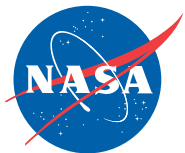


MAY 4, 2010 / RESEARCH REPORT

# Investigating Real-Time Planning and Execution of Human Space Missions

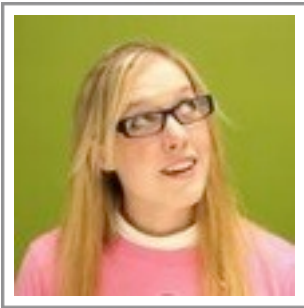


**Carnegie Mellon**

Team **Lumina**

**Katy Linn**  
**Christine Wu**  
**Jesse Venticinque**  
**Jennifer Lu**  
**Noah Levin**

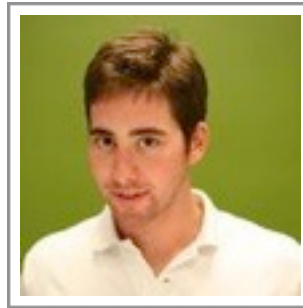
# MEET THE TEAM



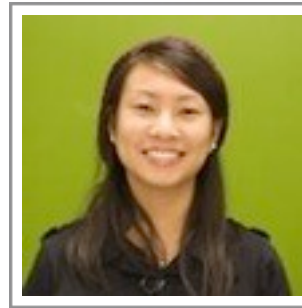
**Katy** Linn  
Project  
Coordinator



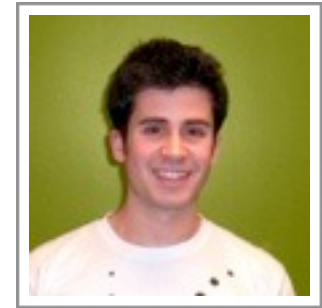
**Christine** Wu  
Technical Lead



**Jesse** Venticinque  
Design Lead



**Jennifer** Lu  
User Research



**Noah** Levin  
Web /  
Documentation

# MEET THE CLIENT



**HCI Group**  
**NASA Ames Research Center**



# BACKGROUND

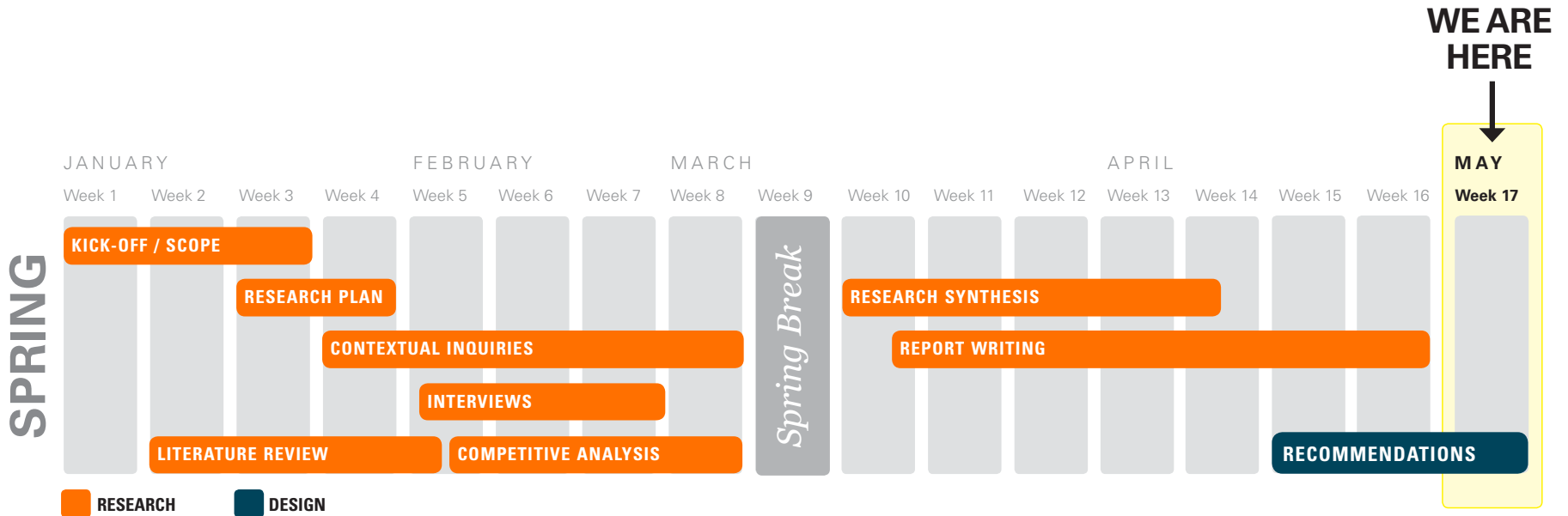
## RESEARCH

## PROBLEMS & OPPORTUNITIES

## NEXT STEPS



# SCHEDULE: RESEARCH PHASE



# CLIENT'S REQUEST

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

# PROJECT FOCUS

A photograph of the International Space Station (ISS) in orbit above Earth. The station's complex structure, including multiple large solar panel arrays, is clearly visible against the blackness of space. Below the station, the blue and white clouds of the Earth are visible. A small figure of a person is visible on the station's deck, providing a sense of scale.

1998 NASA joined four international space agencies to help build the **International Space Station (ISS)**

# PROJECT FOCUS

A photograph of the International Space Station (ISS) in orbit above Earth. The station's complex structure, including multiple large solar panel arrays, is clearly visible against the blackness of space. The Earth's blue surface and white clouds are visible in the background.

1998 NASA joined four international space agencies to help build the **International Space Station (ISS)**.

Crew teams rotate in **six month increments**



# PROJECT FOCUS

1998 NASA joined four international space agencies to help build the **International Space Station (ISS)**.

Crew teams rotate in **six month increments**

Home to research in **physical sciences, astronomy, meteorology, human sciences, and space medicine**

# PROJECT FOCUS

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

# PROJECT FOCUS

Astronaut's workday is **planned down to the minute**  
Ensure they can accomplish the **maximum amount of work** during these hours

# PROJECT FOCUS

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

Ensure they can accomplish the **maximum amount of work** during these hours

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

# HUMAN SPACE PLANNING

Plan  
Visibility

International  
Partners

Desire for  
Autonomy

Political  
Agendas

Re-planning

Human  
Error

Constraint  
Negotiations

Unforeseen  
Circumstances

Task  
Priorities

Version  
Control

Plan View vs  
Execution View

Multiple Roles  
Affecting  
The Plan

Equipment  
Sharing

Shift  
Handoffs

Sequential  
Tasks

Different  
Payloads

Communication  
Delays



# HUMAN SPACE PLANNING

Plan  
Visibility

International  
Partners

Political  
Agendas

Re-planning

# Complex Planning Space

Constraint/  
Negotiation

Control

Plan View vs  
Execution View

Equipment  
Sharing

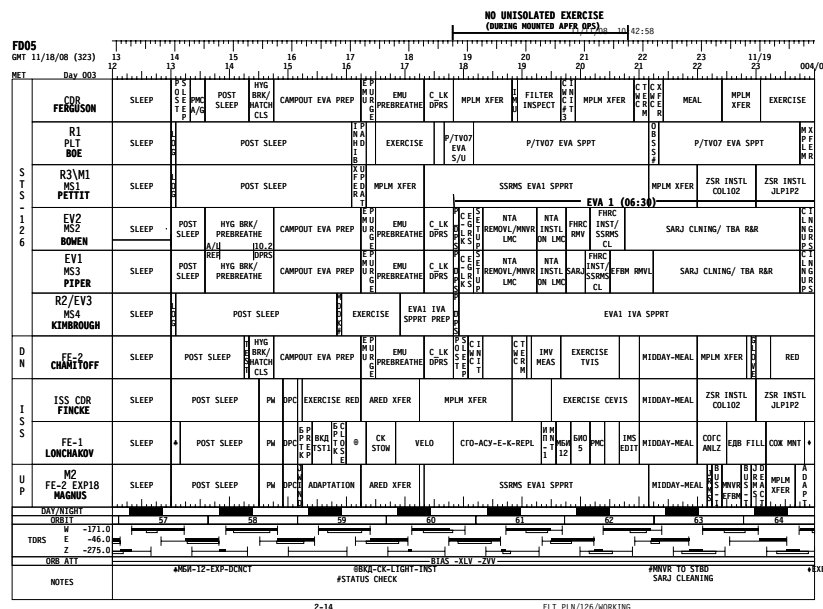
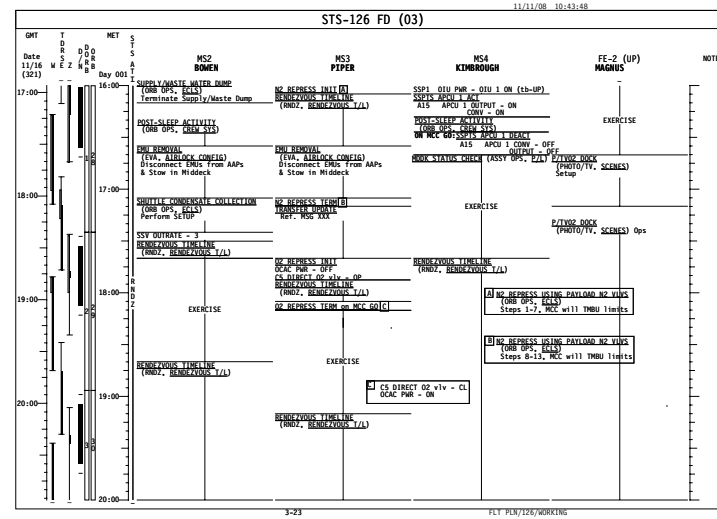
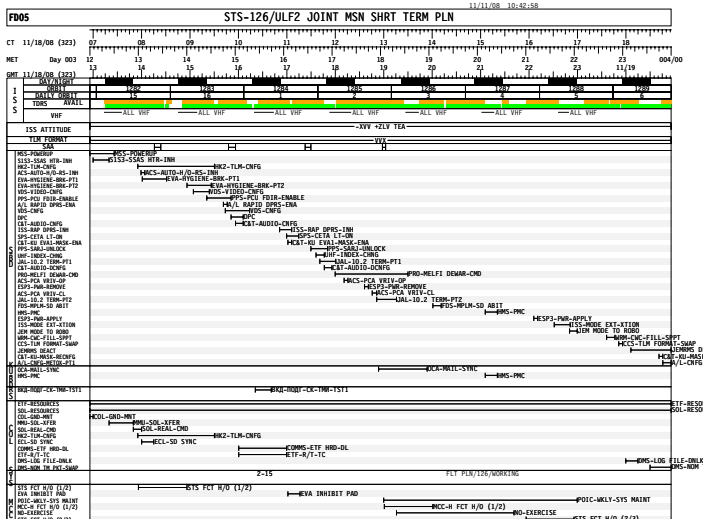
Shift  
Handoffs

Sequential  
Tasks

Different  
Payloads

Communication  
Delays





# RESEARCH GOALS



We want to understand the **cultural context**, **communication strategies**, and **unexpected circumstances** affecting real-time planning in order to facilitate efficient execution of human space missions.



