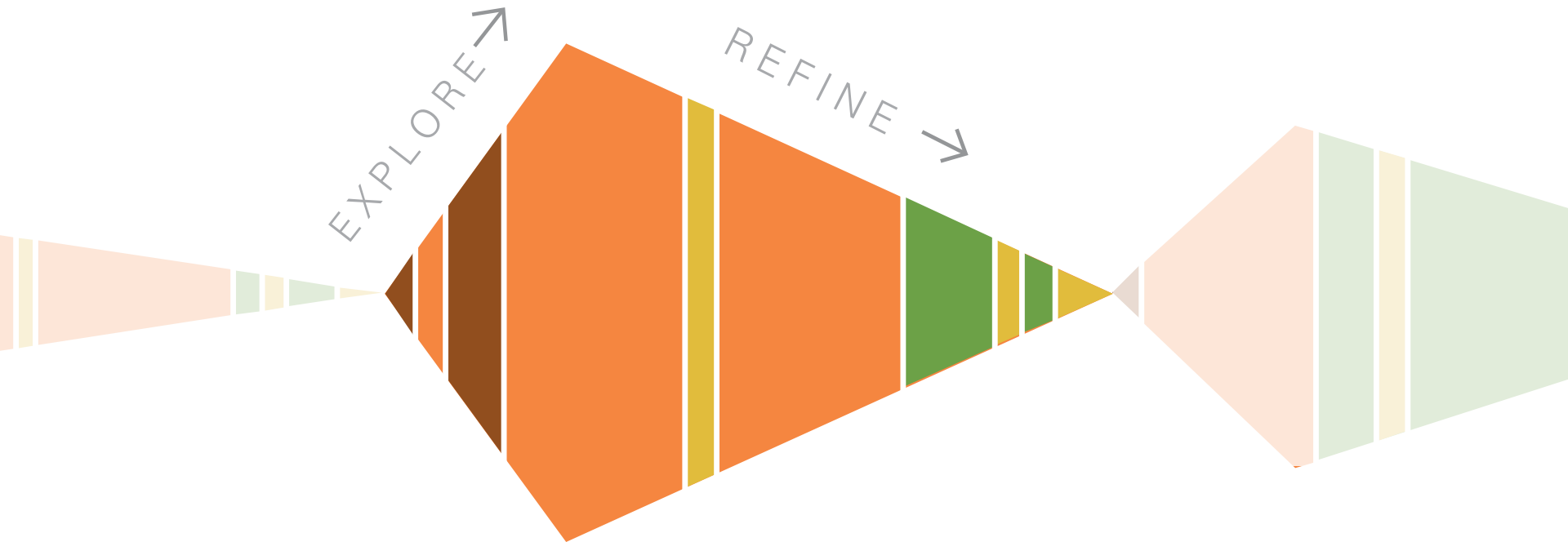
ITERATIVE DESIGN CYCLES



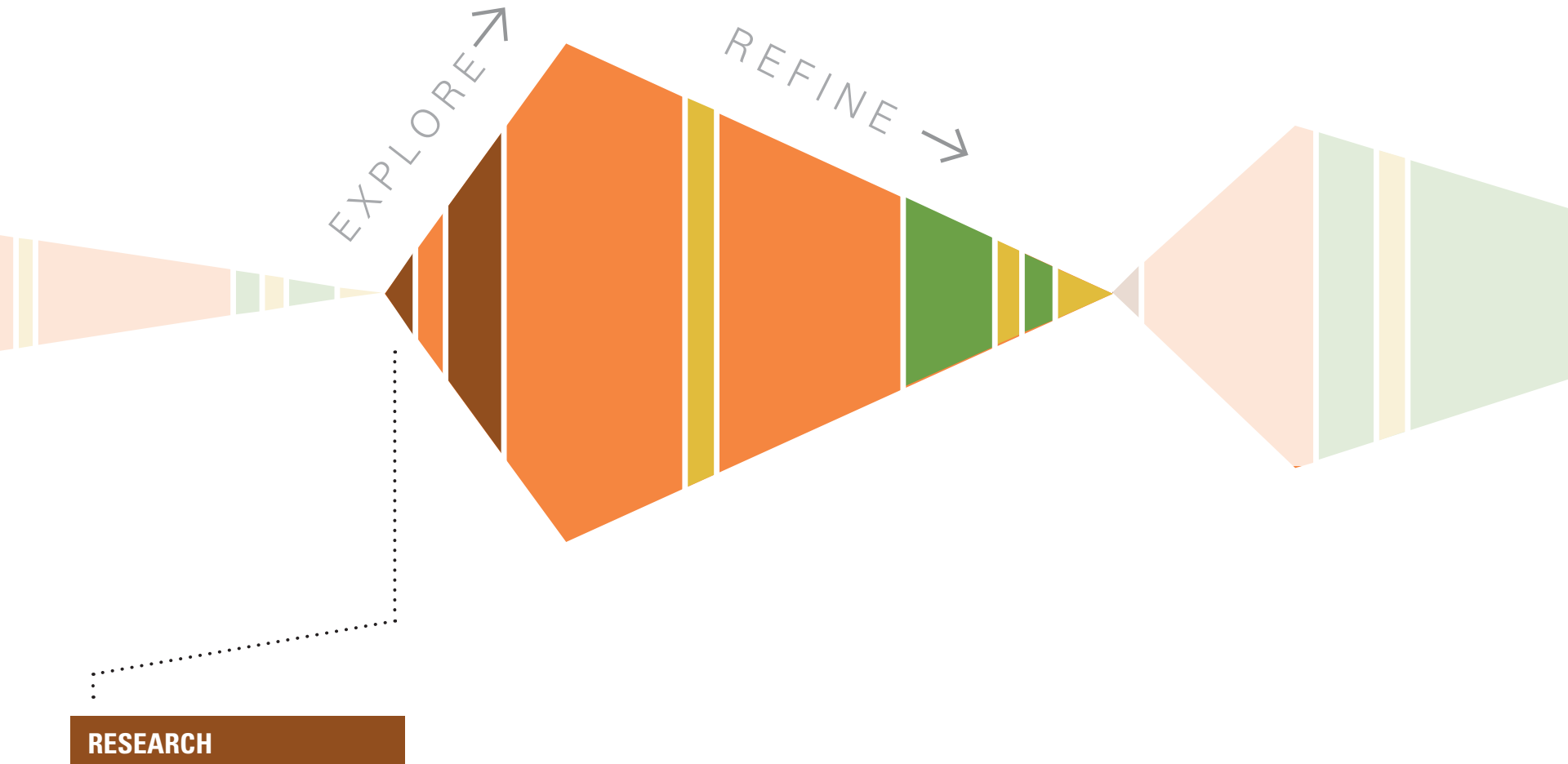
ITERATIVE DESIGN CYCLES



EXPLORE, THEN REFINE

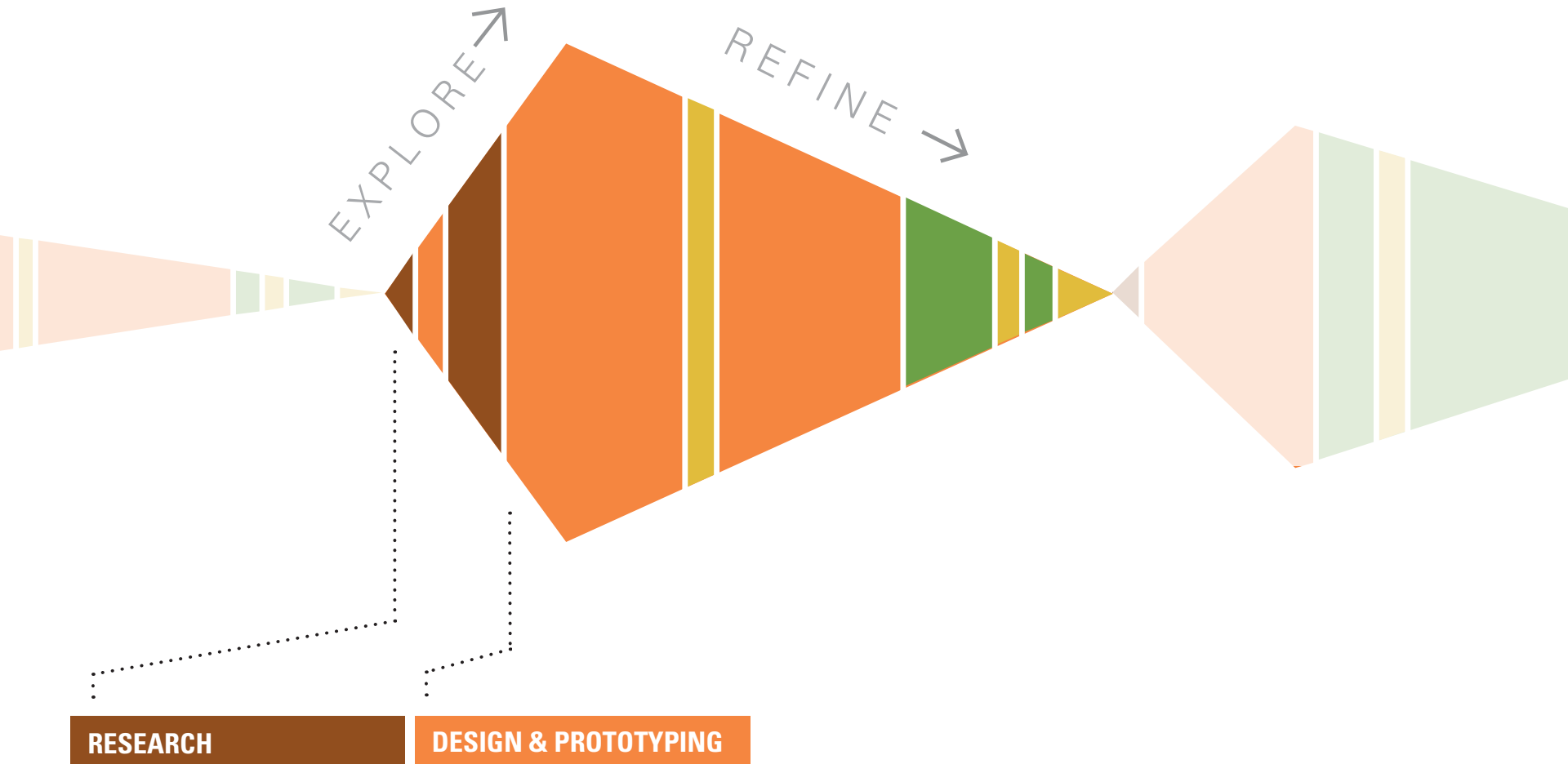


EXPLORE, THEN REFINE



RESEARCH

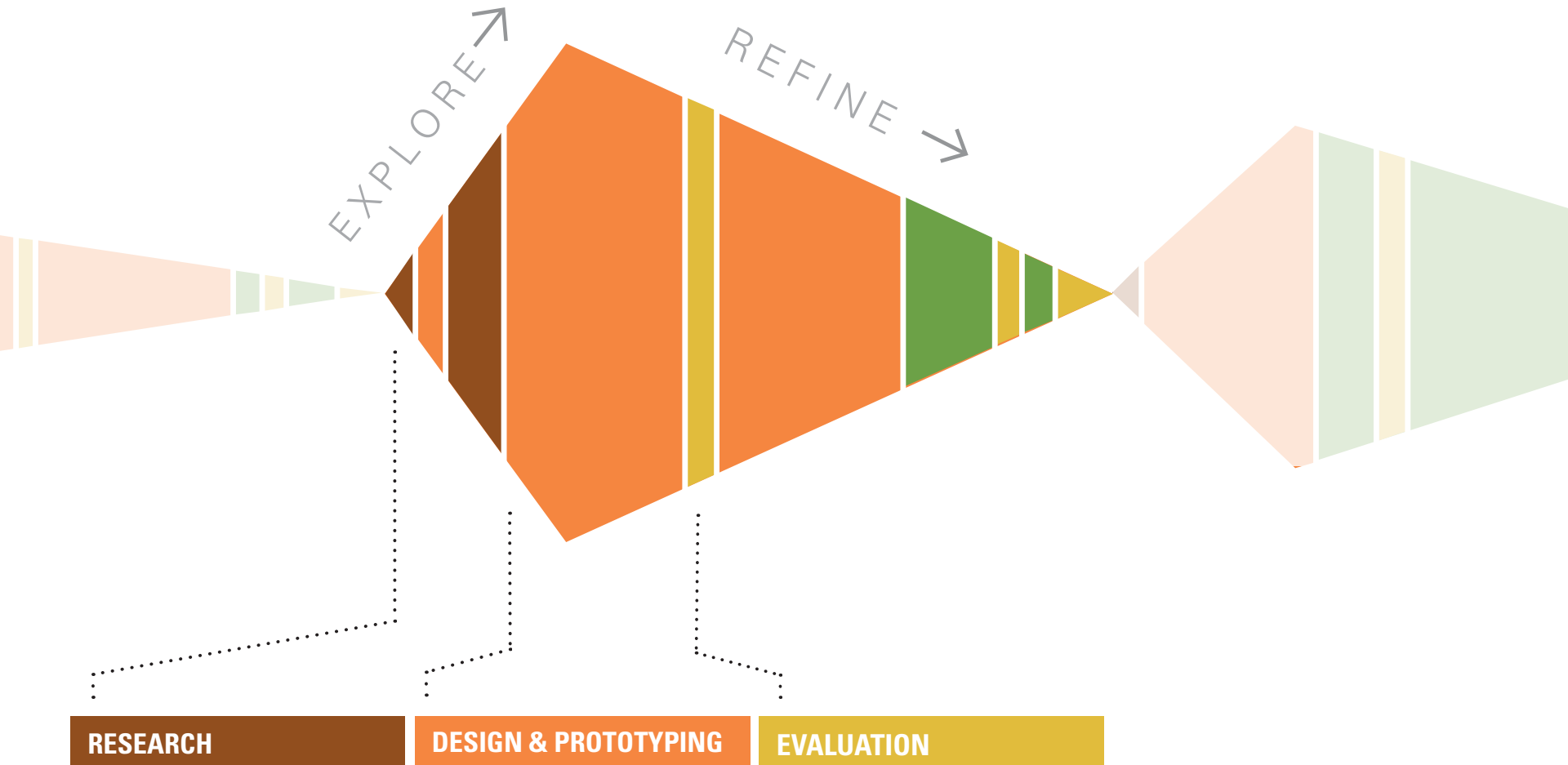
EXPLORE, THEN REFINE



RESEARCH

DESIGN & PROTOTYPING