BACKGROUND

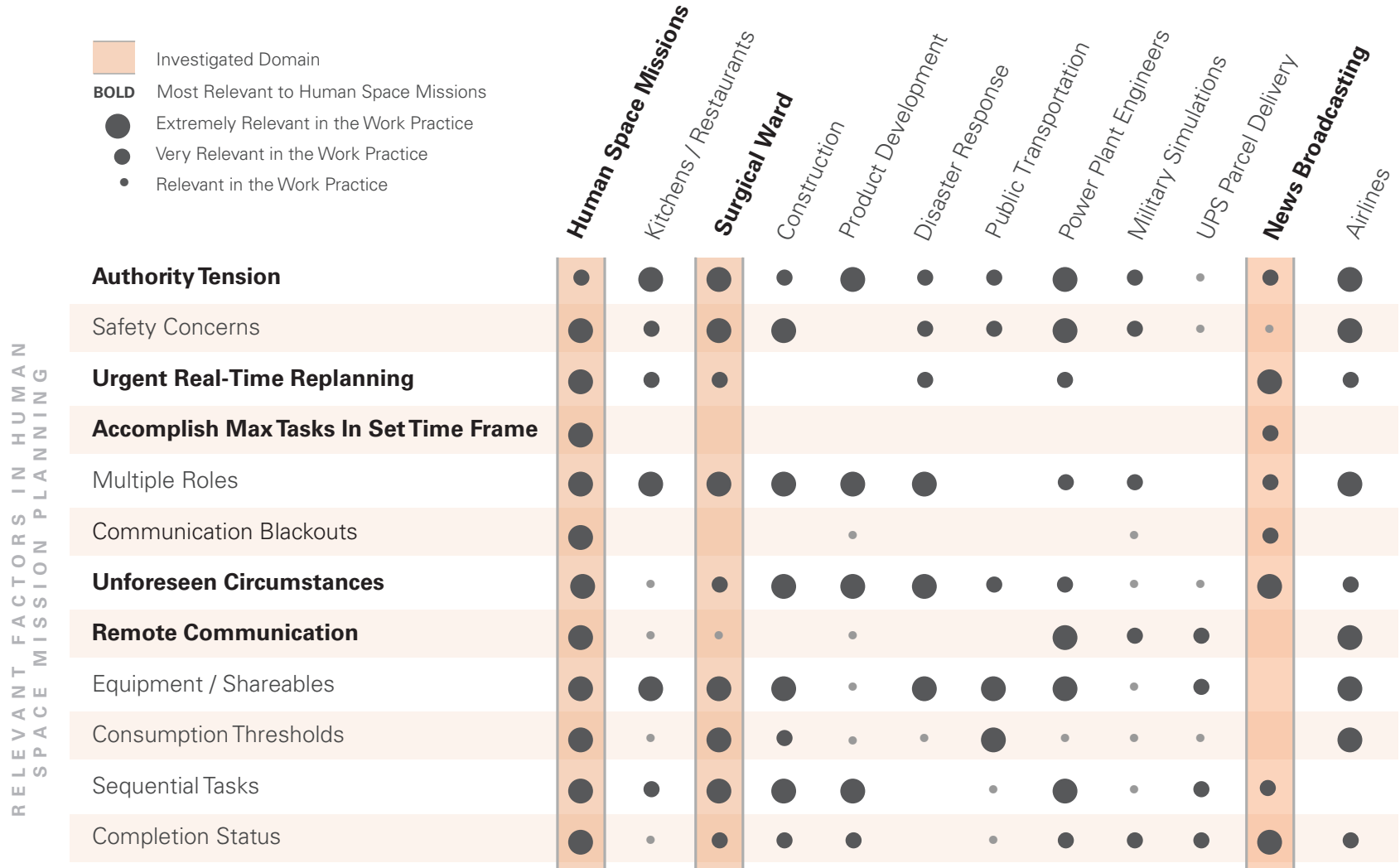
**RESEARCH**

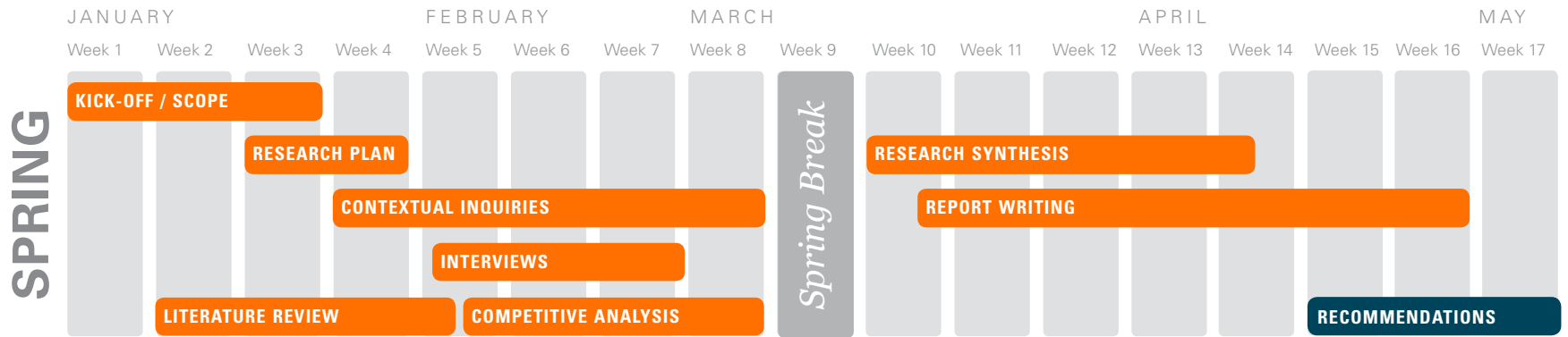
PROBLEMS & OPPORTUNITIES

NEXT STEPS



# WHY ANALOGOUS DOMAINS





JANUARY

FEBRUARY

MARCH

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Week 9

KICK-OFF / SCOPE

RESEARCH PLAN

CONTEXTUAL INQUIRIES

INTERVIEWS

LITERATURE REVIEW

COMPETITIVE ANALYSIS

*Spring Break*

SPRING

Approaches to **structuring work** and **managing resources**



JANUARY

FEBRUARY

MARCH

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Week 9

KICK-OFF / SCOPE

RESEARCH PLAN

CONTEXTUAL INQUIRIES

INTERVIEWS

LITERATURE REVIEW

COMPETITIVE ANALYSIS

*Spring Break*

SPRING

Approaches to structuring work and managing resources

**14 Papers** across **Airlines**, **Surgical Wards**, and **Space**

**6 Papers** related to the **Cognitive Science** of planning

JANUARY

FEBRUARY

MARCH

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Week 9

KICK-OFF / SCOPE

RESEARCH PLAN

CONTEXTUAL INQUIRIES

INTERVIEWS

LITERATURE REVIEW

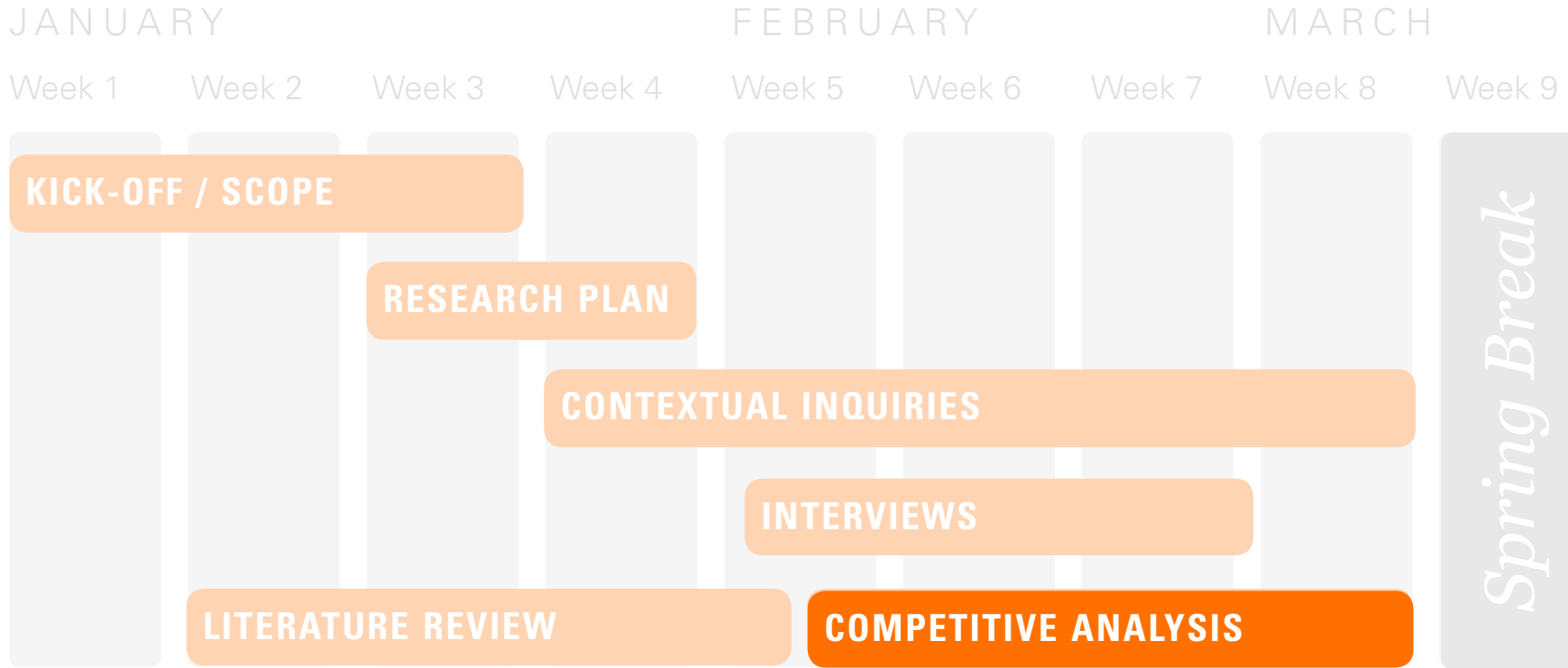
COMPETITIVE ANALYSIS

*Spring Break*

SPRING

Understand **existing practices** around central themes  
**Multi-User Collaboration, Issue Tracking** and others

SPRING



Understand existing practices around central themes  
 Multi-User Collaboration, Issue Tracking and others

**3 Project Management Tools**



**3 Industry-Specific Tools**



JANUARY

FEBRUARY

MARCH

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Week 9

KICK-OFF / SCOPE

RESEARCH PLAN

CONTEXTUAL INQUIRIES

INTERVIEWS

LITERATURE REVIEW

COMPETITIVE ANALYSIS

*Spring Break*

SPRING

Discover **what is actually happening** in their work space





JANUARY

FEBRUARY

MARCH

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Week 9

KICK-OFF / SCOPE

RESEARCH PLAN

CONTEXTUAL INQUIRIES

INTERVIEWS

LITERATURE REVIEW

COMPETITIVE ANALYSIS

*Spring Break*

Discover what is actually happening in their work space

**6 Contextual Inquiries** across **News Broadcasting** (1),  
**Surgical Ward** (1), and **Space** (4)

JANUARY

FEBRUARY

MARCH

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Week 9

KICK-OFF / SCOPE

RESEARCH PLAN

CONTEXTUAL INQUIRIES

INTERVIEWS

LITERATURE REVIEW

COMPETITIVE ANALYSIS

*Spring Break*

SPRING

Reveal **retrospective accounts of breakdowns**  
in a planning and execution cycle

JANUARY

FEBRUARY

MARCH

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Week 9

KICK-OFF / SCOPE

RESEARCH PLAN

CONTEXTUAL INQUIRIES

INTERVIEWS

LITERATURE REVIEW

COMPETITIVE ANALYSIS

*Spring Break*

Reveal retrospective accounts of breakdowns  
in a planning and execution cycle

### 3 Interviews in the Space domain

SPRING

JANUARY

FEBRUARY

MARCH

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Week 9

KICK-OFF / SCOPE

RESEARCH PLAN

CONTEXTUAL INQUIRIES

INTERVIEWS

LITERATURE REVIEW

COMPETITIVE ANALYSIS

Spring Break

**Observed 28 People Total**





**LAURA**



**PETE**



**KARL**



**JIM**

NEWS  
BROADCASTING

SURGICAL  
WARD

SPACE

SPACE

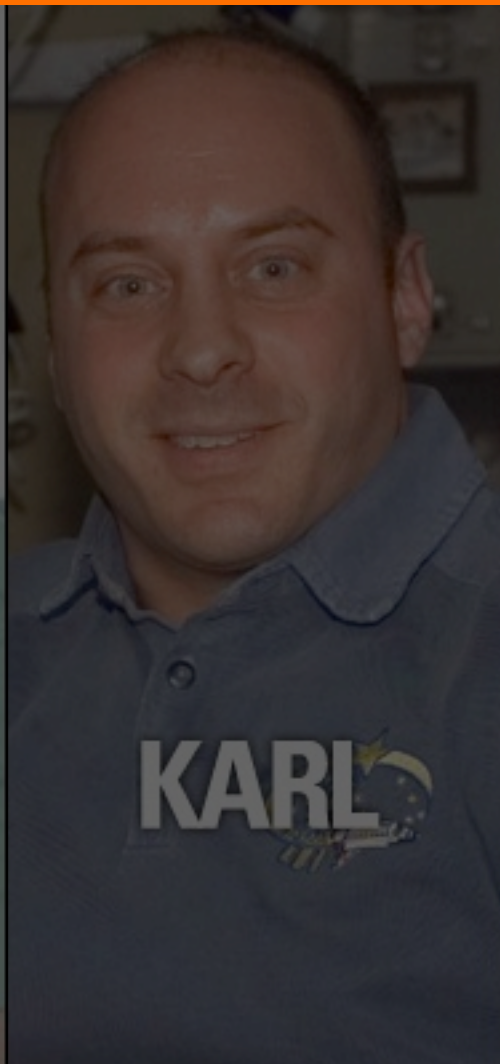




LAURA



PETE



KARL



JIM

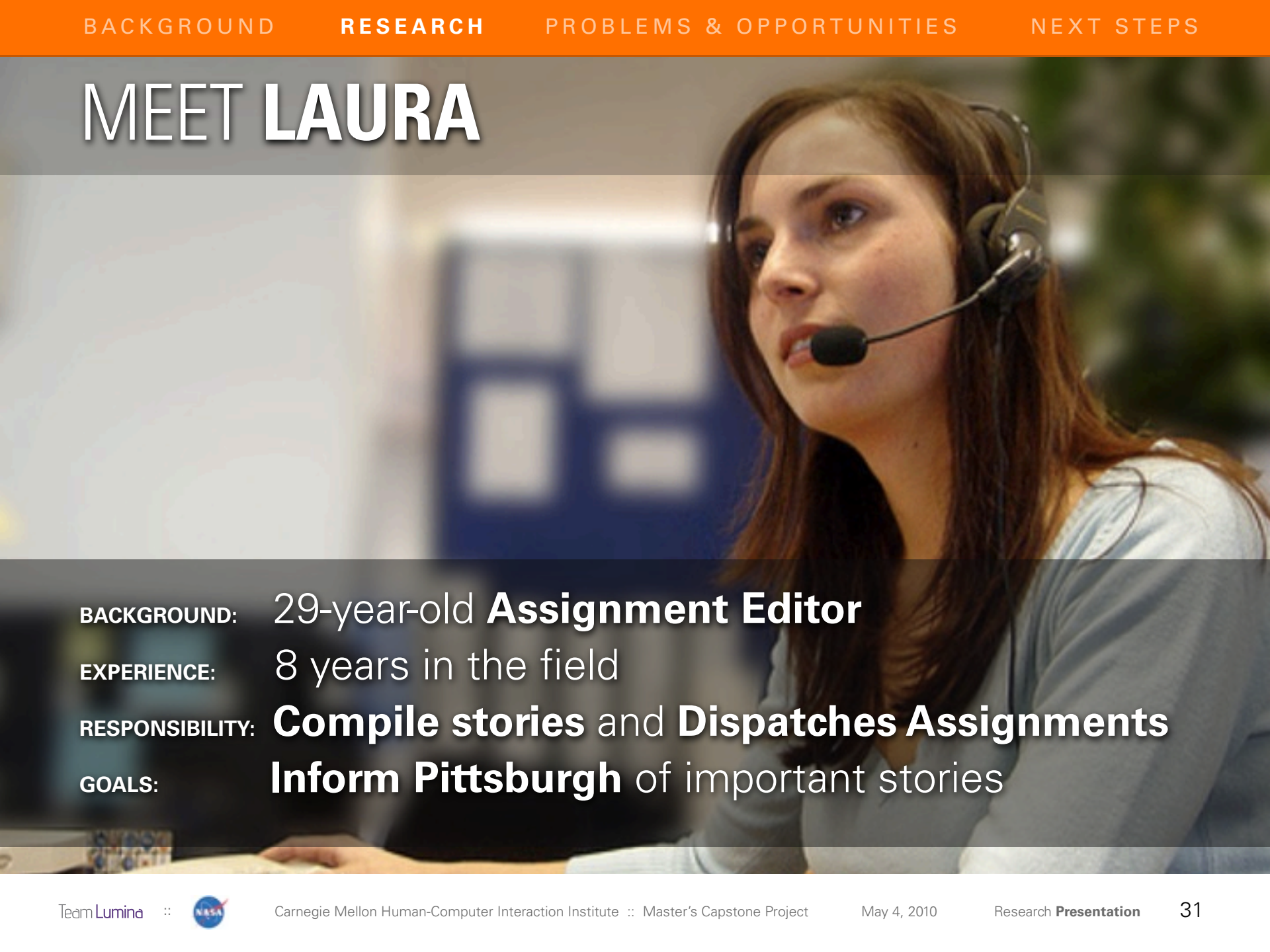
NEWS  
BROADCASTING

SURGICAL  
WARD

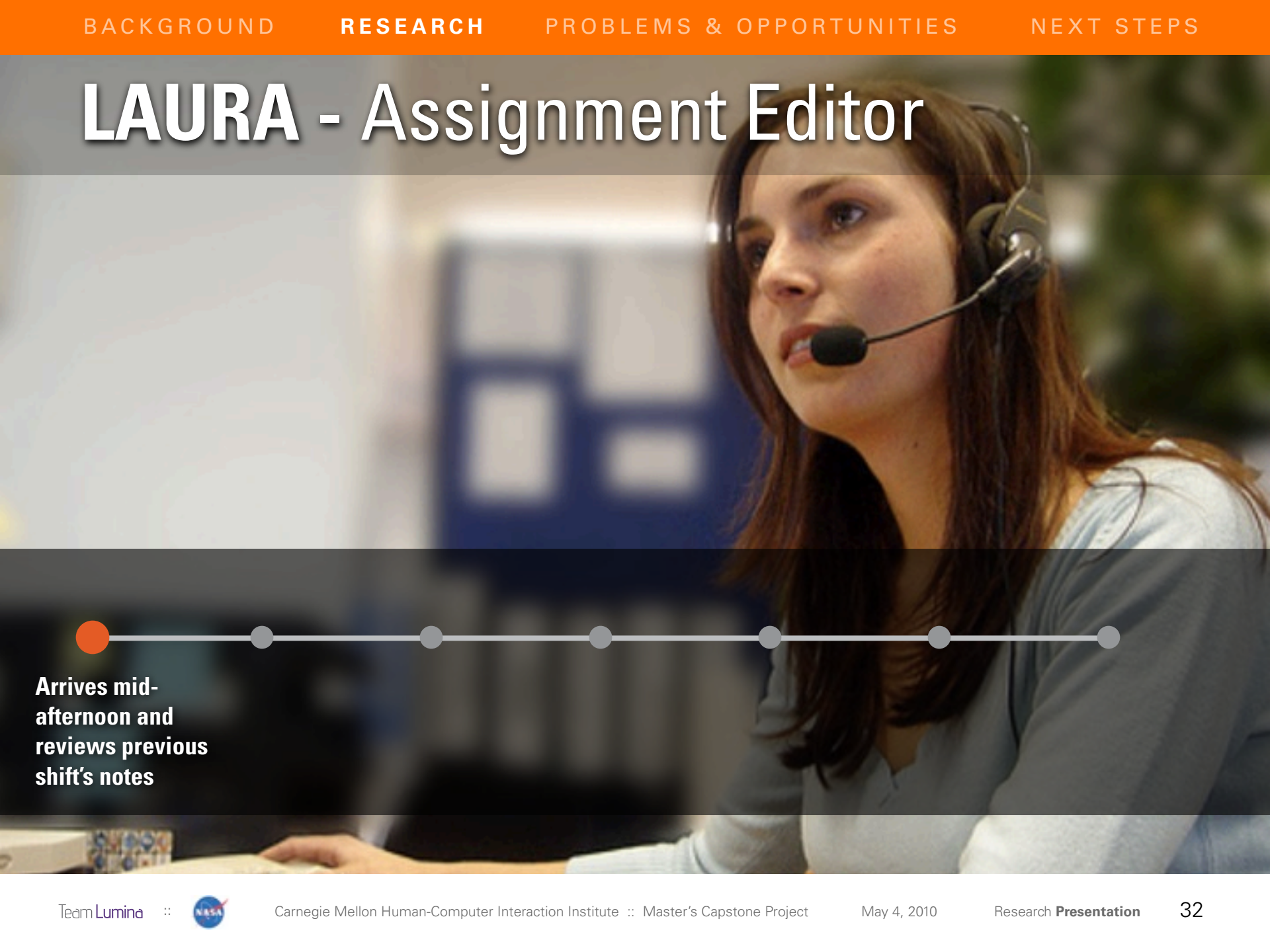
SPACE

SPACE

# MEET LAURA

- 
- BACKGROUND:** 29-year-old **Assignment Editor**
- EXPERIENCE:** 8 years in the field
- RESPONSIBILITY:** **Compile stories** and **Dispatches Assignments**
- GOALS:** **Inform Pittsburgh** of important stories


# LAURA - Assignment Editor



Arrives mid-afternoon and reviews previous shift's notes



# LAURA - Assignment Editor



Arrives mid-afternoon and reviews previous shift's notes

**Attends daily planning meeting to decide today's stories**

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**Dispatches reporters, photographers, and drivers**

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Dispatches reporters, photographers, and drivers

**Reporter: I don't like that story**  
**Driver: I want my truck**

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Reporter: I don't like that story  
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**Publishes final assignments on ENPS, producer writes scripts**

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Hears "collapsed house" over police scanner

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**Assigns near by reporters to the scene**

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Reporter: I don't like that story  
Driver: I want my truck

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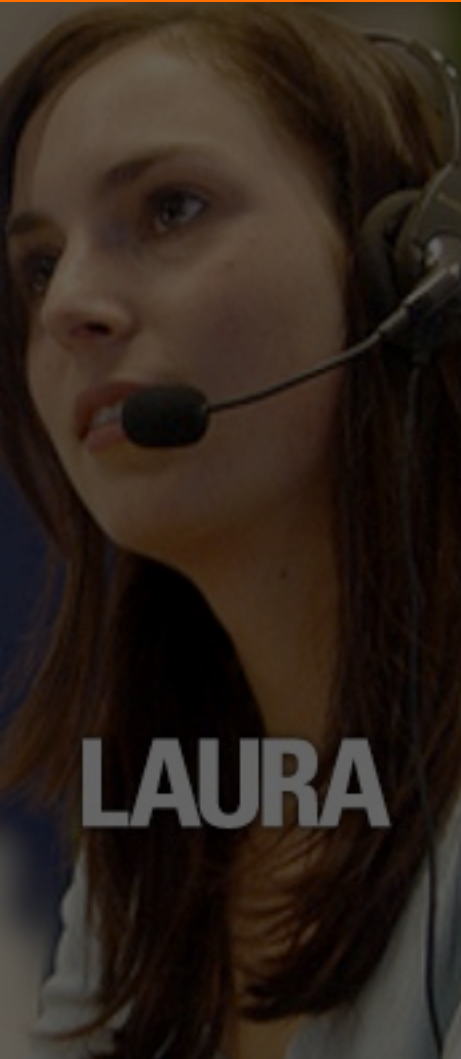
Hears "collapsed house" over police scanner

Assigns near by reporters to the scene

# KEY OBSERVATION

Laura's **dependency on ENPS** for both planning and execution

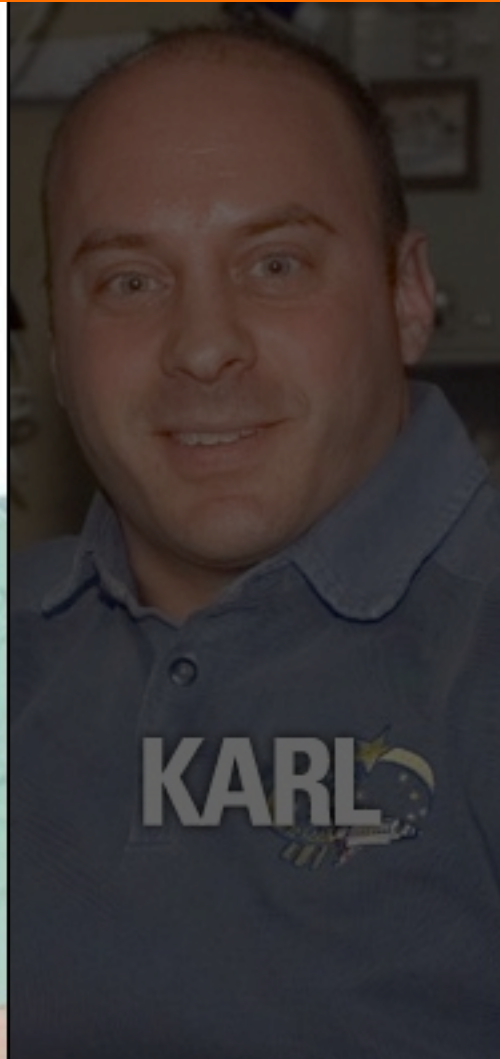




**LAURA**



**PETE**



**KARL**



**JIM**

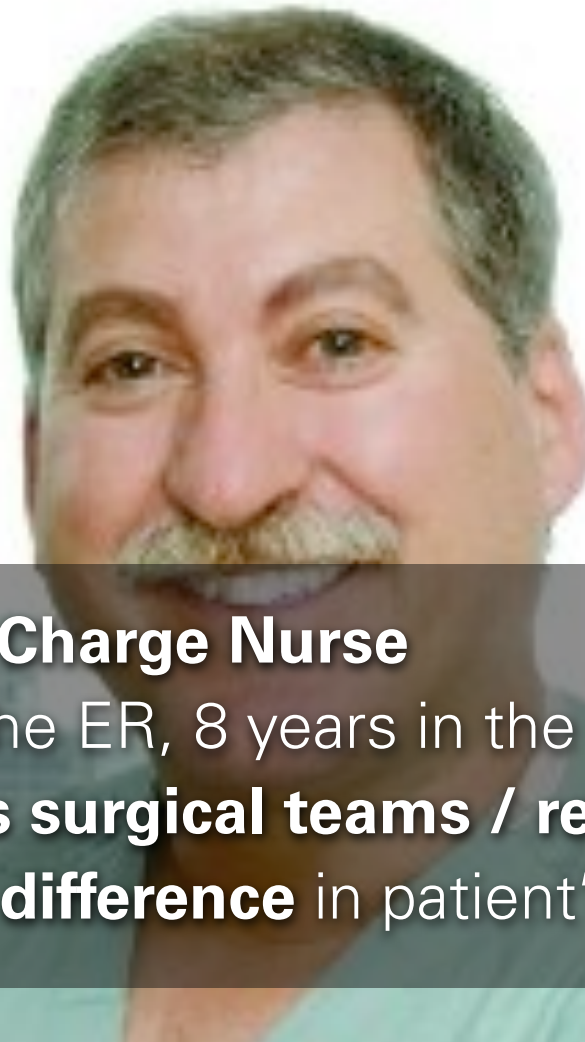
NEWS  
BROADCASTING

SURGICAL  
WARD

SPACE

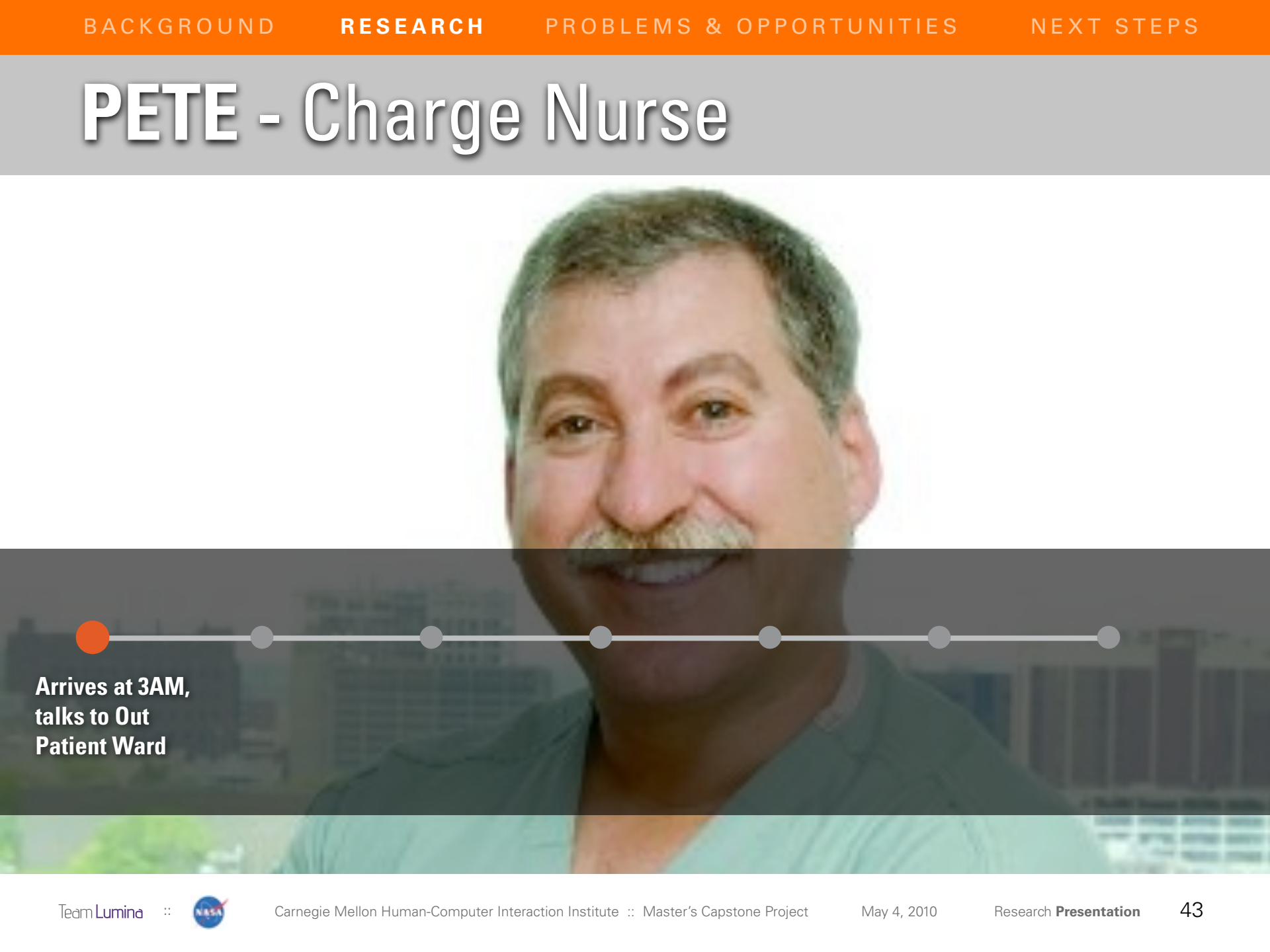
SPACE

# MEET PETE



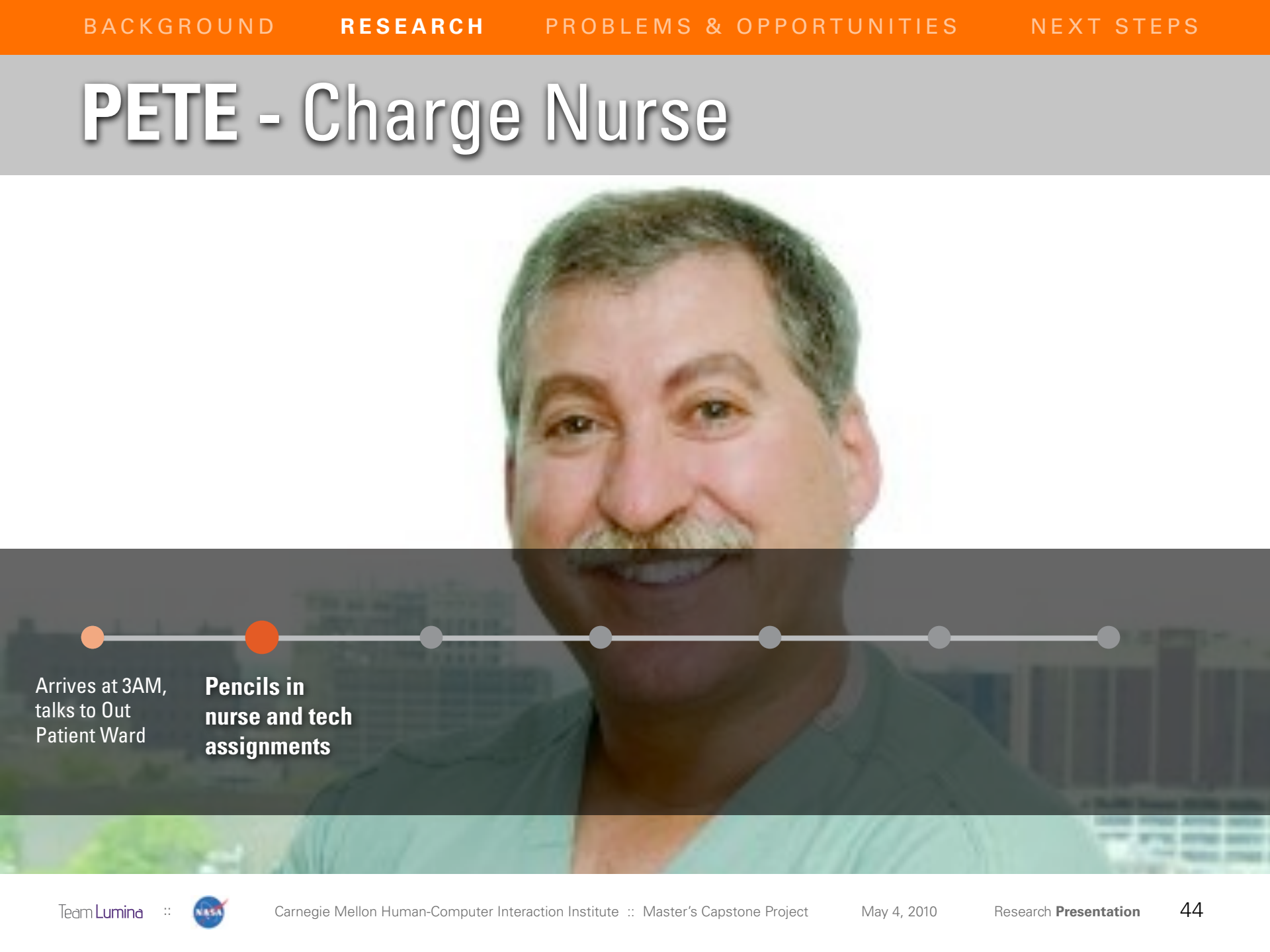
- BACKGROUND:** 50-year-old **Charge Nurse**
- EXPERIENCE:** 3 years in the ER, 8 years in the **Surgical Ward**
- RESPONSIBILITY:** **Assembles surgical teams / replans**
- GOALS:** **To make a difference** in patient's lives