EXPLORE, THEN REFINE

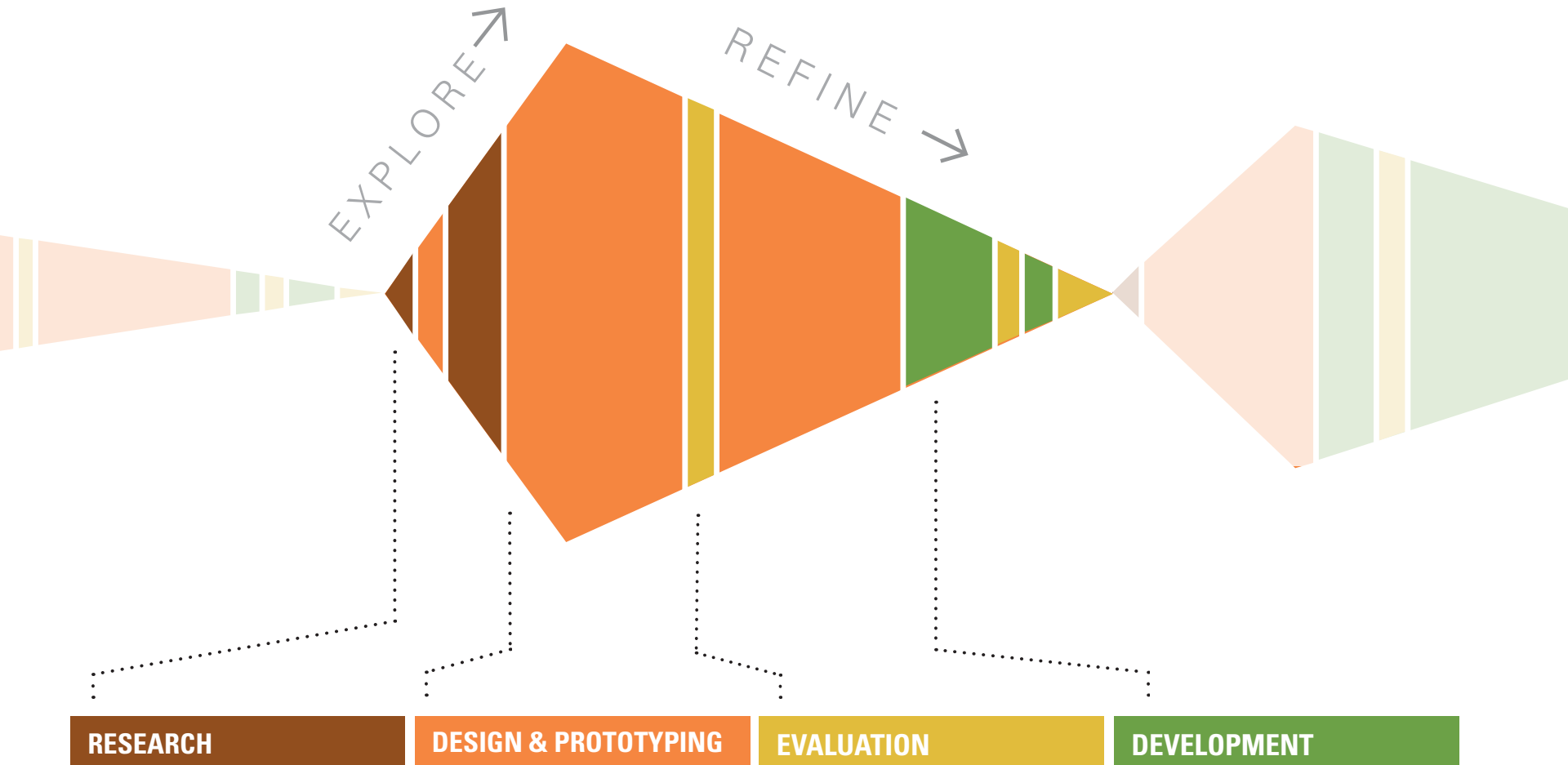


RESEARCH

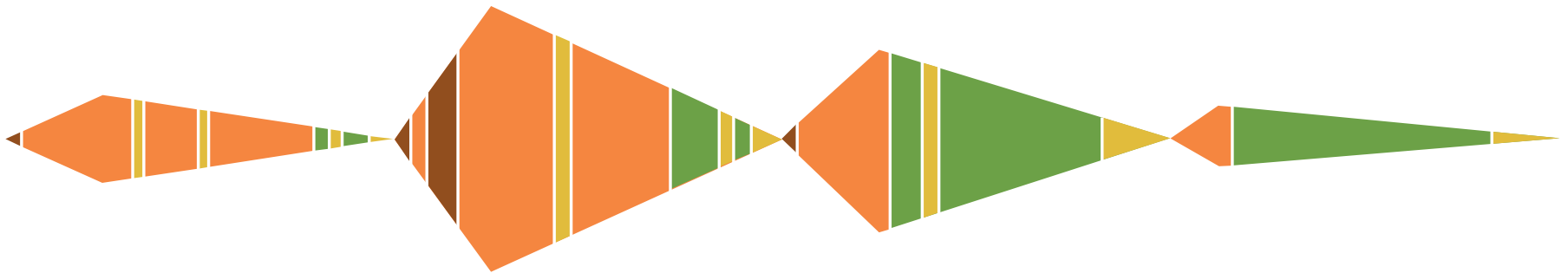
DESIGN & PROTOTYPING

EVALUATION

EXPLORE, THEN REFINE



EXPLORE, THEN REFINE



RESEARCH

DESIGN & PROTOTYPING

EVALUATION

DEVELOPMENT

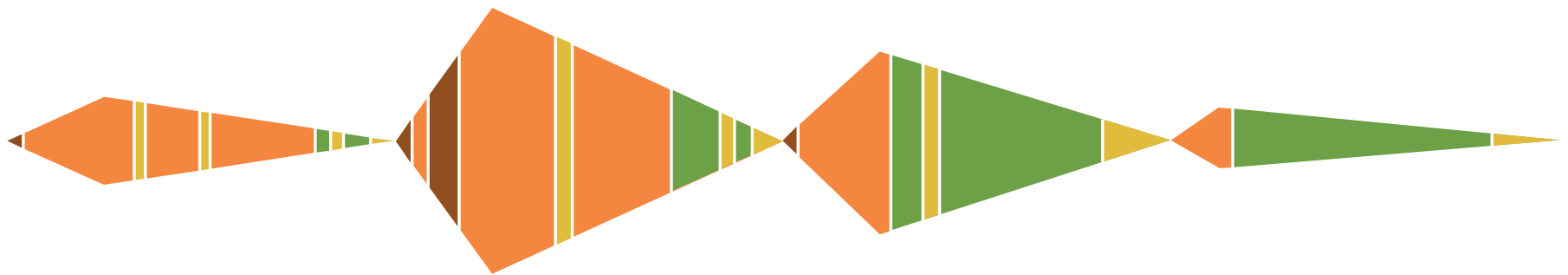
EXPLORE, THEN REFINE (RINSE & REPEAT)