# PETE - Charge Nurse



**Arrives at 3AM,  
talks to Out  
Patient Ward**

# PETE - Charge Nurse



Arrives at 3AM,  
talks to Out  
Patient Ward

**Pencils in  
nurse and tech  
assignments**

# PETE - Charge Nurse

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talks to Out  
Patient Ward

Pencils in  
nurse and tech  
assignments

**Publishes  
assignments on  
Warboard and  
assignment sheet**

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Patient Ward

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nurse and tech  
assignments

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assignments on  
Warboard and  
assignment sheet

**Surgeon: Where's  
my equipment?  
Nurse: I want my  
lunch now**

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Surgeon: Where's  
my equipment?  
Nurse: I want my  
lunch now

**Constantly updates  
the Warboard**

# PETE - Charge Nurse

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talks to Out  
Patient Ward

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Surgeon: Where's  
my equipment?  
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lunch now

Constantly updates  
the Warboard

**Septic patient  
requires surgery  
immediately**



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my equipment?  
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lunch now

Constantly updates  
the Warboard

Septic patient  
requires surgery  
immediately

**Contacts surgeon,  
anesthesiologist,  
nurse, and tech for  
emergency**

# PETE - Charge Nurse

Equipment  
Sharing

Plan  
Visibility

Shift  
Handoffs

Constraint  
Negotiations

Multiple Roles  
Affecting  
The Plan

Unforeseen  
Circumstances

Re-planning

Arrives at 3AM,  
talks to Out  
Patient Ward

Pencils in  
nurse and tech  
assignments

Publishes  
assignments on  
Warboard and  
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Surgeon: Where's  
my equipment?  
Nurse: I want my  
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Constantly updates  
the Warboard

Septic patient  
requires surgery  
immediately

Contacts surgeon,  
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emergency

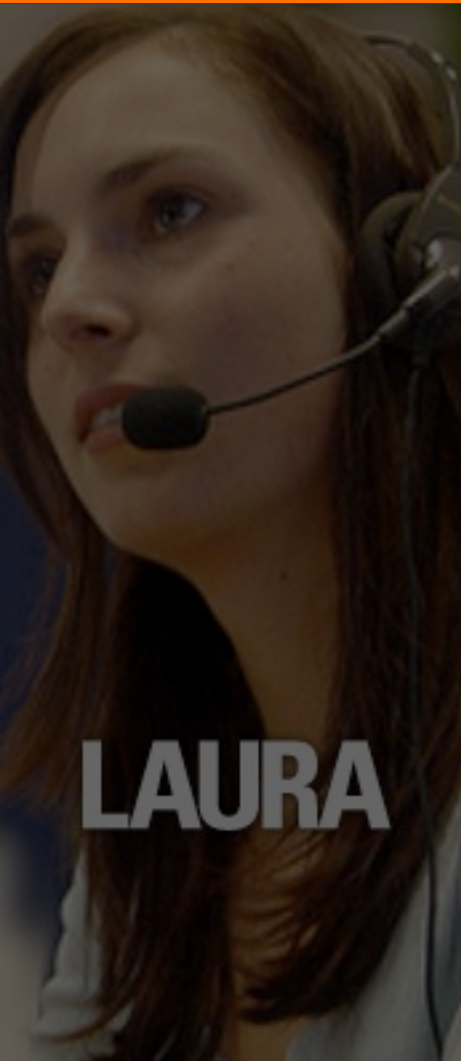
# KEY OBSERVATIONS

**Many roles rely on Pete** for orientation during plan updates and patient emergencies

# KEY OBSERVATIONS

**Many roles rely on Pete** for orientation during plan updates and patient emergencies

The plan is often tracked and managed tacitly, but Pete manages the Warboard **for the sake of communication and awareness**



LAURA



PETE



KARL



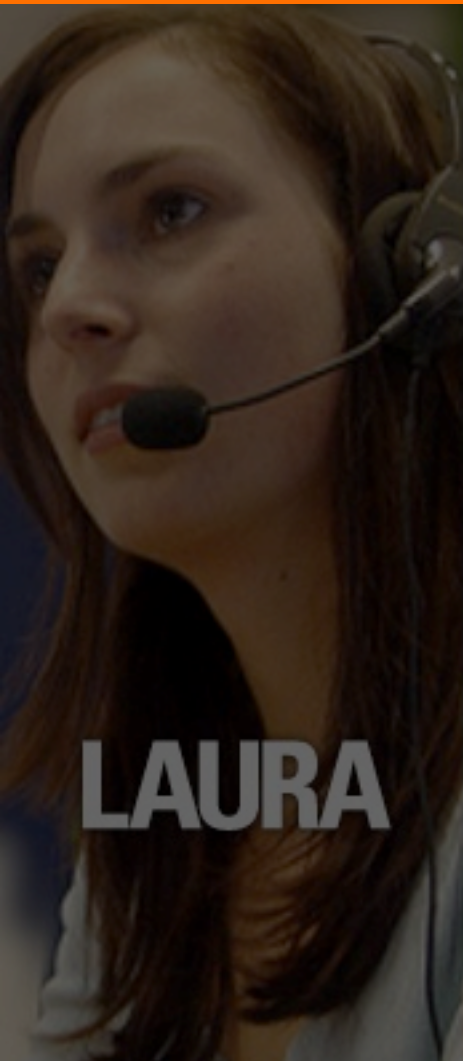
JIM

NEWS  
BROADCASTING

SURGICAL  
WARD

SPACE

SPACE



LAURA

NEWS  
BROADCASTING



PETE

SURGICAL  
WARD



KARL

SPACE



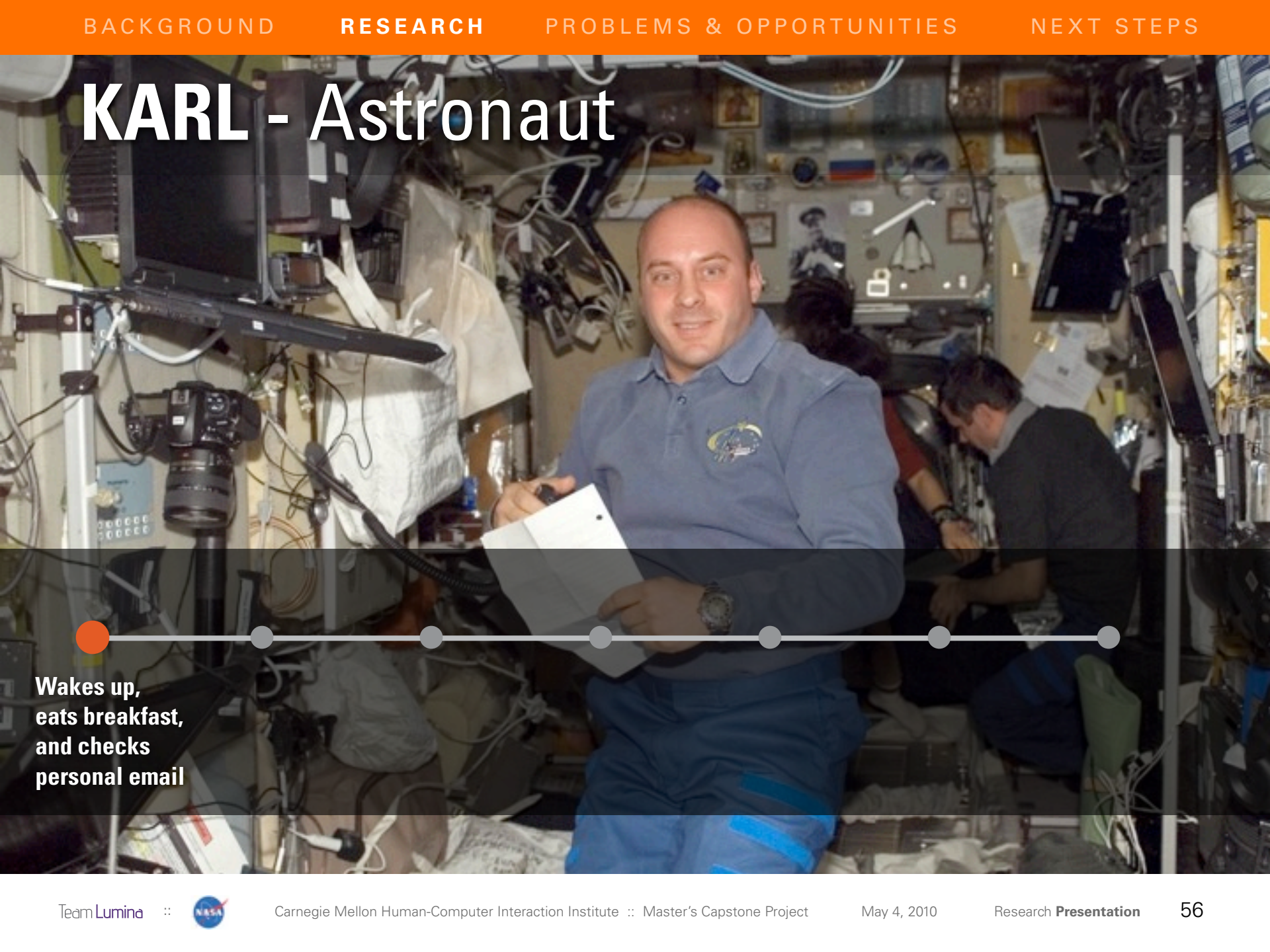
JIM

SPACE

# MEET KARL

- 
- A photograph of astronaut Karl in a space station module. He is wearing a blue polo shirt with a NASA patch and blue pants. He is holding a white folder and looking towards the camera. The background is filled with various equipment, cables, and another person working in the background.
- BACKGROUND:** 46-year-old **Astronaut**
- EXPERIENCE:** Second time in Space
- RESPONSIBILITY:** **Execute off of the plan**
- GOALS:** Wants to be **as helpful as possible**


# KARL - Astronaut



Wakes up,  
eats breakfast,  
and checks  
personal email



# KARL - Astronaut



Wakes up,  
eats breakfast,  
and checks  
personal email

**Opens up  
timeline to see  
today's activities**

# KARL - Astronaut

Wakes up,  
eats breakfast,  
and checks  
personal email

Opens up  
timeline to see  
today's activities

**Prepares for  
taking a photo  
of a volcanic  
eruption**

# KARL - Astronaut


Wakes up,  
eats breakfast,  
and checks  
personal email

Opens up  
timeline to see  
today's activities

Prepares for  
taking a photo  
of a volcanic  
eruption

**Could not locate  
the camera,  
contacts ground**

# KARL - Astronaut



Wakes up,  
eats breakfast,  
and checks  
personal email

Opens up  
timeline to see  
today's activities

Prepares for  
taking a photo  
of a volcanic  
eruption

Could not locate  
the camera,  
contacts ground

**Ground: The  
stowage notes  
didn't get  
updated, sorry**

# KARL - Astronaut

Wakes up,  
eats breakfast,  
and checks  
personal email

Opens up  
timeline to see  
today's activities

Prepares for  
taking a photo  
of a volcanic  
eruption

Could not locate  
the camera,  
contacts ground

Ground: The  
stowage notes  
didn't get  
updated, sorry

**Takes the  
photos and  
marks status as  
complete**

# KARL - Astronaut

Wakes up,  
eats breakfast,  
and checks  
personal email

Opens up  
timeline to see  
today's activities

Prepares for  
taking a photo  
of a volcanic  
eruption

Could not locate  
the camera,  
contacts ground

Ground: The  
stowage notes  
didn't get  
updated, sorry

Takes the  
photos and  
marks status as  
complete

**Wants to  
exercise instead  
of doing next  
activity**

# KARL - Astronaut

**Plan View vs  
Execution View**

**Different  
Payloads**

**Unforeseen  
Circumstances**

**Human  
Error**

**Task  
Priorities**

**Re-planning**

**Desire for  
Autonomy**

Wakes up,  
eats breakfast,  
and checks  
personal email

Opens up  
timeline to see  
today's activities

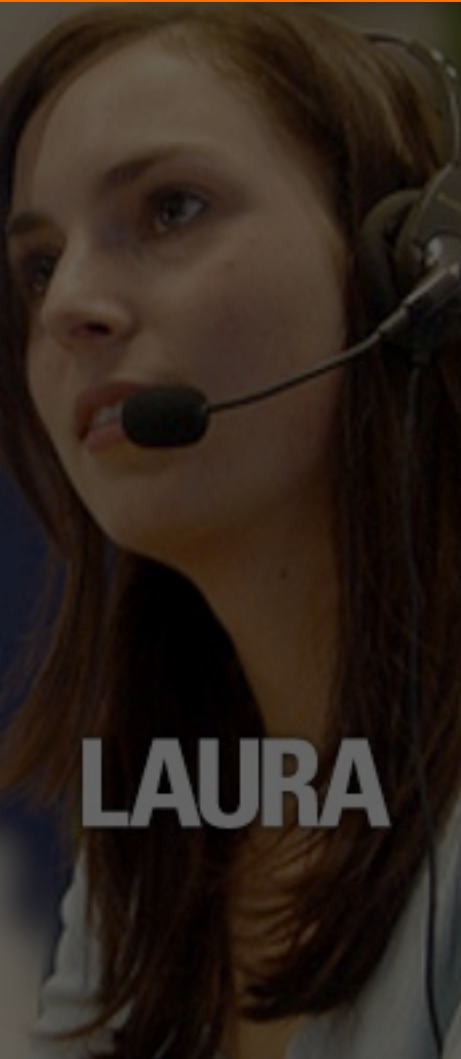
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photos and  
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next activity



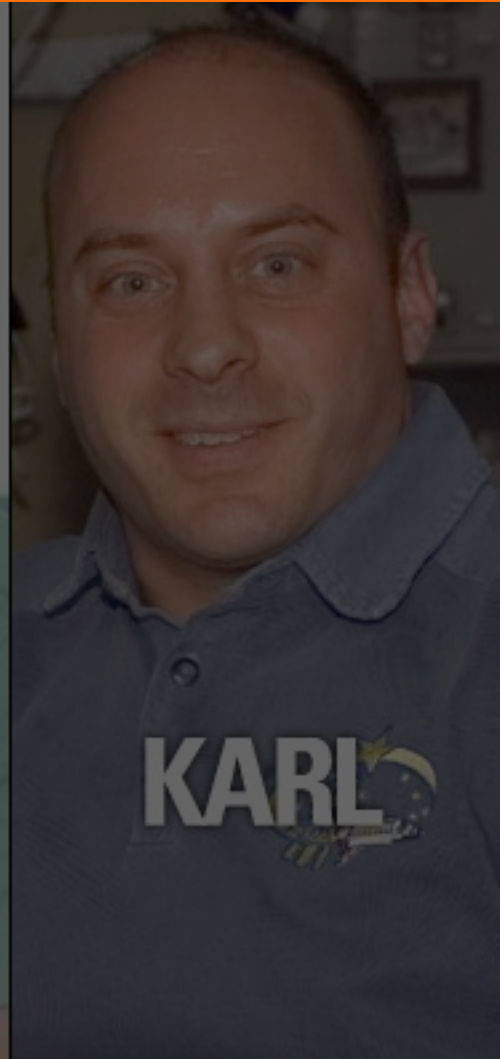
LAURA

NEWS  
BROADCASTING



PETE

SURGICAL  
WARD



KARL

SPACE



JIM

SPACE



# MEET JIM

**BACKGROUND:**

39-year-old **Real-Time Planning Engineer (RPE)**

**EXPERIENCE:**

Was a Shuttle Planner for 3 yrs, RPE for 4 yrs


**RESPONSIBILITY:**

**Implement real-time changes to the plan**

**GOALS:**


Ensure that the plan is **as accurate as possible**

# JIM - Real-time Planning Engineer



Arrives at console early in the morning

# JIM - Real-time Planning Engineer



Arrives at console early in the morning

**Reads previous shift's console log**

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Arrives at console early in the morning

Reads previous shift's console log

**Gets on the loop for Daily Planning Conference**

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Arrives at console early in the morning

Reads previous shift's console log

Gets on the loop for Daily Planning Conference

**Ops Planner: Astronaut Karl wants to change his exercise time**

# JIM - Real-time Planning Engineer

Arrives at console early in the morning

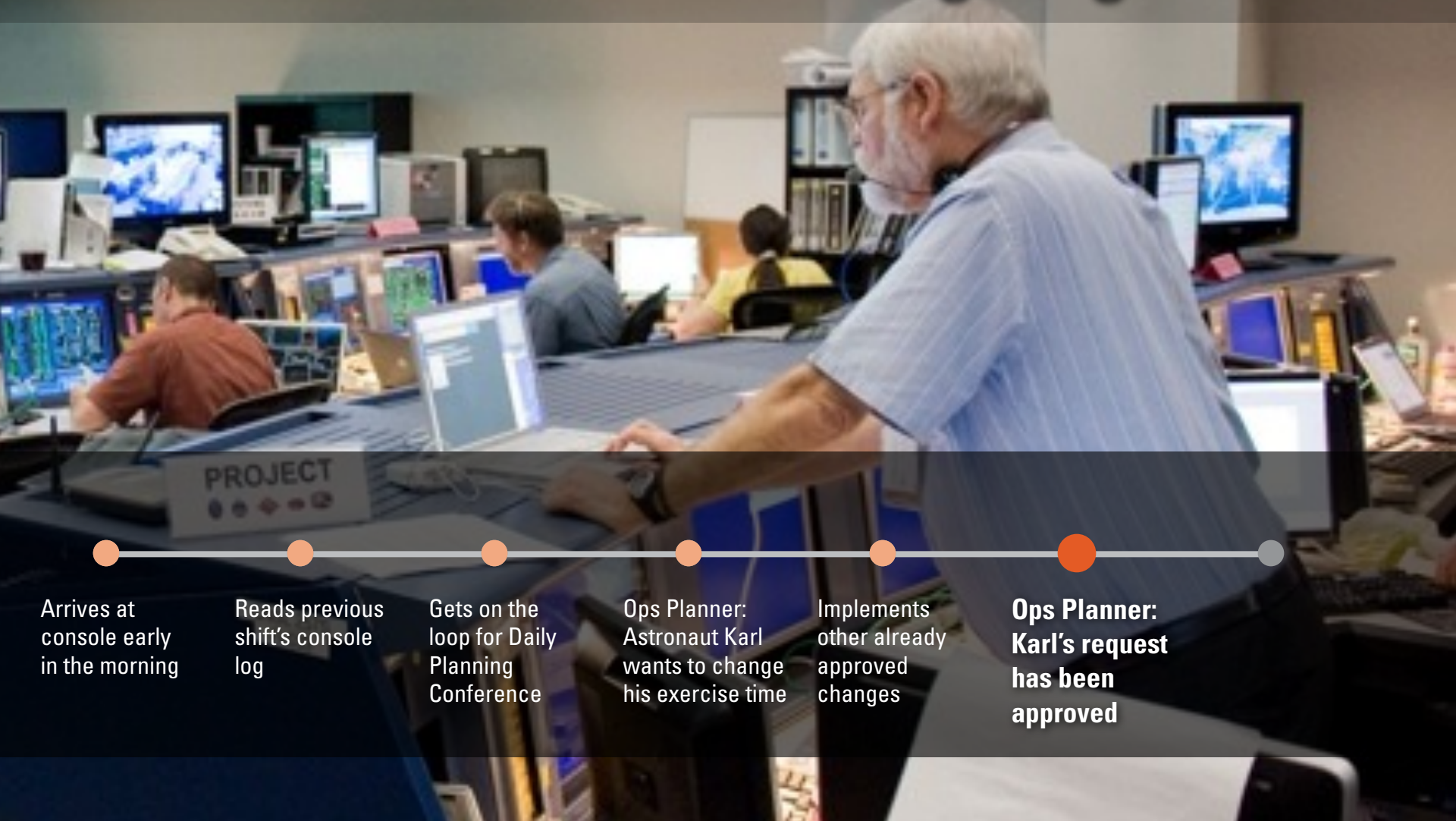
Reads previous shift's console log

Gets on the loop for Daily Planning Conference

Ops Planner: Astronaut Karl wants to change his exercise time

**Implements other already approved changes**

# JIM - Real-time Planning Engineer



Arrives at console early in the morning

Reads previous shift's console log

Gets on the loop for Daily Planning Conference

Ops Planner: Astronaut Karl wants to change his exercise time

Implements other already approved changes

**Ops Planner: Karl's request has been approved**

# JIM - Real-time Planning Engineer

Arrives at console early in the morning

Reads previous shift's console log

Gets on the loop for Daily Planning Conference

Ops Planner: Astronaut Karl wants to change his exercise time

Implements other already approved changes

Ops Planner: Karl's request has been approved

**Implements Karl's request to the plan**



# JIM - Real-time Planning Engineer

Shift Handoffs

Multiple Roles Affecting The Plan

Desire for Autonomy

Communication Delays

Unforeseen Circumstances

Version Control

Re-planning

Plan View vs Execution View

Arrives at console early in the morning

Reads previous shift's console log

Gets on the loop for Daily Planning Conference

Ops Planner: Astronaut Karl wants to change his exercise time

Implements other already approved changes

Ops Planner: Karl's request has been approved

Implements Karl's request to the plan

# KEY OBSERVATIONS

Jim and Karl both need different kinds of information from the same plan

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Karl **executes the plan out of order**

# KEY OBSERVATIONS

Jim and Karl both need different kinds of information from the same plan

Karl **executes the plan out of order**

The **payload takes precedence over the plan**



**LAURA**



**PETE**



**KARL**



**JIM**

NEWS  
BROADCASTING

SURGICAL  
WARD

SPACE

SPACE



BACKGROUND

RESEARCH

**PROBLEMS & OPPORTUNITIES**

NEXT STEPS





20 Literature Reviews  
6 Competitive Analyses  
6 Contextual Inquiries  
3 Interviews

} ~300 Findings



- 20 Literature Review
- 6 Competitive Analysis
- 6 Contextual Inquiries
- 3 Interviews

} 300 Findings }

**7 Categories**



① **Inflexible Plans** fail to capture the variable nature of execution



② The difficulties of **communicating experiential** and **in situ knowledge** results in uninformed plan making



③ **Shift handoffs** with roles often involve poor information transfer, resulting in poor situational awareness and increased expense



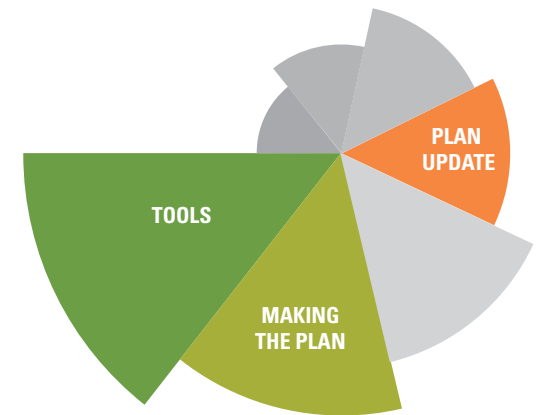
④ Dependencies between **highly siloed roles** ungracefully accommodates human error, which has cascading effects



⑤ Any **single representation of the plan** fails to accommodate the varying needs and responsibilities across roles utilizing the plan



# 1 **Inflexible Plans** fail to capture the variable nature of execution



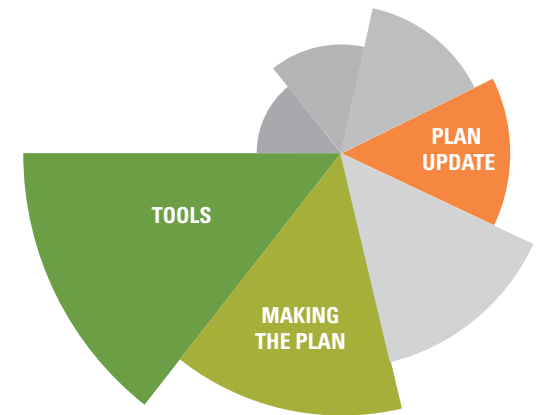
# 1 Inflexible Plans fail to capture the variable nature of execution

## DESCRIPTION

## EVIDENCE

## RECOMMENDATIONS

- Plans are often deliberately inflexible



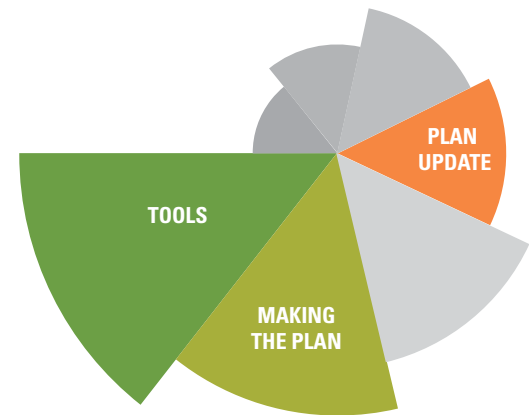
# 1 Inflexible Plans fail to capture the variable nature of execution

## DESCRIPTION

## EVIDENCE

## RECOMMENDATIONS

- Plans are often deliberately inflexible
- Discrepancies arise between the plan and actual execution
  - inflexible plans fail to capture the “fuzzy” nature of execution



# 1 Inflexible Plans fail to capture the variable nature of execution

DESCRIPTION

**EVIDENCE**

RECOMMENDATIONS



# 1 Inflexible Plans fail to capture the variable nature of execution

DESCRIPTION

**EVIDENCE**

RECOMMENDATIONS



*“The plan is just a suggestion...”*

*Former astronaut (3/1/2010)*

# 1 Inflexible Plans fail to capture the variable nature of execution

DESCRIPTION

**EVIDENCE**

RECOMMENDATIONS




The **plan is a contract** between planners & executors

# 1 Inflexible Plans fail to capture the variable nature of execution

DESCRIPTION

EVIDENCE

**RECOMMENDATIONS**

Support **continuous planning**  
- planning extends throughout execution



# 1 Inflexible Plans fail to capture the variable nature of execution

DESCRIPTION

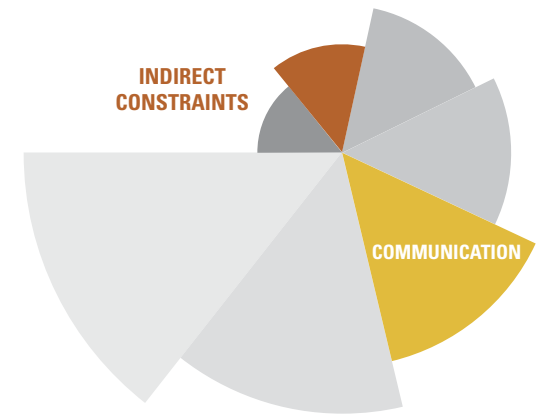
EVIDENCE

**RECOMMENDATIONS**

Support **continuous planning**  
- planning extends throughout execution

**Allow executors to schedule** time  
insensitive activities

## ② The difficulties of **communicating experiential** and ***in situ*** knowledge results in uninformed plan making



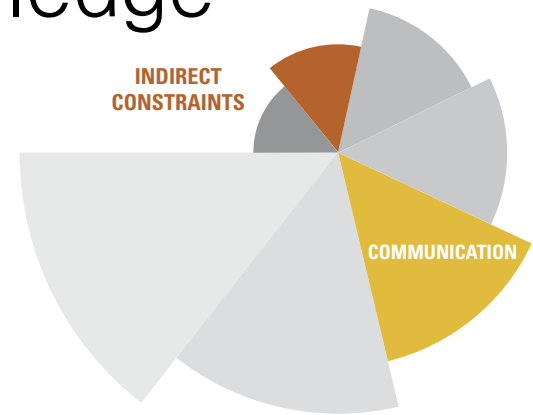
- 2** The difficulties of **communicating experiential** and **in situ knowledge** results in uninformed plan making

**DESCRIPTION**

## EVIDENCE

## RECOMMENDATIONS

- Soft constraints: personal goals, organizational standards, skill disparities
- Reliance on experiential knowledge in the plan creation process



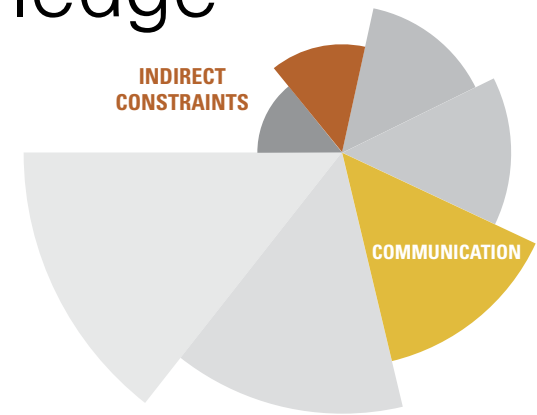
## 2 The difficulties of **communicating experiential** and **in situ knowledge** results in uninformed plan making