FIRST ITERATION

SECOND ITERATION

THIRD ITERATION

FINAL ITERATION



EARLY SUMMER

Research, Design & Prototyping

LATE SUMMER

Development & Evaluation

RESEARCH

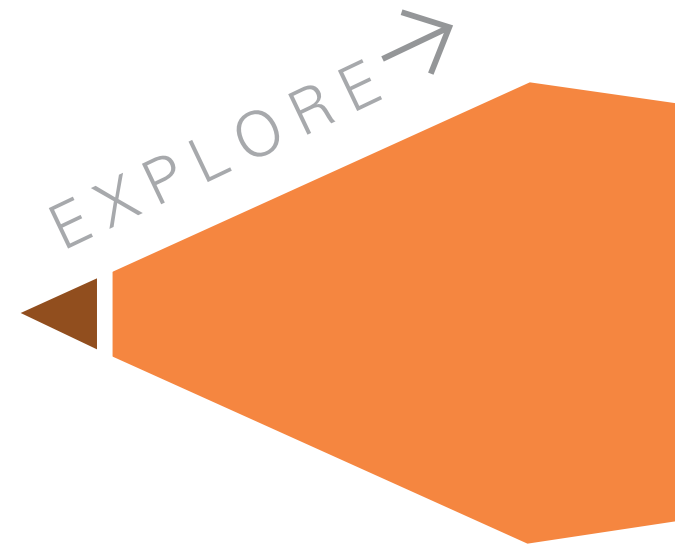
DESIGN & PROTOTYPING

EVALUATION

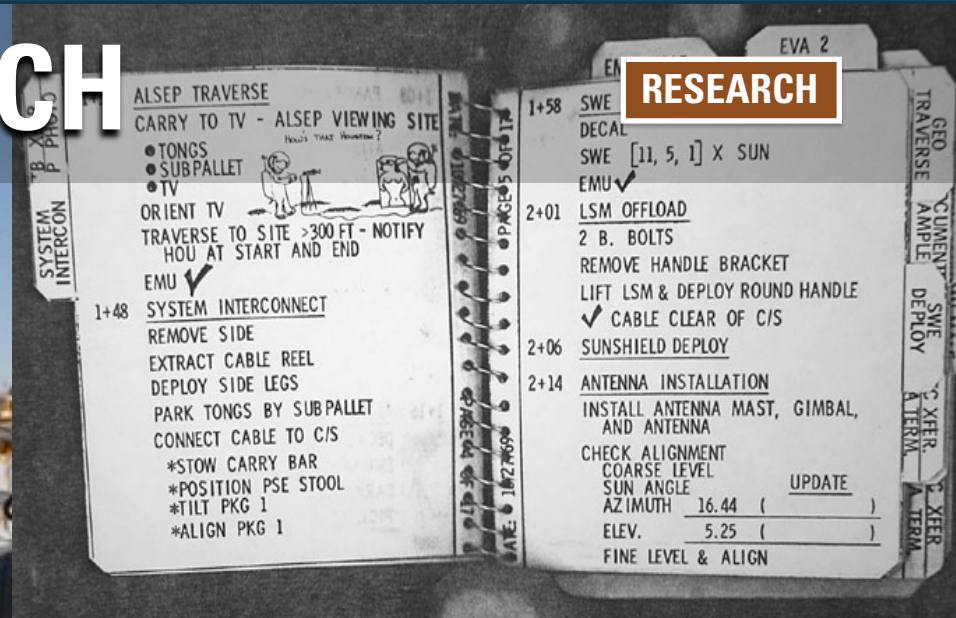
DEVELOPMENT

EXPLORATION METHODS

Domain Research	RESEARCH
Metaphors	DESIGN & PROTOTYPING
Brainstorm	DESIGN & PROTOTYPING
Bodystorm	DESIGN & PROTOTYPING
Lo-Fi Sketches	DESIGN & PROTOTYPING



DOMAIN RESEARCH



Desert RATS, Paper & Electronic Cuff Checklist

METAPHORS

DESIGN & PROTOTYPING

TOOLS

- GETAWAY CAR
- GLOVES
- ACCOMPLICE
- SPARE VIDEO TAPE FOOTAGE
- GUN
- VOICE MODULATOR

COM

RESOURCES & CONSTRAINTS

- JUST ENOUGH INFO
- TIME - MAX TIME
- REACT QUICKLY
- BACKUP PLAN
- BATS

ROBBING A BANK

3RD DATE

- LIP GLOSS
- GUM
- PEPPERSPRAY
- BACKUP PLAN
- FRIEND CALL
- KILL PLAN
- BATS / CREDIT
- CAR

Summary

- BODY LANGUAGE
- CONVO TOPICS
- AVOID RELIGION & POLITICS
- PREVIOUS DATES
- INSIDE JOKE
- NEXT DATE
- MONEY
- GAS
- RESERVATIONS
- ENERGY
- MEMORY
- CASH
- TIME

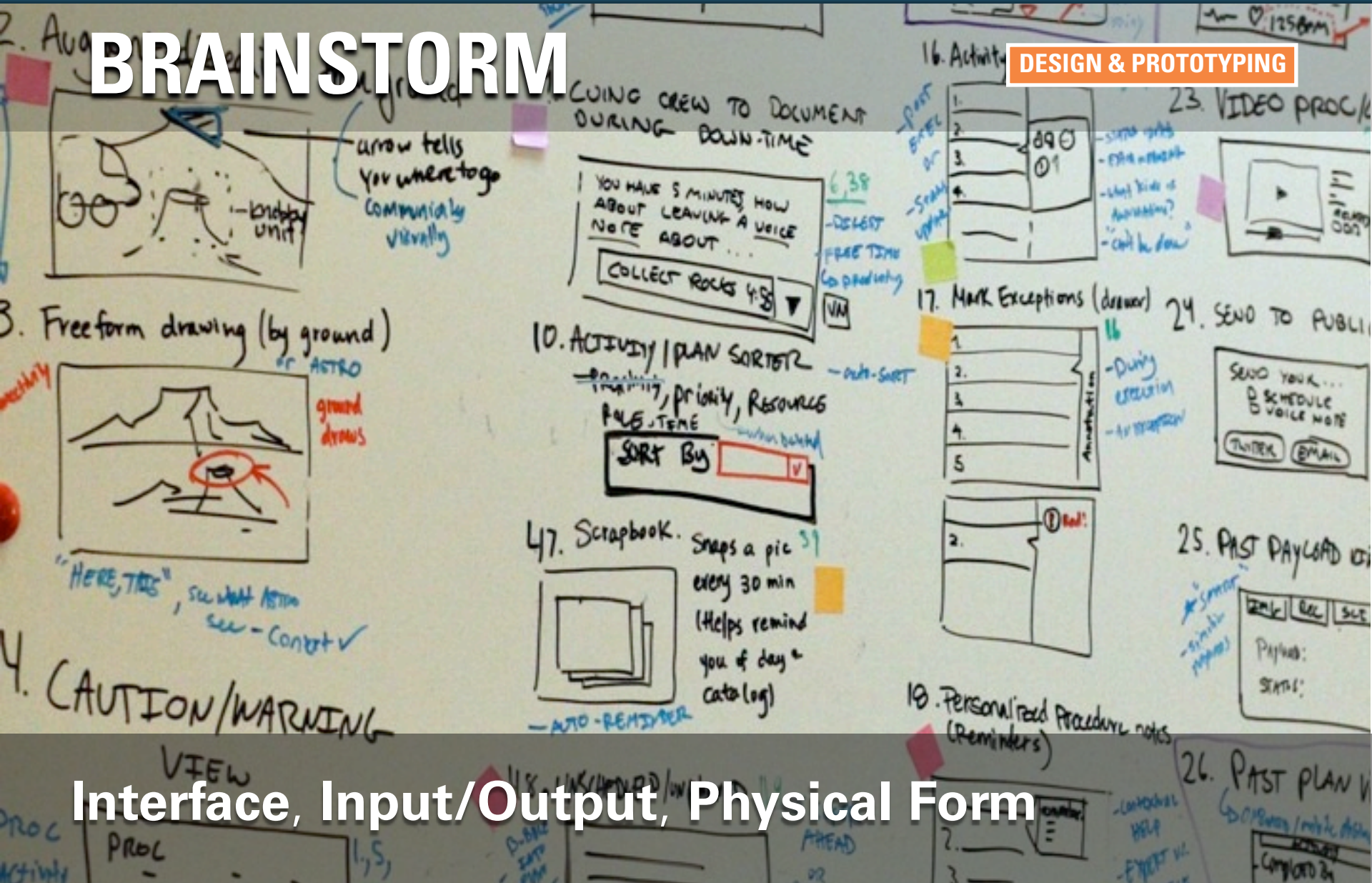
PLAN

- HANDLE UNFORESEEN
- SAVED
- Step by Step
- DINNER RESERVATIONS
- PICKUP/DROP OFF
- PAYLOAD
- BODY
- PERSON
- ASK ST

Explore planning and execution parallels:
Robbing a bank, Football play, Third date

BRAINSTORM

DESIGN & PROTOTYPING



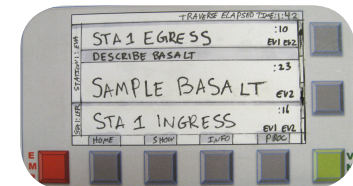
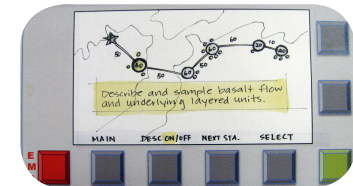
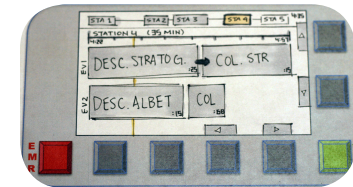
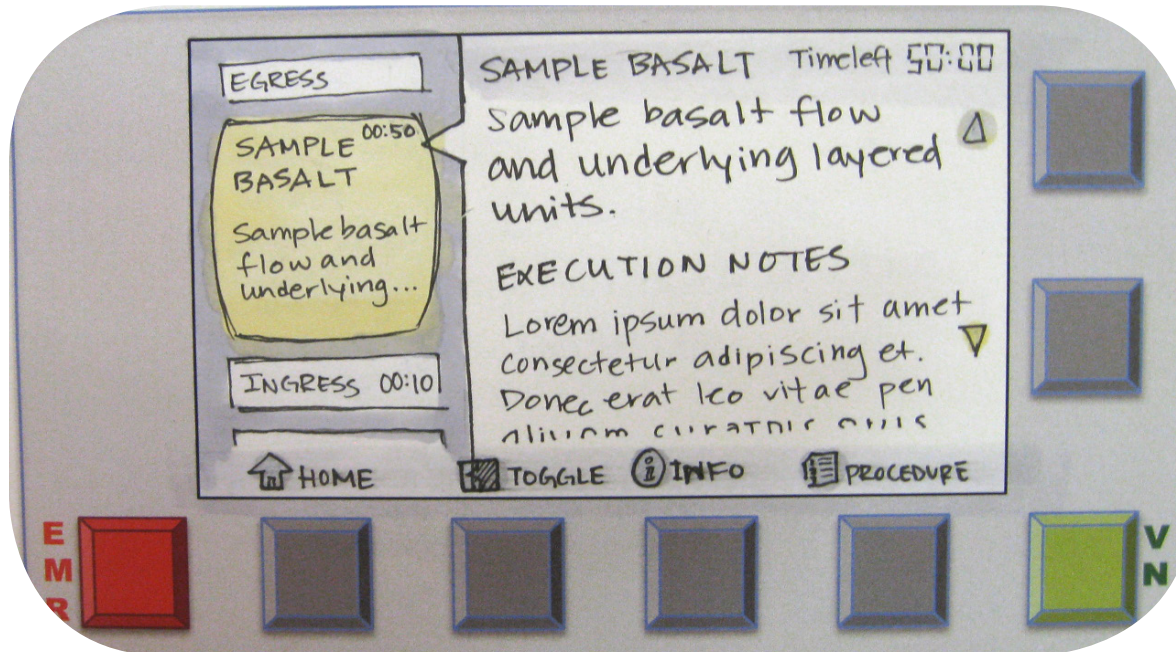
BODYSTORM

DESIGN & PROTOTYPING

Experienced physical constraints:
Motorcycle safety gear

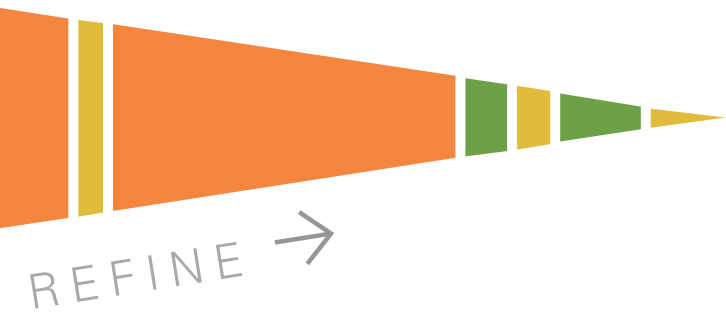
LO-FI SKETCHES

DESIGN & PROTOTYPING



Non-Interactive, Used for Speed Dating:
Split View, Station Centric, Bar Chart, Paper Towel

REFINEMENT METHODS



Speed Dating

EVALUATION

Mid-Fi Wireframes

DESIGN & PROTOTYPING

Think Alouds

EVALUATION

Hi-Fi Prototypes

DEVELOPMENT

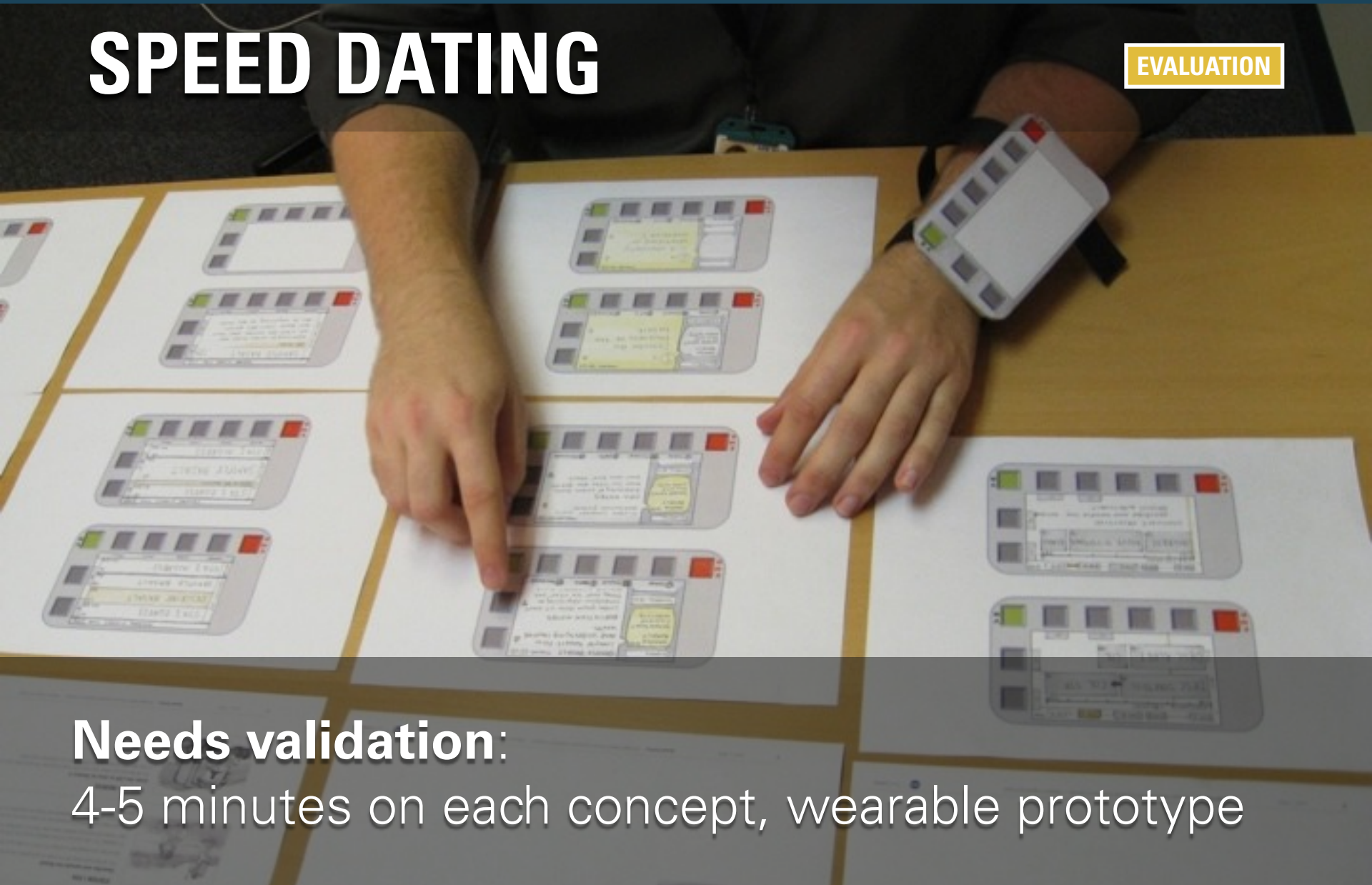
ORT

EVALUATION

Operational Readiness Test

SPEED DATING

EVALUATION

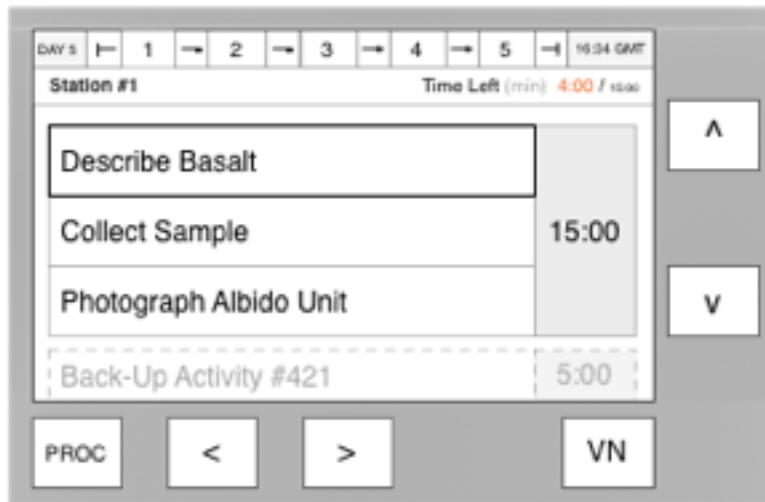


Needs validation:

4-5 minutes on each concept, wearable prototype

MID-FI WIREFRAMES

DESIGN & PROTOTYPING



Interactive, Used for shared understanding
 Helped for quick and simple Think Alouds

THINK ALOUDS

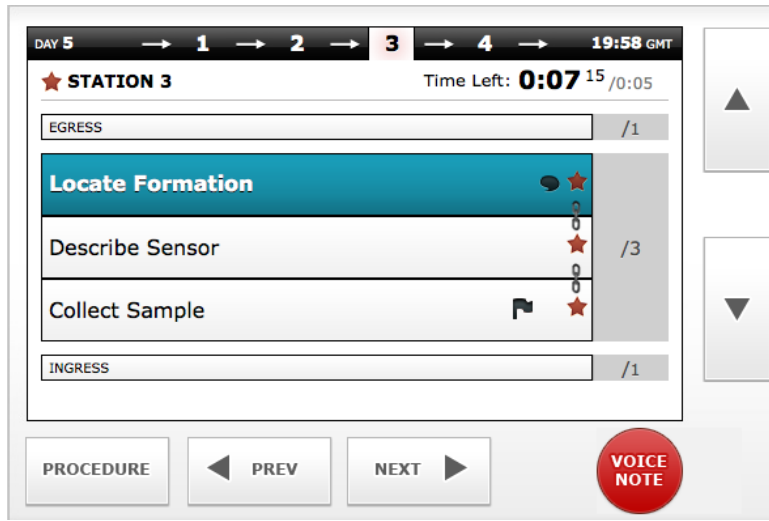
EVALUATION

Interaction exploration:

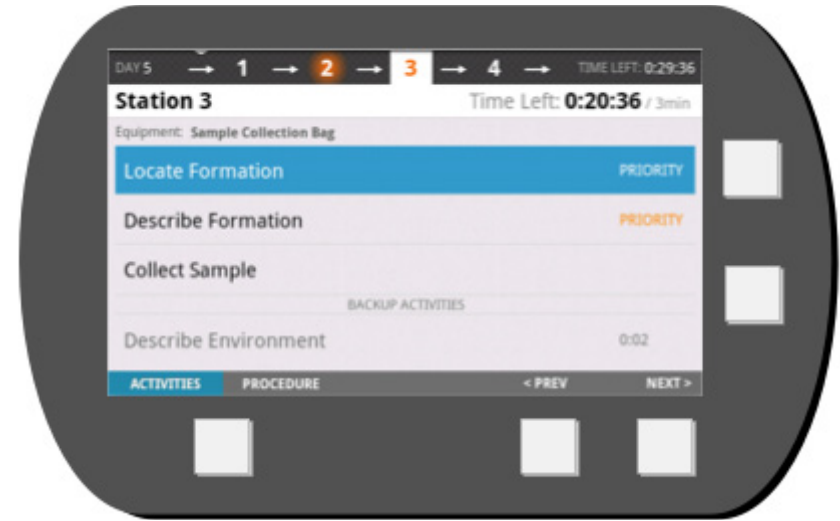
Asked participants to externalize thoughts while completing a task