### DESCRIPTION

### EVIDENCE

### RECOMMENDATIONS

- Soft constraints: personal goals, organizational standards, skill disparities
- Reliance on experiential knowledge in the plan creation process
  - Process Knowledge



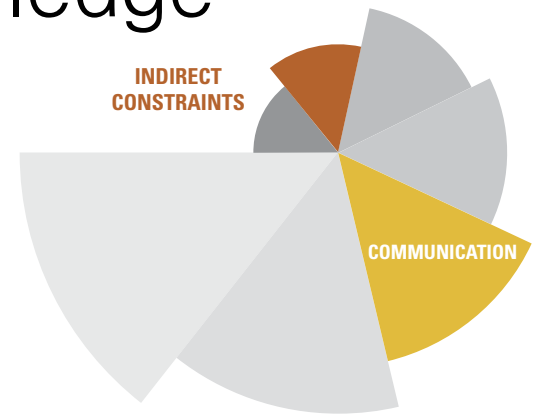
## 2 The difficulties of **communicating experiential** and **in situ knowledge** results in uninformed plan making

### DESCRIPTION

### EVIDENCE

### RECOMMENDATIONS

- Soft constraints: personal goals, organizational standards, skill disparities
- Reliance on experiential knowledge in the plan creation process
  - Process Knowledge
  - Planning Knowledge



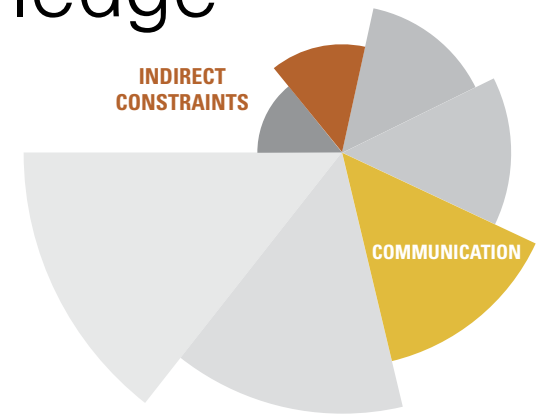
## 2 The difficulties of **communicating experiential** and **in situ knowledge** results in uninformed plan making

### DESCRIPTION

### EVIDENCE

### RECOMMENDATIONS

- Soft constraints: personal goals, organizational standards, skill disparities
- Reliance on experiential knowledge in the plan creation process
  - Process Knowledge
  - Planning Knowledge
  - Real-time Response Knowledge

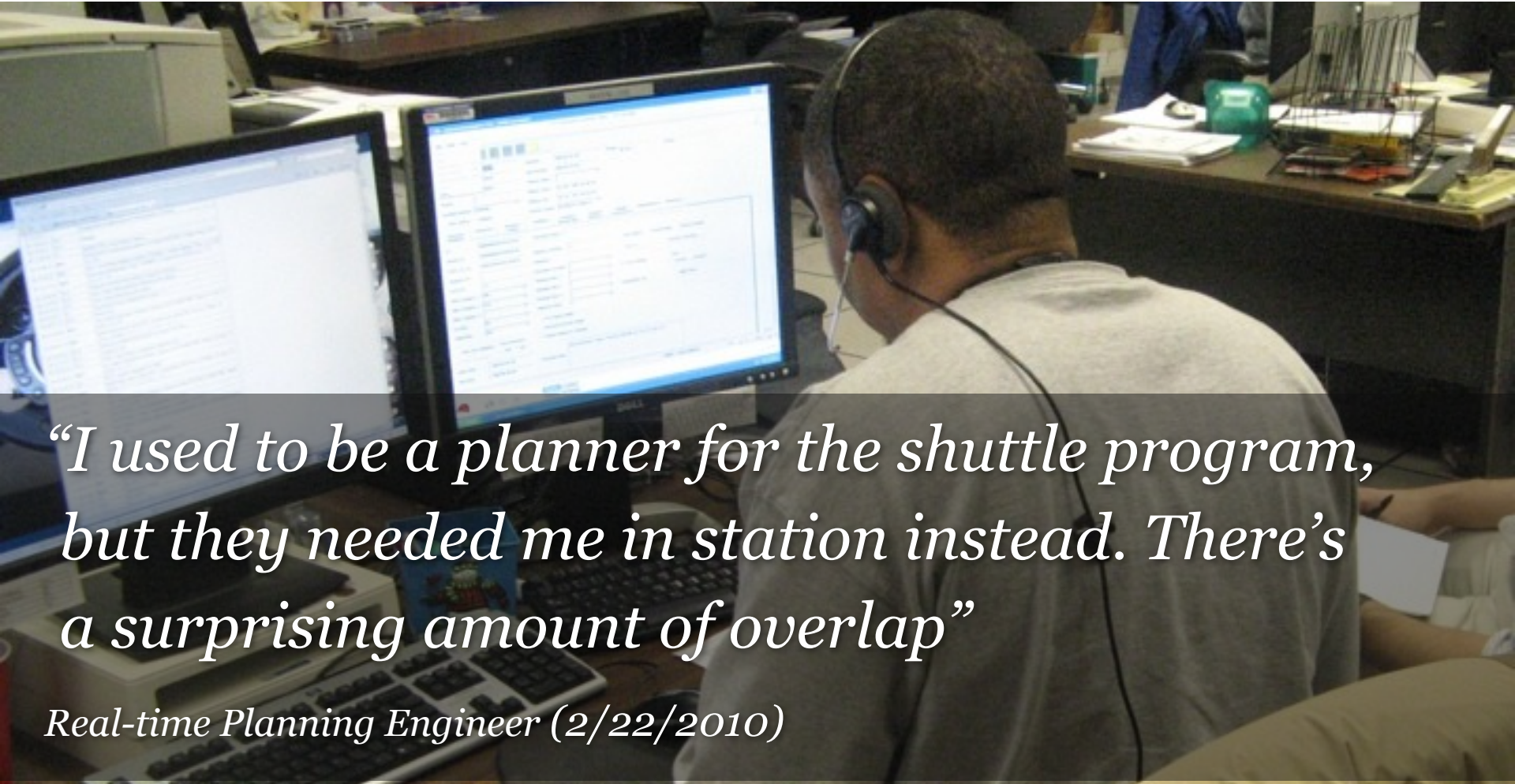


## 2 The difficulties of **communicating experiential** and **in situ knowledge** results in uninformed plan making

DESCRIPTION

**EVIDENCE**

RECOMMENDATIONS



*“I used to be a planner for the shuttle program, but they needed me in station instead. There’s a surprising amount of overlap”*

*Real-time Planning Engineer (2/22/2010)*

## 2 The difficulties of **communicating experiential** and **in situ knowledge** results in uninformed plan making

DESCRIPTION

**EVIDENCE**

RECOMMENDATIONS



*“[The CAPCOM]’s really good at the happy words, making the crew feel comfortable.”*

*Real-time Planning Engineer Support (2/23/2010)*



**2** The difficulties of **communicating experiential** and **in situ knowledge** results in uninformed plan making

DESCRIPTION

**EVIDENCE**

RECOMMENDATIONS


A portrait of a middle-aged man with short, graying hair and a mustache, smiling. He is wearing a light blue button-down shirt. The background is a blurred outdoor scene with buildings.

Assembles surgical teams based on **indirect constraints**

## 2 The difficulties of **communicating experiential** and **in situ knowledge** results in uninformed plan making

DESCRIPTION

EVIDENCE


**RECOMMENDATIONS**

**Capture and expose knowledge** where possible

## 2 The difficulties of **communicating experiential** and **in situ knowledge** results in uninformed plan making

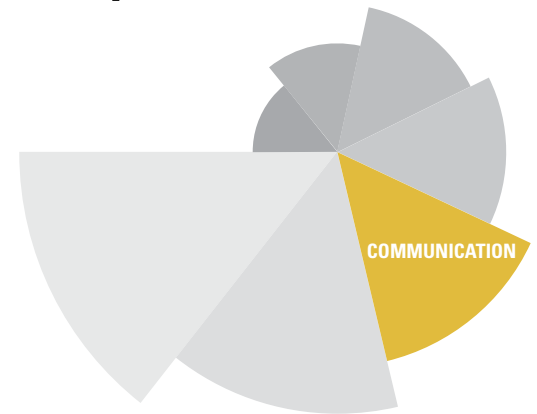
DESCRIPTION

EVIDENCE

**RECOMMENDATIONS**

**Capture and expose knowledge** where possible  
Offer **contextual help** to novices

**3 Shift handoffs** with roles often involve poor information transfer, resulting in poor situational awareness and increased expense



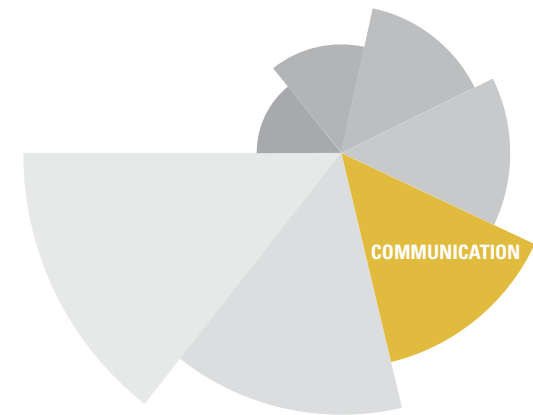
- 3 Shift handoffs** with roles often involve poor information transfer, resulting in poor situational awareness and increased expense

**DESCRIPTION**

## EVIDENCE

## RECOMMENDATIONS

- Ensure that the new shift has the knowledge necessary to continue the plan



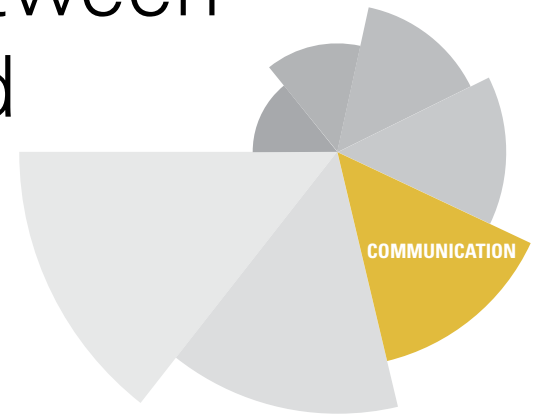
- 3 Shift handoffs** with roles often involve poor information transfer, resulting in poor situational awareness and increased expense

**DESCRIPTION**

## EVIDENCE

## RECOMMENDATIONS

- Ensure that the new shift has the knowledge necessary to continue the plan
- Inefficient communication between roles impact plan iteration and execution



**3 Shift handoffs** with roles often involve poor information transfer, resulting in poor situational awareness and increased expense

DESCRIPTION

**EVIDENCE**

RECOMMENDATIONS

*“Our team doesn’t do shift handoffs well... [it happens] usually in emails or at the water cooler”*

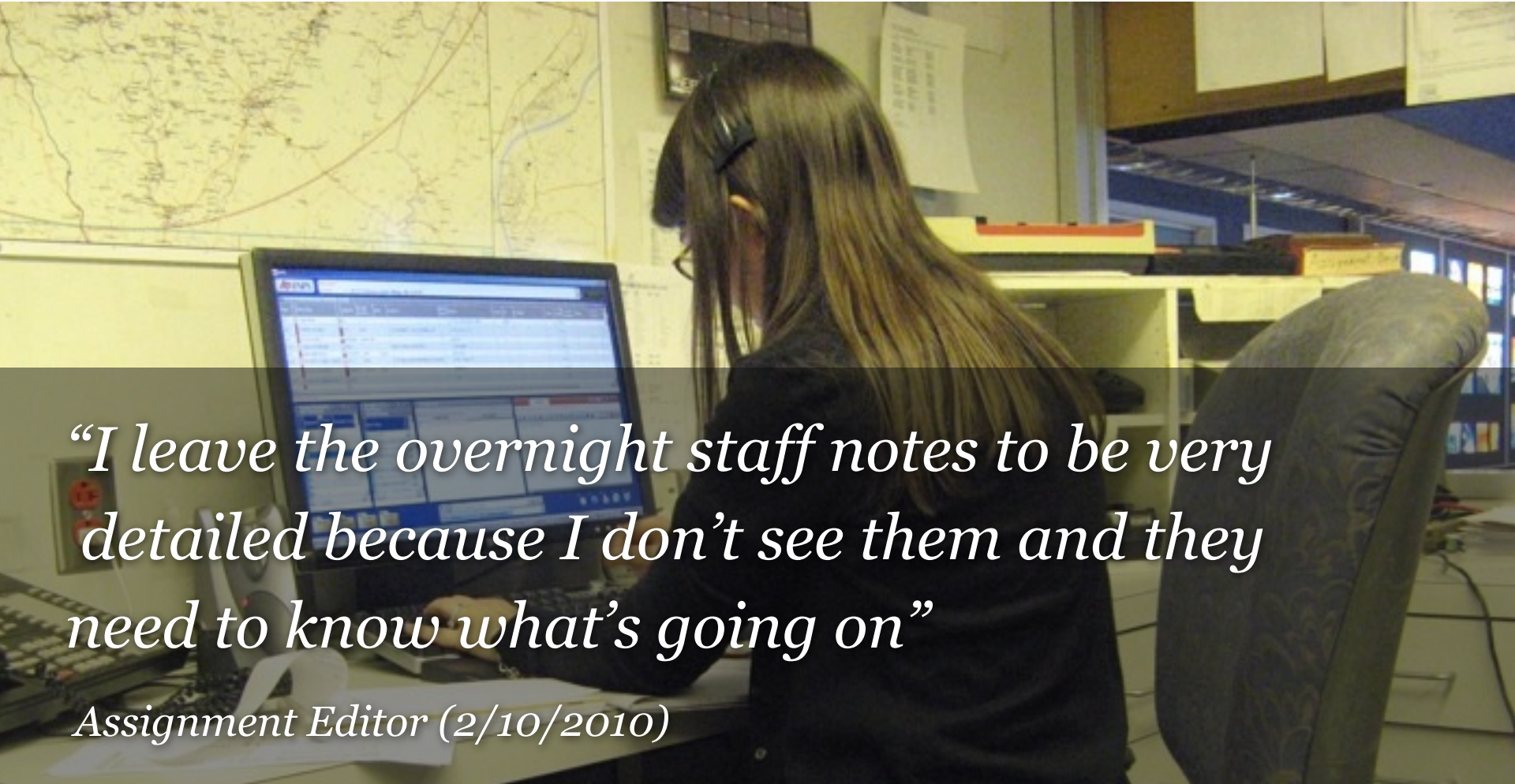
*Specialist (2/26/2010)*

### 3 Shift handoffs with roles often involve poor information transfer, resulting in poor situational awareness and increased expense

DESCRIPTION

EVIDENCE

RECOMMENDATIONS



*“I leave the overnight staff notes to be very detailed because I don’t see them and they need to know what’s going on”*

*Assignment Editor (2/10/2010)*



**3 Shift handoffs** with roles often involve poor information transfer, resulting in poor situational awareness and increased expense

DESCRIPTION

**EVIDENCE**

RECOMMENDATIONS




*“The night-shift is incompetent, so I start their work before I leave”*

*Charge Nurse (3/10/2010)*

### 3 Shift handoffs with roles often involve poor information transfer, resulting in poor situational awareness and increased expense