HI-FI PROTOTYPES

DEVELOPMENT



HTML + Javascript

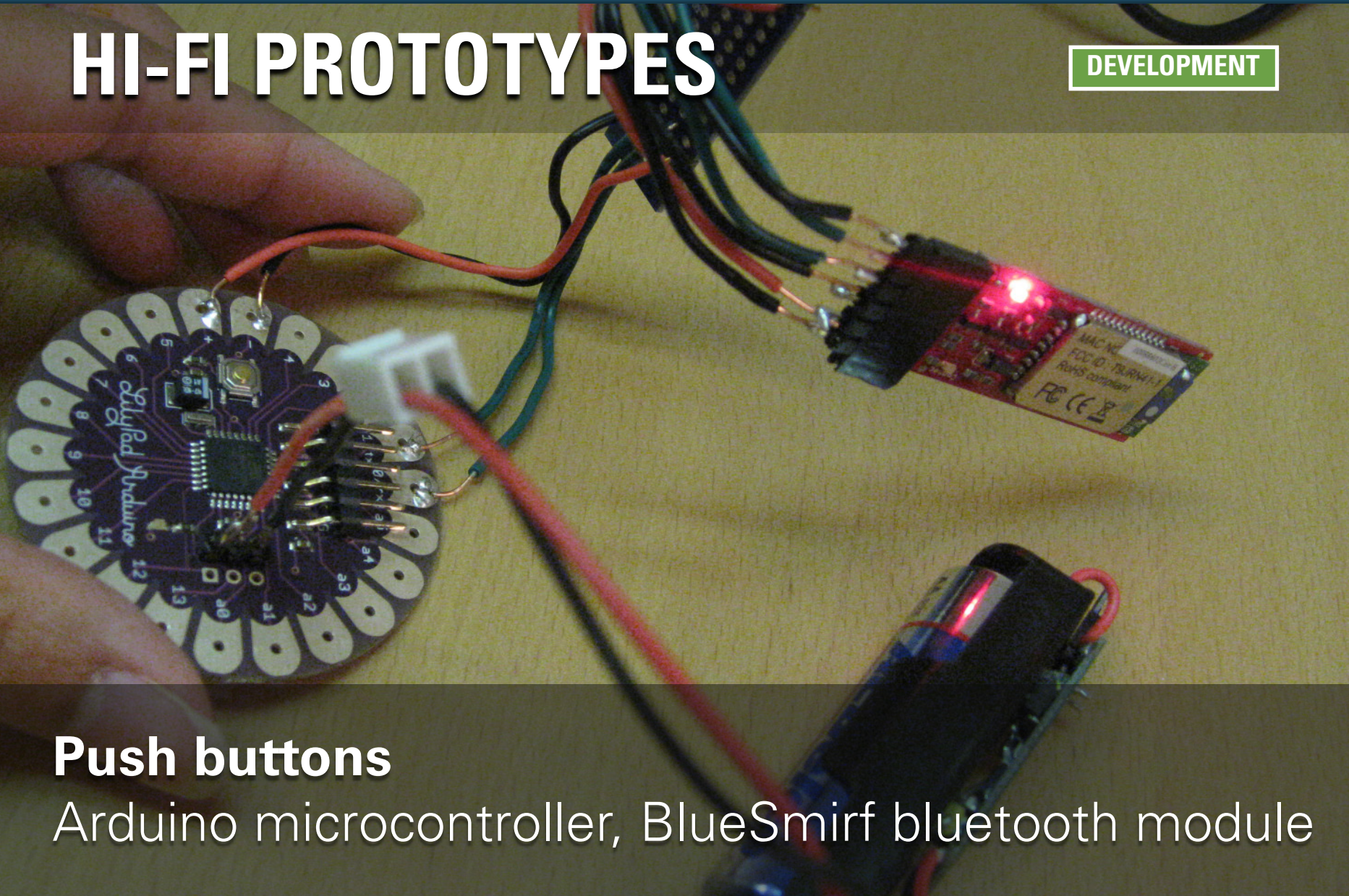


Android Application

Interactive, Used for Operational Readiness Tests

HI-FI PROTOTYPES

DEVELOPMENT



Push buttons

Arduino microcontroller, BlueSmirf bluetooth module

HI-FI PROTOTYPES

DEVELOPMENT



Foam enclosure, **cuff-mounted**

ORT: Operational Readiness Test

EVALUATION

30 minute **mock planetary exploration mission**

ORT: Operational Readiness Test

EVALUATION

- DO return to basecamp safely & on time.
- DO collaborate with us to change the plan if you get behind.
- DO use the mobile device to execute activities in the field, LER plan in the vehicle
- DO think out loud, and let note any problems with the interface as you find them
- DO use the tools for the activity

Mission briefing & device training

ORT: Operational Readiness Test

EVALUATION



Traverse from station to station

ORT: Operational Readiness Test

EVALUATION



Perform activities

Observations, sample collection, maintenance



ORT: Operational Readiness Test

EVALUATION



Mission debrief & user feedback

SUMMARY OF METHODS

Exploration

- Domain Research
- Metaphors
- Brainstorm
- Bodystorm
- Lo-Fi Sketches

Refinement

- Speed Dating
- Mid-Fi Wireframes
- Think Alouds
- Hi-Fi Prototypes
- ORT



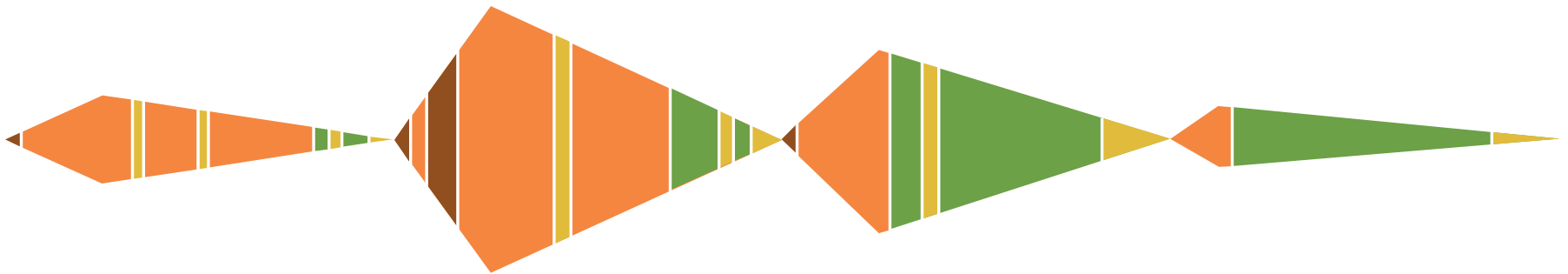
EVOLUTION OF KEY FEATURES

FIRST ITERATION

SECOND ITERATION

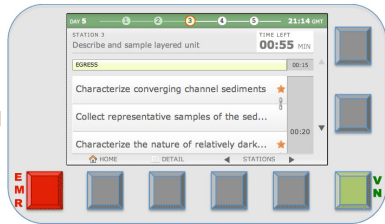
THIRD ITERATION

FINAL ITERATION

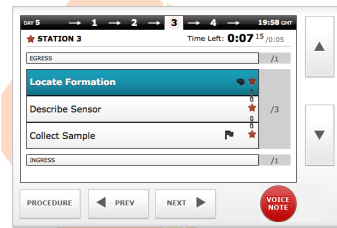


EVOLUTION OF KEY FEATURES

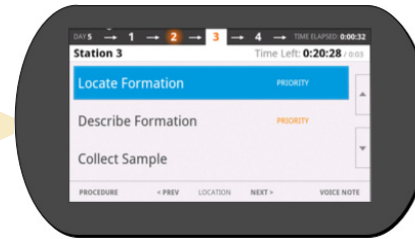
FIRST ITERATION



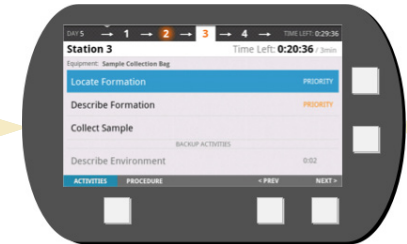
SECOND ITERATION



THIRD ITERATION



FINAL ITERATION



VISUAL DESIGN



It sure is bright out here

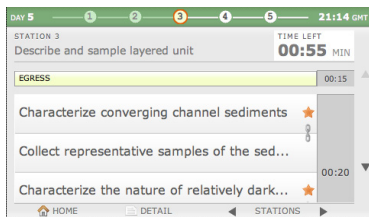


VISUAL DESIGN

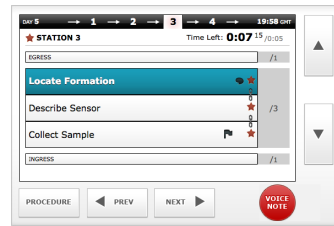


It sure is bright out here

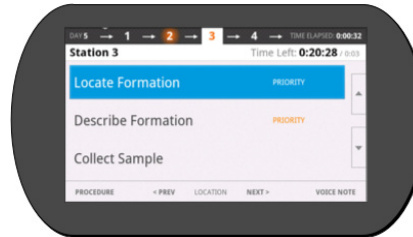
FIRST ITERATION



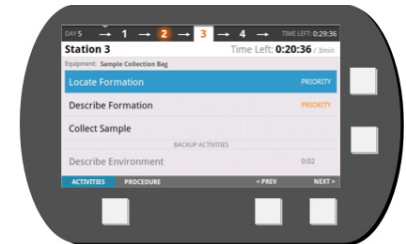
SECOND ITERATION



THIRD ITERATION



FINAL ITERATION

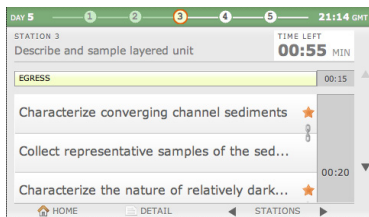


VISUAL DESIGN

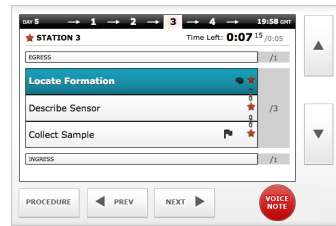


It sure is bright out here

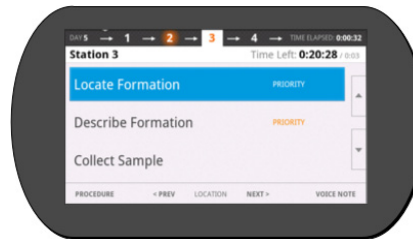
FIRST ITERATION



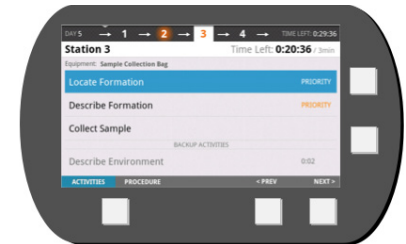
SECOND ITERATION



THIRD ITERATION



FINAL ITERATION



**soft
subtle colors**

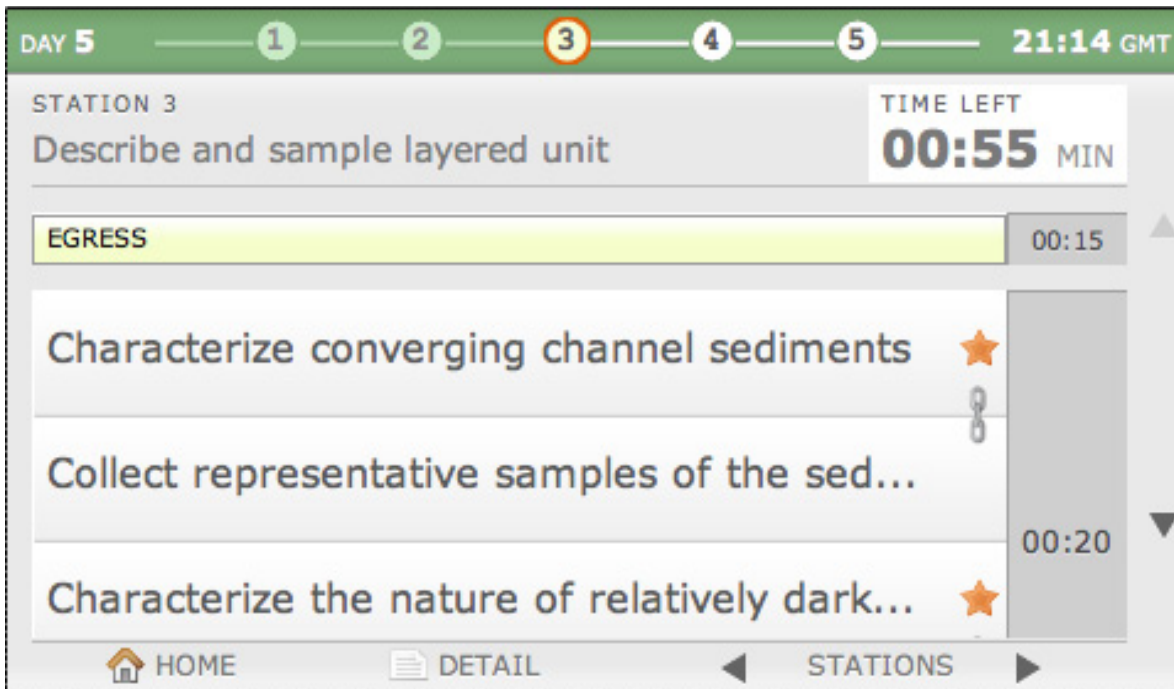


**bold
high contrast**

VISUAL DESIGN



FIRST ITERATION



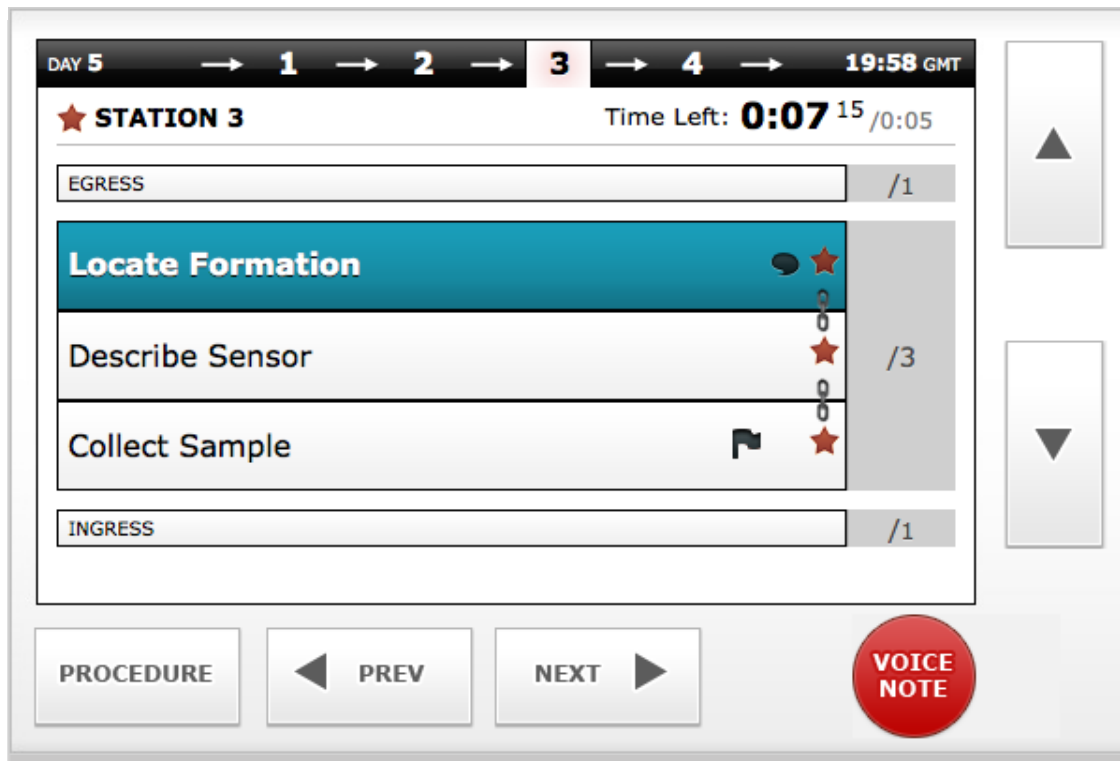
“The colors are really pale and non-contrast.”

- Peer feedback

VISUAL DESIGN



SECOND ITERATION



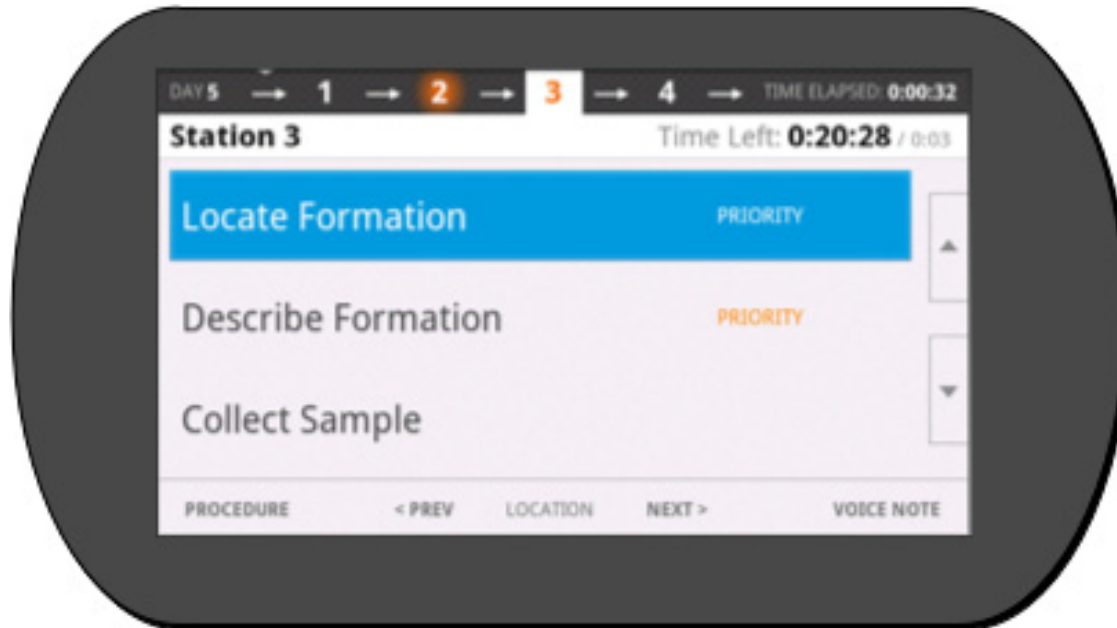
“The orange is hard to see. The text could be bigger, too.”

- ORT Participant

VISUAL DESIGN



THIRD ITERATION

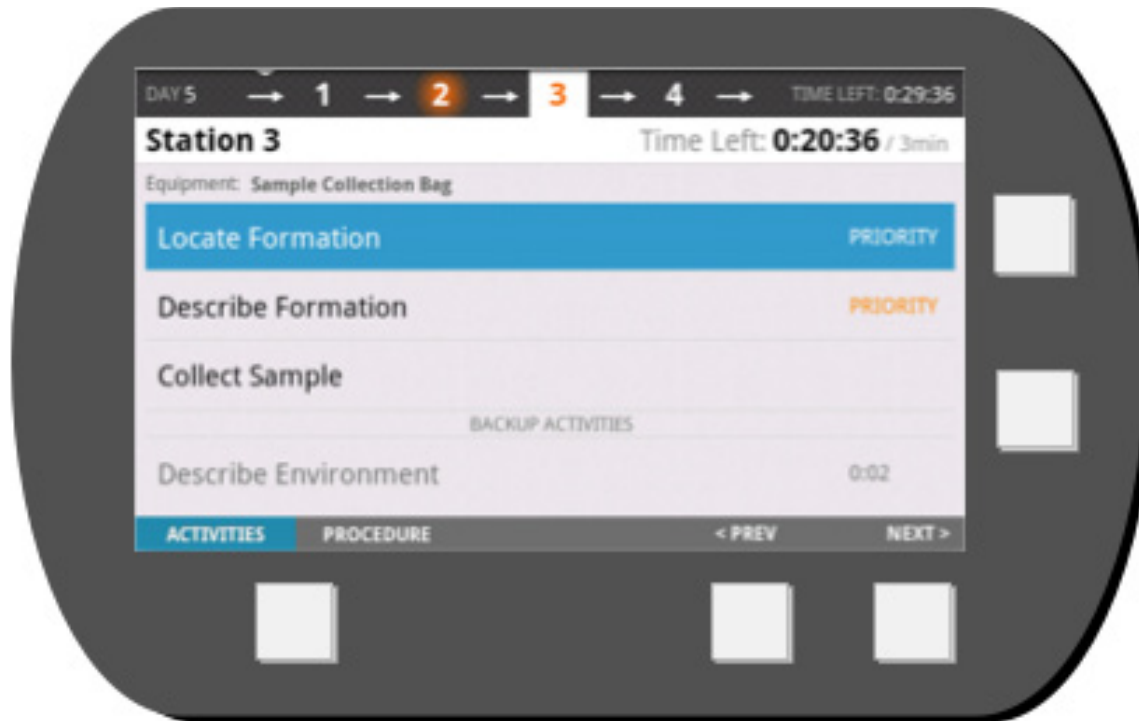


“I like how the text is big and easy to see.”
- ORT Participant

VISUAL DESIGN



FINAL ITERATION



“I can walk and read this at the same time.”

- ORT Participant

TIME



Glanceable



Delta

Time, served three ways



TIME



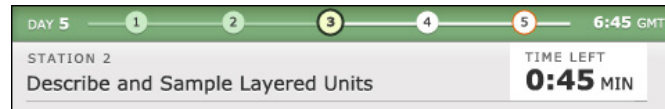
Glanceable



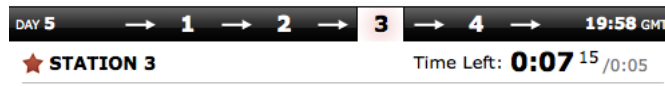
Delta

Time, served three ways

FIRST ITERATION



SECOND ITERATION



THIRD ITERATION



FINAL ITERATION



TIME



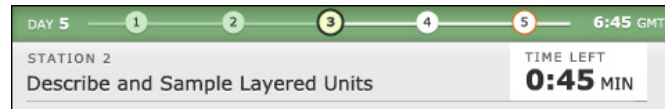
Glanceable



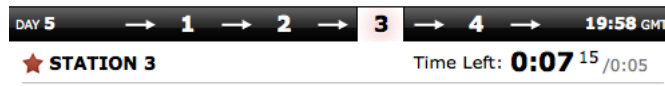
Delta

Time, served three ways

FIRST ITERATION



SECOND ITERATION



THIRD ITERATION



FINAL ITERATION



GMT
Station time left



Mission time left
Station time left
Marcus Bains Notch

TIME

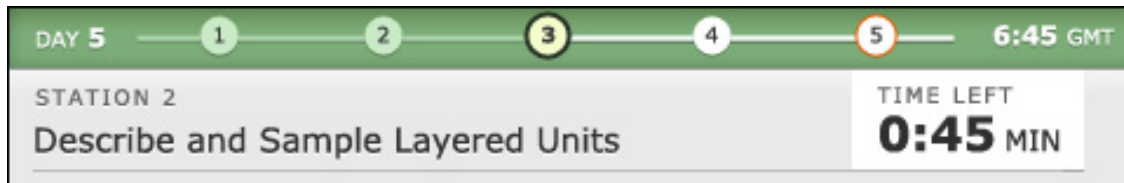


Glanceable



Delta

FIRST ITERATION



*“ 45 minutes out
of what?”*

- Peer feedback

TIME



Glanceable



Delta

SECOND ITERATION



“Is 0:05 minutes or seconds?”

- ORT Participant

“I never used the current time for GMT”

- ORT Participant

TIME



Glanceable



Delta

THIRD ITERATION



“ I thought it was weird to see something counting up and another counting down. And I never used Time Elapsed.”

- ORT Participant

“ Is 0:04 seconds or minutes.”

- ORT Participant

TIME



Glanceable



Delta

FINAL ITERATION



*“ When I was ahead, I used the Mission Time Left.
When I was behind, I used Station Time Left.”*

- ORT Participant

“ If the text is red, I know, ‘oh, I’m Late!’”