DESCRIPTION

EVIDENCE

**RECOMMENDATIONS**

**Streamline** shift handoffs

### 3 Shift handoffs with roles often involve poor information transfer, resulting in poor situational awareness and increased expense

DESCRIPTION

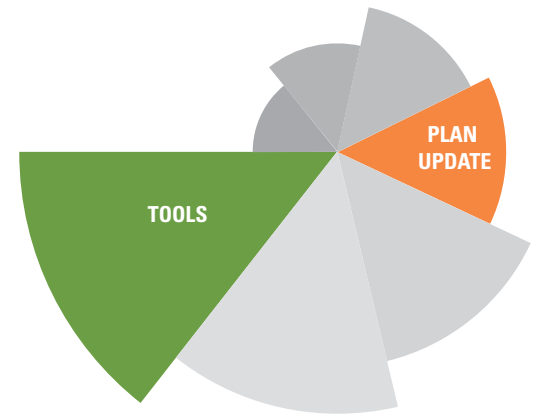
EVIDENCE

**RECOMMENDATIONS**

**Streamline** shift handoffs

**Automatically integrate** shift handoffs during execution

④ Dependencies between **highly siloed roles** ungracefully accommodate human error, which has cascading effects



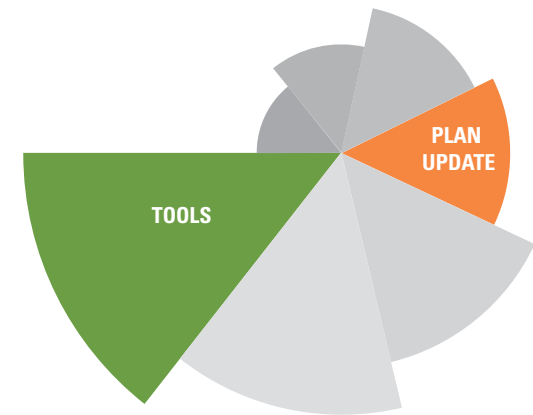
- 4 Dependencies between **highly siloed roles** ungracefully accommodate human error, which has cascading effects

**DESCRIPTION**

## EVIDENCE

## RECOMMENDATIONS

- Multiple roles and tools promote input error that impacts execution



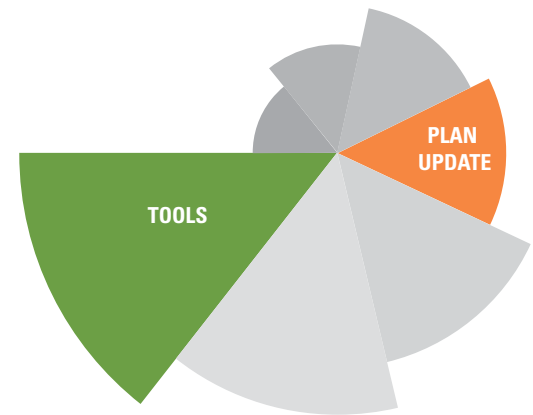
- 4 Dependencies between **highly siloed roles** ungracefully accommodate human error, which has cascading effects

**DESCRIPTION**

## EVIDENCE

## RECOMMENDATIONS

- Multiple roles and tools promote input error that impacts execution
- Unforeseen incidents are often internally originated



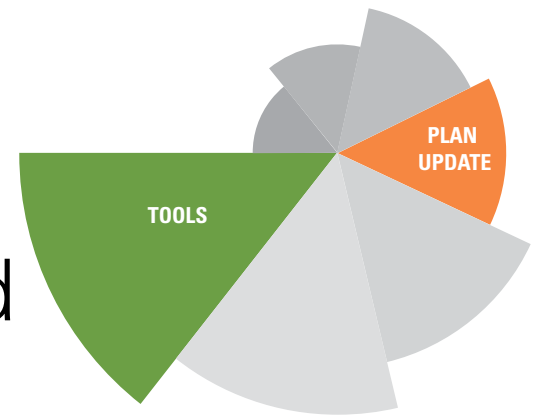
- 4 Dependencies between **highly siloed roles** ungracefully accommodate human error, which has cascading effects

**DESCRIPTION**

## EVIDENCE

## RECOMMENDATIONS

- Multiple roles and tools promote input error that impacts execution
- Unforeseen incidents are often internally originated
- A plan scattered across many roles prevents systematic and unified updates



## 4 Dependencies between **highly siloed roles** ungracefully accommodate human error, which has cascading effects

DESCRIPTION

**EVIDENCE**

RECOMMENDATIONS



**Inventory Manager:** tracks ISS equipment locations  
**Procedure Writers:** assumes the ISS is accurately inventoried



## 4 Dependencies between **highly siloed roles** ungracefully accommodate human error, which has cascading effects

DESCRIPTION

**EVIDENCE**

RECOMMENDATIONS



**Inventory inaccuracies** impact plan execution

- 4 Dependencies between **highly siloed roles** ungracefully accommodate human error, which has cascading effects

DESCRIPTION

EVIDENCE

RECOMMENDATIONS

*“The meteorologist sometimes doesn’t listen to constraints, and it becomes a big problem because other stories can get cut”*

*Assignment Editor (2/10/2010)*



# 4 Dependencies between **highly siloed roles** ungracefully accommodate human error, which has cascading effects

## DESCRIPTION

## EVIDENCE

## RECOMMENDATIONS



# Too many roles and tools



## 4 Dependencies between **highly siloed roles** ungracefully accommodate human error, which has cascading effects

DESCRIPTION

EVIDENCE

**RECOMMENDATIONS**

Reduce **diffusion of responsibility**

## 4 Dependencies between **highly siloed roles** ungracefully accommodate human error, which has cascading effects

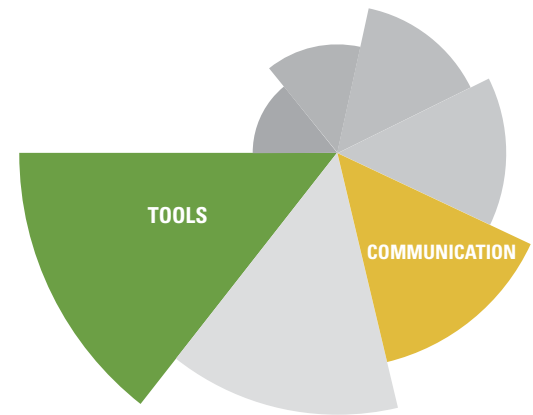
DESCRIPTION

EVIDENCE

**RECOMMENDATIONS**

Reduce **diffusion of responsibility**  
**Consolidate tools**

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



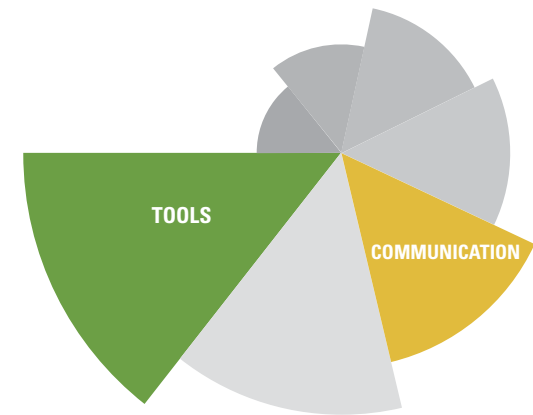
- 5 Any **single representation of the plan** fails to accommodate the varying needs and responsibilities across roles utilizing the plan

**DESCRIPTION**

## EVIDENCE

## RECOMMENDATIONS

- The plan is viewed, interpreted, and updated by many different roles



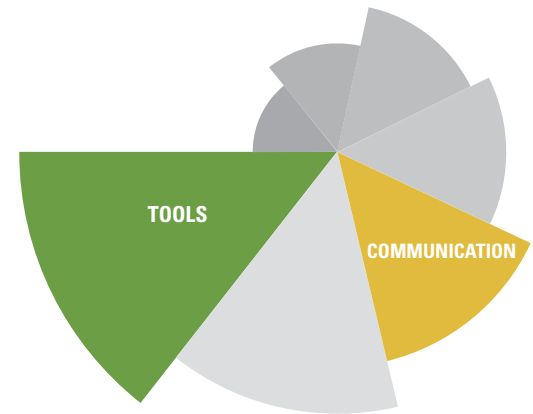
- 5 Any **single representation of the plan** fails to accommodate the varying needs and responsibilities across roles utilizing the plan

**DESCRIPTION**

## EVIDENCE

## RECOMMENDATIONS

- The plan is viewed, interpreted, and updated by many different roles
- Plan structure often does not match how plans are naturally conceptualized





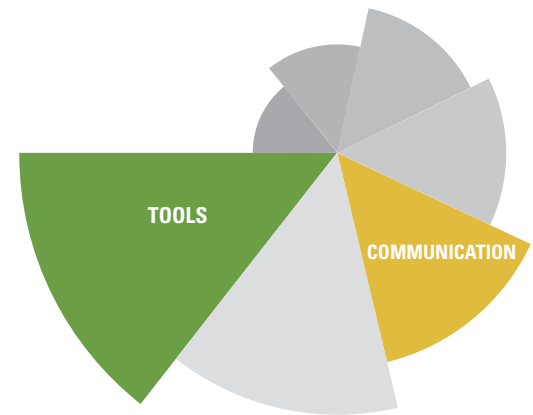
- 5 Any **single representation of the plan** fails to accommodate the varying needs and responsibilities across roles utilizing the plan

**DESCRIPTION**

## EVIDENCE

## RECOMMENDATIONS

- The plan is viewed, interpreted, and updated by many different roles
- Plan structure often does not match how plans are naturally conceptualized
- The plan must accommodate a variety goals among roles

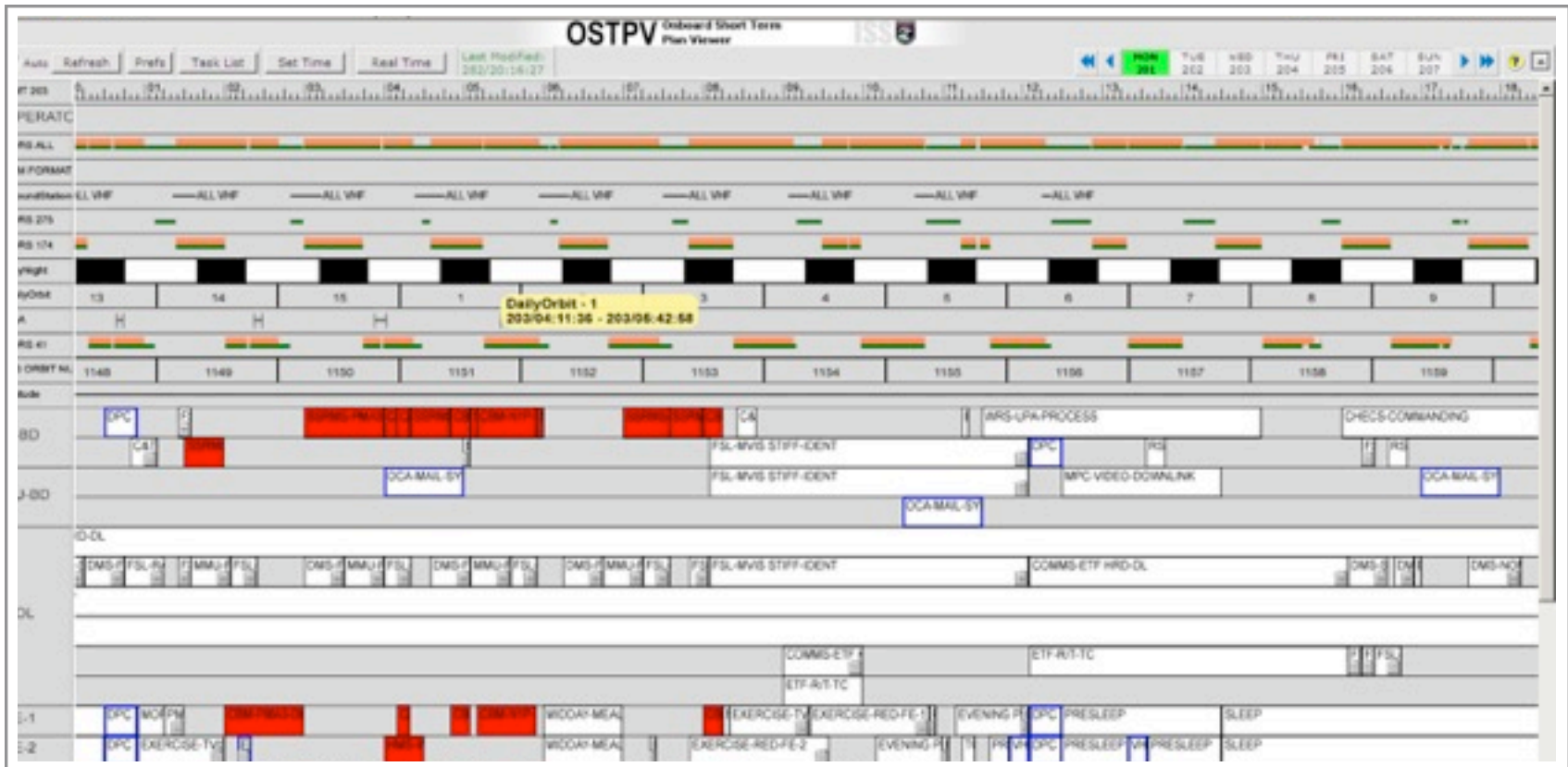


- 5 Any **single representation of the plan** fails to accommodate the varying needs and responsibilities across roles utilizing the plan

DESCRIPTION

EVIDENCE

RECOMMENDATIONS



## ISS On Board Plan

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

DESCRIPTION

EVIDENCE

RECOMMENDATIONS



## Astro Karl's Plan

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

DESCRIPTION

EVIDENCE

RECOMMENDATIONS

Date: 2-19-10

The spaces are filled in by names of the surgeons, scrub nurses, circulation nurses

OR	START TIME	AM SURGEON	SCRUB	CIRC	LUNCH SCRUB	LUNCH CIRC
1	645					
2	700					
3						
4	730					
5						
6	730					
7	730					
8	830					
9	730					
10	1030					
11	700					
12	715					