- ORT Participant

ACTIVITY LIST



Glanceable



Timeline optimized



Autonomy

The story of Goldilocks



ACTIVITY LIST



Glanceable



Timeline optimized



Autonomy

The story of Goldilocks

FIRST ITERATION

EGRESS		0:10
Collect representative samples		0:20
Characterize nature of albedo		

SECOND ITERATION

EGRESS		/1
Locate Formation		/3
Describe Sensor		

THIRD ITERATION

Locate Broken Sensor	PRIORITY x1
Repair sensor	PRIORITY

FINAL ITERATION

Equipment: Core tube, Hammer	
Collect core tube sample	PRIORITY
Stow core sample	PRIORITY
BACKUP ACTIVITIES	



ACTIVITY LIST



Glanceable



Timeline optimized



Autonomy

The story of Goldilocks

FIRST ITERATION

EGRESS		0:10
Collect representative samples		0:20
Characterize nature of albedo		

SECOND ITERATION

EGRESS		/1
Locate Formation	★	/3
Describe Sensor	★	

THIRD ITERATION

Locate Broken Sensor	PRIORITY	🗨️ x1
Repair sensor	PRIORITY	

FINAL ITERATION

Equipment: Core tube, Hammer		
Collect core tube sample	PRIORITY	▲
Stow core sample	PRIORITY	▼
BACKUP ACTIVITIES		

**Beveled rendering
Ambiguous &
extraneous information**



**Flat rendering
Obvious & relevant
information**

ACTIVITY LIST



Glanceable



Timeline optimized



Autonomy

FIRST ITERATION

EGRESS	0:10
Collect representative samples	0:20
Characterize nature of albedo	
INGRESS	0:15

“How important is it that I do things in order?”

- Peer Feedback

ACTIVITY LIST



Glanceable






Timeline optimized



Autonomy

SECOND ITERATION

EGRESS	/1
Locate Formation	
Describe Sensor	
Collect Sample	
INGRESS	/1

“It’s not very obvious what the star means.”

- ORT Participant

“I pretty much just did things in order.”

- ORT Participant

ACTIVITY LIST



Glanceable



Timeline optimized



Autonomy

THIRD ITERATION

The screenshot shows a task list interface. At the top, a blue bar contains the text "Locate Broken Sensor" on the left and "PRIORITY" followed by a speech bubble icon and "x1" on the right. Below this, a grey bar contains the text "Repair sensor" on the left and "PRIORITY" in orange on the right. Underneath, the text "BACKUP ACTIVITIES" is centered. At the bottom, another grey bar contains the text "Describe Spherical Structures" on the left and "0:02" on the right.

“ It wastes a lot of time when I have to go back for the tools.”

- ORT Participant

“ I can’t help but want to touch the blue bar!”

- ORT Participant

ACTIVITY LIST



Glanceable



Timeline optimized



Autonomy

FINAL ITERATION

Equipment: Core tube, Hammer

Collect core tube sample

PRIORITY

Stow core sample

PRIORITY

BACKUP ACTIVITIES

Photograph environment

10min



“I never once touched the screen.”

- ORT Participant

“I did backup activities first because I can do them while walking towards the formation.”

- Repeat ORT Participant

PROCEDURE VIEW



Glanceable



Timeline optimized

Help is but one button away



PROCEDURE VIEW



Glanceable



Timeline optimized

Help is but one button away


FIRST ITERATION

Not applicable

SECOND ITERATION


Station 3 » Describe Sensor

PROCEDURES:	EXECUTION NOTES:
1. How many vert	For Step 1, Vertical I



THIRD ITERATION


Describe Formation PRIORITY x1

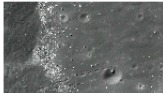
2. How tall is the tallest point? 

For Step 2, Use the ruler to measure in inches.

FINAL ITERATION

Procedure: Collect boulder sample

 1. Locate boulder in crater.

1a.  Bird's eye view of boulder in crater

PROCEDURE VIEW



Glanceable



Timeline optimized

Help is but one button away

FIRST ITERATION


Not applicable

Document view
Blue highlight

SECOND ITERATION


Station 3 » Describe Sensor

PROCEDURES:	EXECUTION NOTES:
1. How many vert	For Step 1, Vertical I



THIRD ITERATION


Describe Formation PRIORITY x1

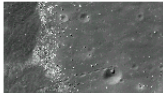
2. How tall is the tallest point? 

For Step 2, Use the ruler to measure in inches.

FINAL ITERATION

Procedure: Collect boulder sample

 1. Locate boulder in crater.

1a.  Bird's eye view of boulder in crater

Inline view
Purple highlight

PROCEDURE VIEW



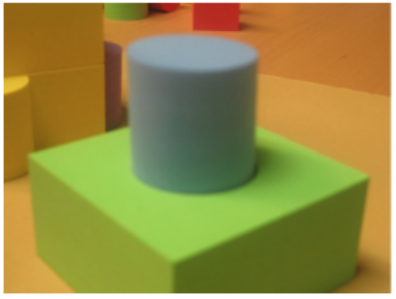
Glanceable



Timeline optimized

SECOND ITERATION

Station 3 » Describe Sensor ★

<p>PROCEDURES:</p> <ol style="list-style-type: none"> 1. How many vertical 2. How many horizo 3. How many distinc 4. Identify any anon 	<p>EXECUTION NOTES:</p> <p>For Step 1, Vertical Protrusion:</p> 
---	--

“I don’t know which procedure steps have notes”

- ORT Participant

“I can’t see the procedure steps when I’m looking at notes.”

- ORT Participant

PROCEDURE VIEW





Glanceable



Timeline optimized

THIRD ITERATION

Describe Formation PRIORITY  x1

2. How tall is the tallest point? 

For Step 2, Use the ruler to measure in inches.

3. Identify any anomalies.

“Sometimes I get confused about whether I’m looking at the Activity List or Procedure View.”

- ORT Participant

PROCEDURE VIEW




Glanceable



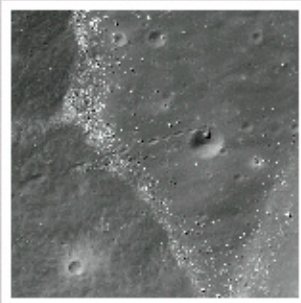
Timeline optimized

FINAL ITERATION

Procedure: Collect boulder sample

 1. Locate boulder in crater.

1a.



Bird's eye view of boulder in crater



“I really like what you guys did with the Activity View”

- Repeat ORT Participant

COMPLETION STATUS?

Status is already **in the astronaut's head**
Unnecessary externalization means mental load

BACKGROUND

DESIGN

DEMO

PROCESS

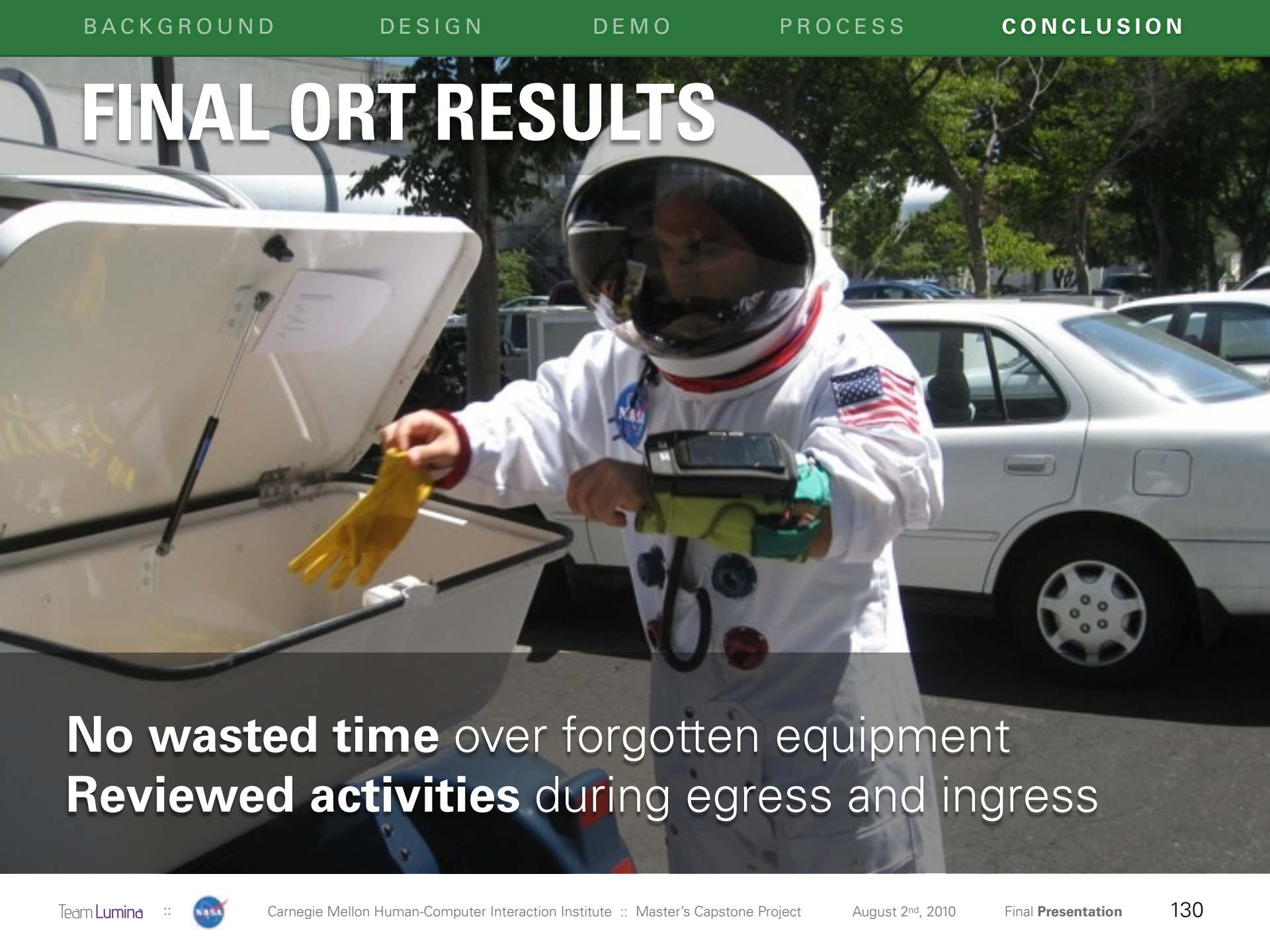
CONCLUSION



FINAL ORT RESULTS

All participants returned minutes **ahead of schedule**
Performed **scheduled and backup** activities

FINAL ORT RESULTS




No wasted time over forgotten equipment
Reviewed activities during egress and ingress

FINAL ORT RESULTS

“I can see this being useful in a long mission where you might forget things or when things might change.”

NASA Scientist (6/22/2010)

FINAL ORT RESULTS

A photograph of two men in white astronaut suits and helmets, standing outdoors. They are wearing white suits with NASA patches and American flags on the sleeves. The man on the right is holding a black rectangular device. The background shows a chain-link fence and some trees under a clear blue sky.

“At this point, it’s just my personal taste, not the overall usability. I think it’s pretty great already.”

Repeat ORT Participant (6/22/2010)

DESERT RATS FEEDBACK

“WOW! What you guys have here represents exactly how I think.”

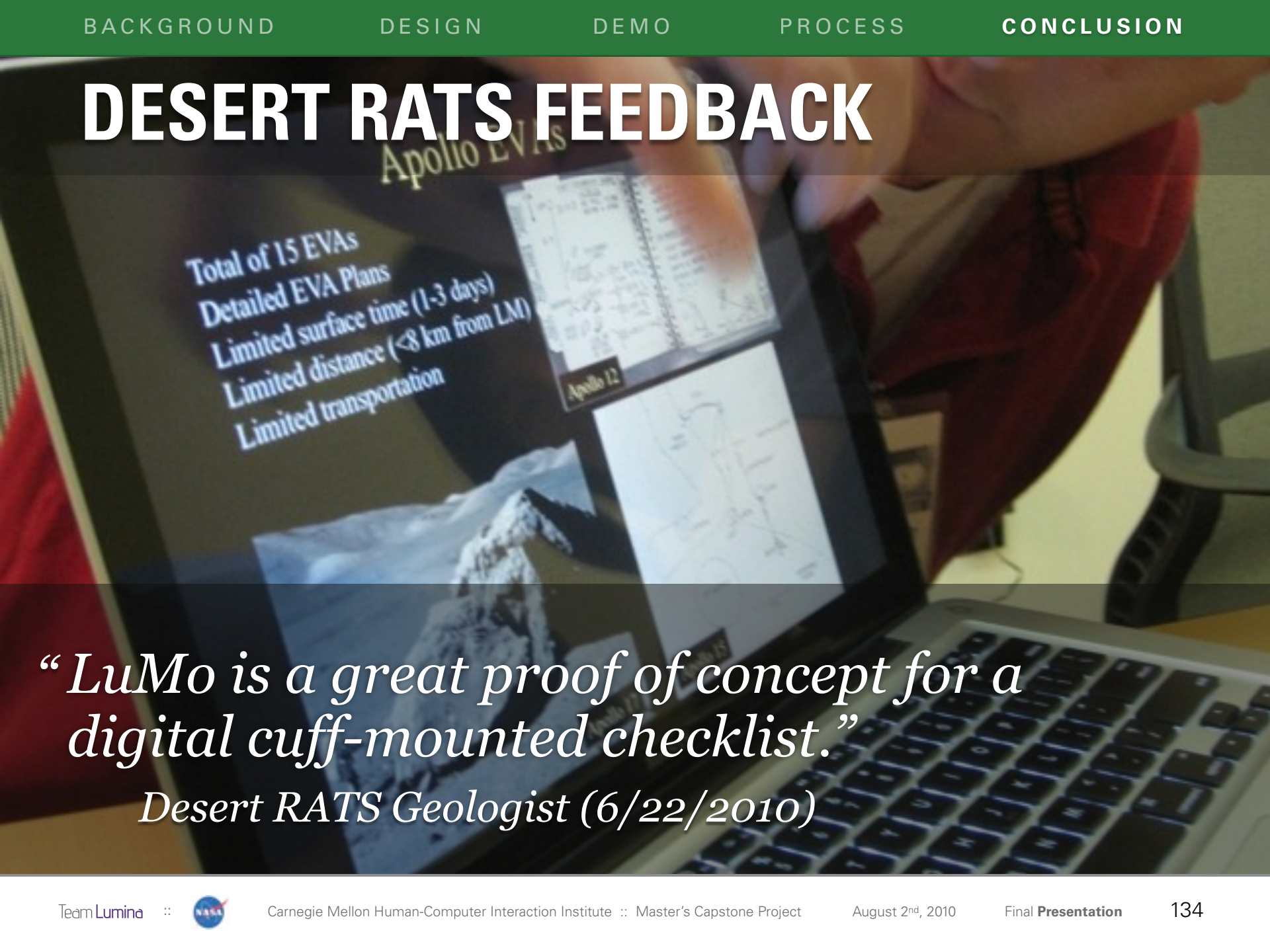
Desert RATS Geologist (6/22/2010)

DESERT RATS FEEDBACK

Apollo EVAs

- Total of 15 EVAs
- Detailed EVA Plans
- Limited surface time (1-3 days)
- Limited distance (<8 km from LM)
- Limited transportation

Apollo 12



“LuMo is a great proof of concept for a digital cuff-mounted checklist.”

Desert RATS Geologist (6/22/2010)

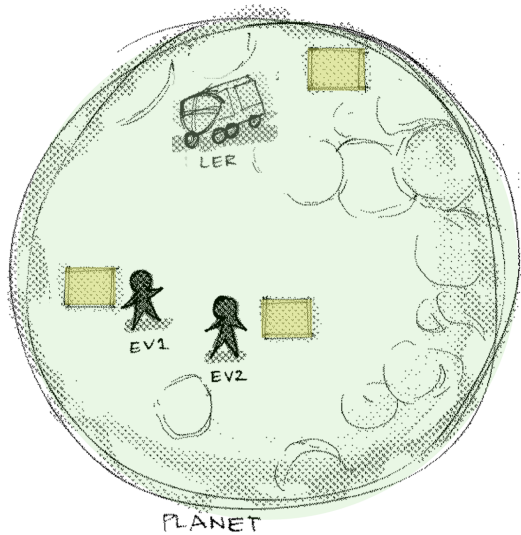
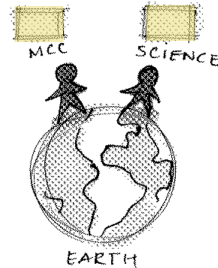
DESERT RATS FEEDBACK

“This looks interesting and novel. Would be interesting to see it developed further.”

Desert RATS Engineer (6/18/2010)

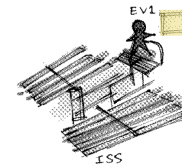
FUTURE WORK

MISSION CONTROL



PLANETARY SURFACE

INTERNATIONAL SPACE STATION



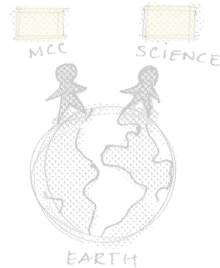
PERSONNEL



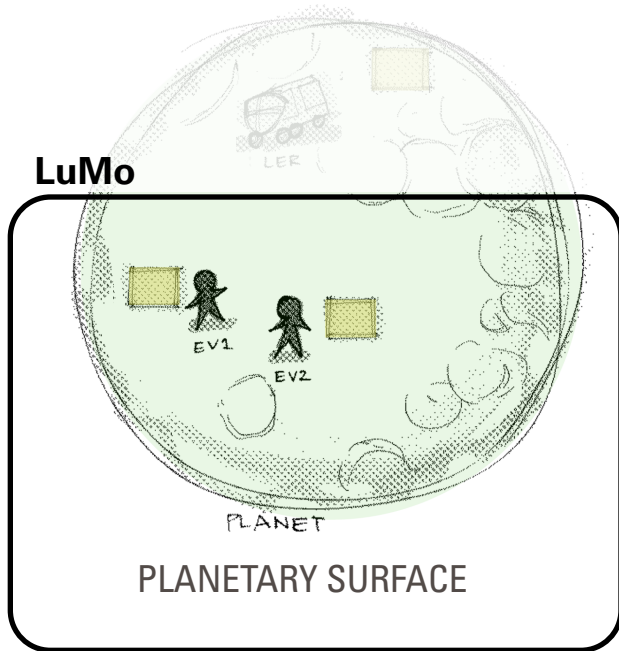
TOOLS

FUTURE WORK

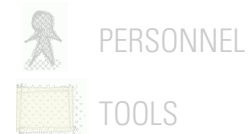
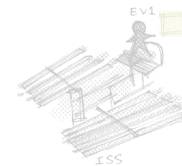
MISSION CONTROL



LuMo



INTERNATIONAL SPACE STATION

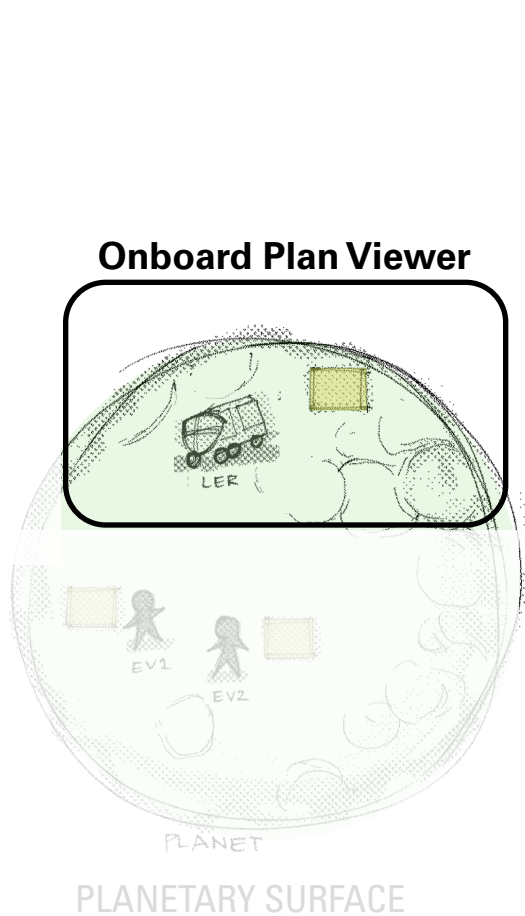


LUMO



Robustness under **extreme conditions**
Collaboration between team members or teams

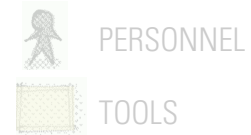
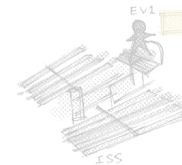
FUTURE WORK



MISSION CONTROL



INTERNATIONAL SPACE STATION



ONBOARD PLAN VIEWER



LuMo+: Map View, Plan History, Partner's Schedule

FUTURE WORK

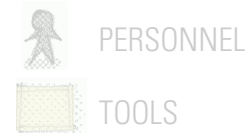
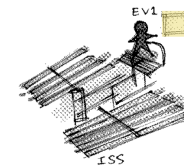
MISSION CONTROL



PLANETARY SURFACE

ISS Extravehicular Activities

INTERNATIONAL SPACE STATION

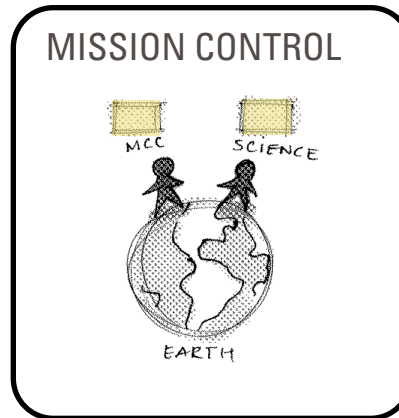


ISS EVA ACTIVITIES

A photograph of an astronaut in a white space suit performing an extravehicular activity (EVA) in space. The astronaut is holding a complex tool with multiple cylindrical components and is connected to a large black bag or equipment by a thick yellow cable. The background shows the Earth's horizon and the dark void of space.

Optimize for **ISS extravehicular activities**:
activities, procedures, and tools

FUTURE WORK

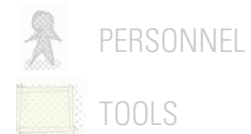
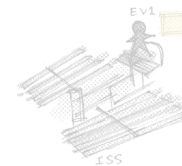


Plan Making Tools



PLANETARY SURFACE

INTERNATIONAL SPACE STATION



PLAN MAKING TOOLS



FLIGHT DIRECTOR



Create procedures and **execution notes** using a form
Push plan updates in real-time



THANK YOU!

Questions?



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