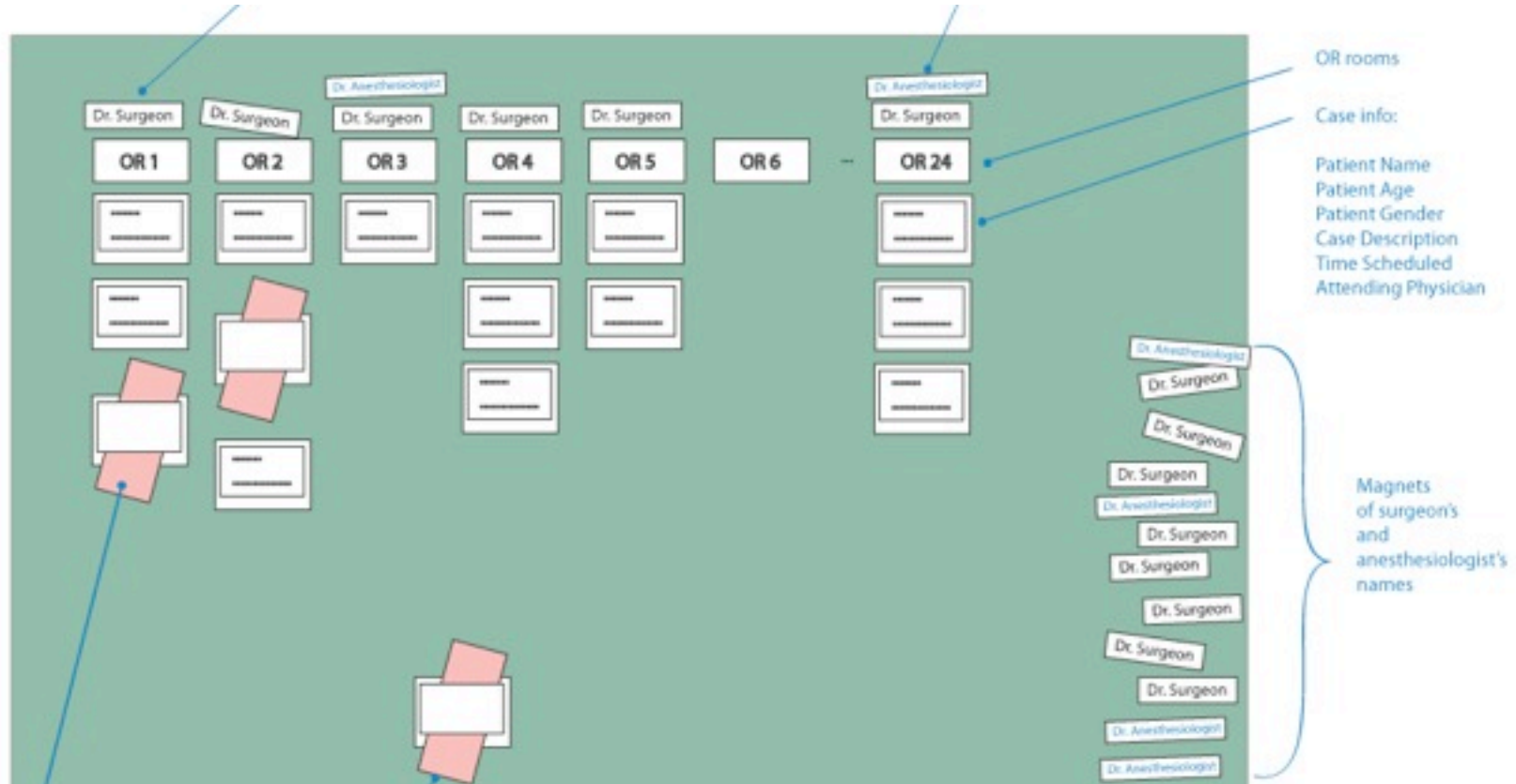
## Nurse's Plan

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

DESCRIPTION

EVIDENCE

RECOMMENDATIONS



## Public Plan

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

DESCRIPTION

EVIDENCE

**RECOMMENDATIONS**

**Tailor the plan structure** to each role

① **Inflexible Plans** fail to capture the variable nature of execution



② The difficulties of **communicating experiential** and **in situ knowledge** results in uninformed plan making



③ **Shift handoffs** with roles often involve poor information transfer, resulting in poor situational awareness and increased expense



④ Dependencies between **highly siloed roles** ungracefully accommodates human error, which has cascading effects



⑤ Any **single representation of the plan** fails to accommodate the varying needs and responsibilities across roles utilizing the plan



① **Inflexible Plans** fail to capture the variable nature of execution



② The difficulties of **in situ knowledge**



③ **Shift handoff** resulting in **transfer, sense**



④ Dependencies **accommodates**



⑤ Any **single representation** to accommodate the varying needs and responsibilities across roles utilizing the plan



# Complex Planning Space



BACKGROUND

RESEARCH

PROBLEMS & OPPORTUNITIES

**NEXT STEPS**



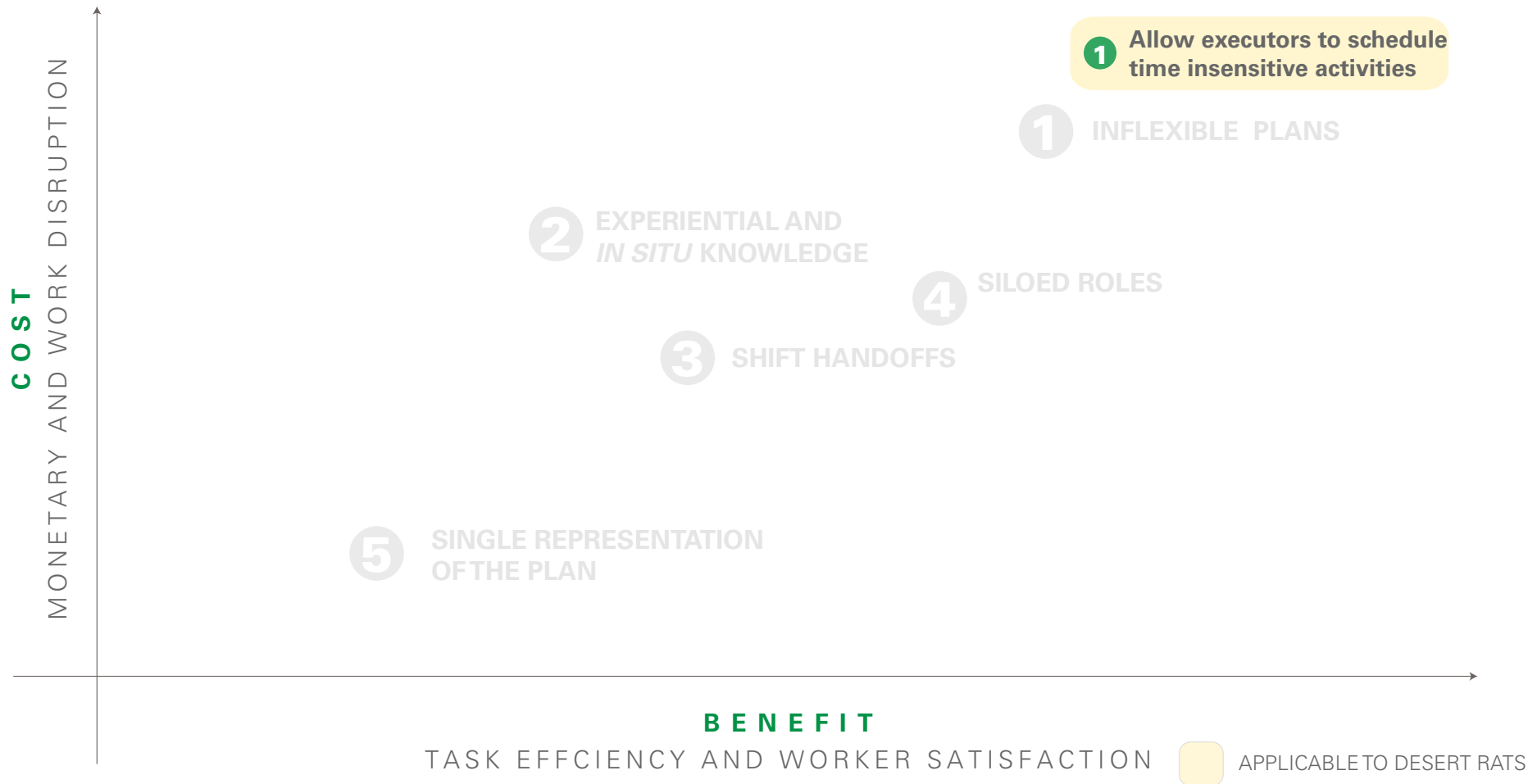


# Desert Research and Technology Studies

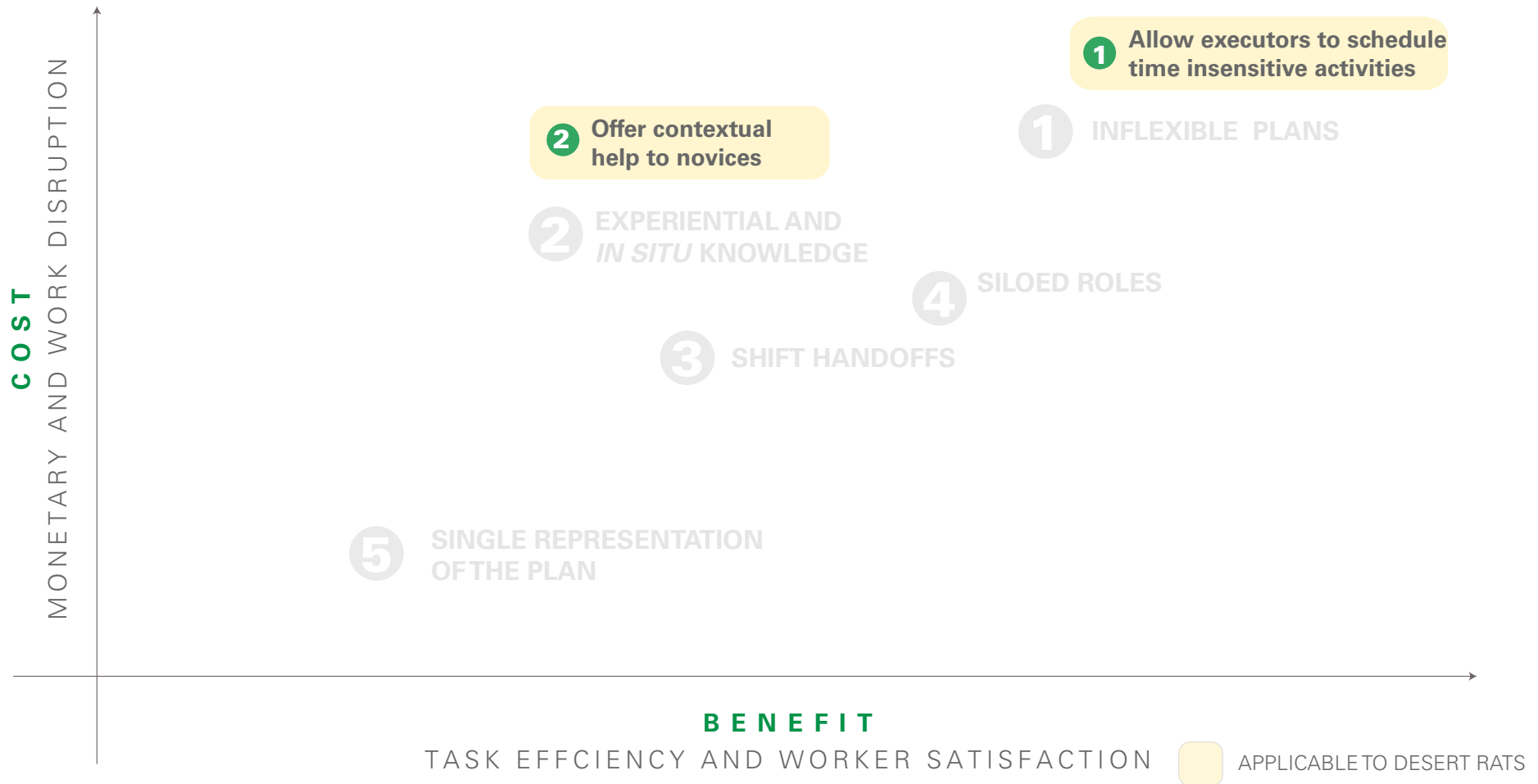
# COST-BENEFIT COMPARISON



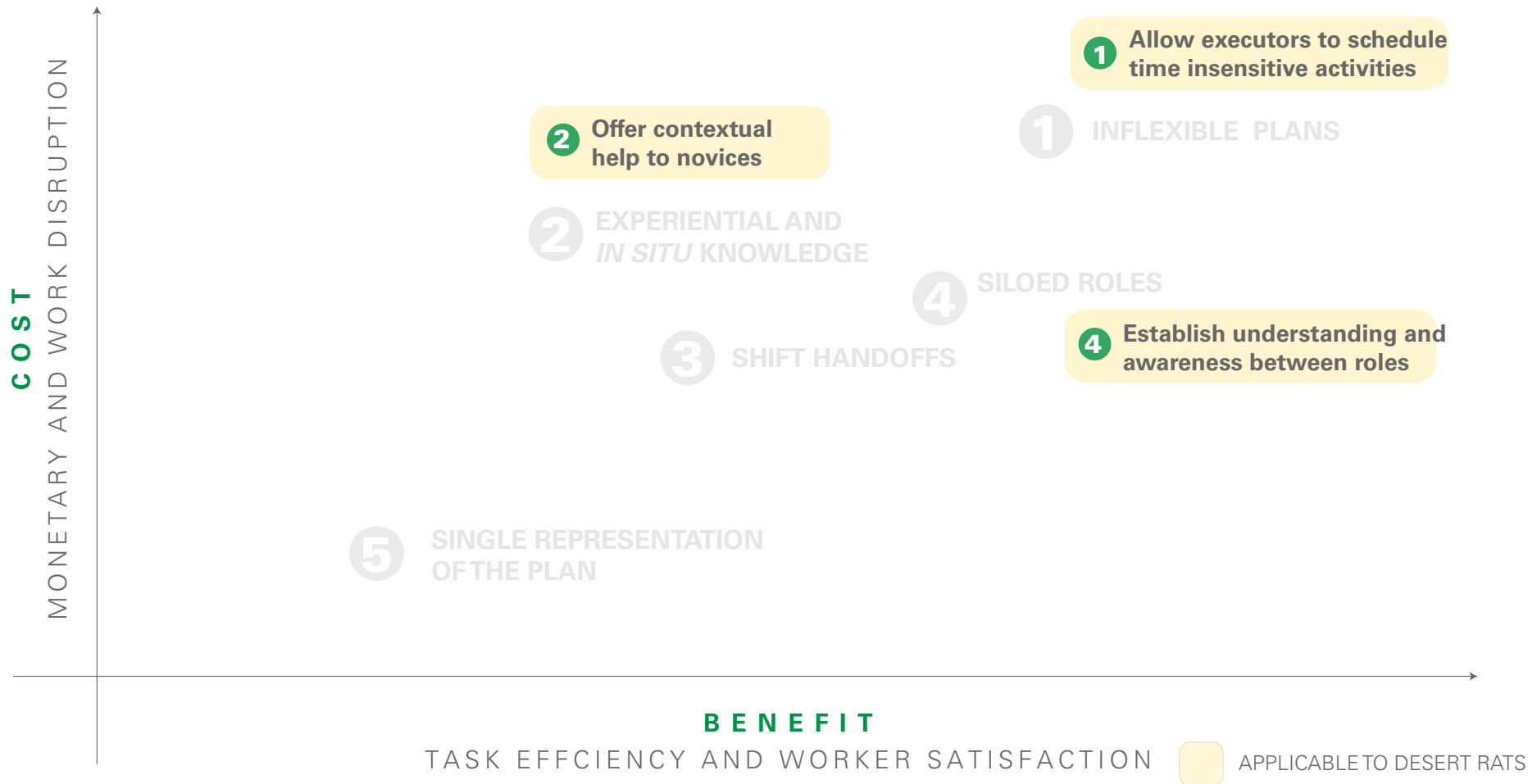
# COST-BENEFIT COMPARISON



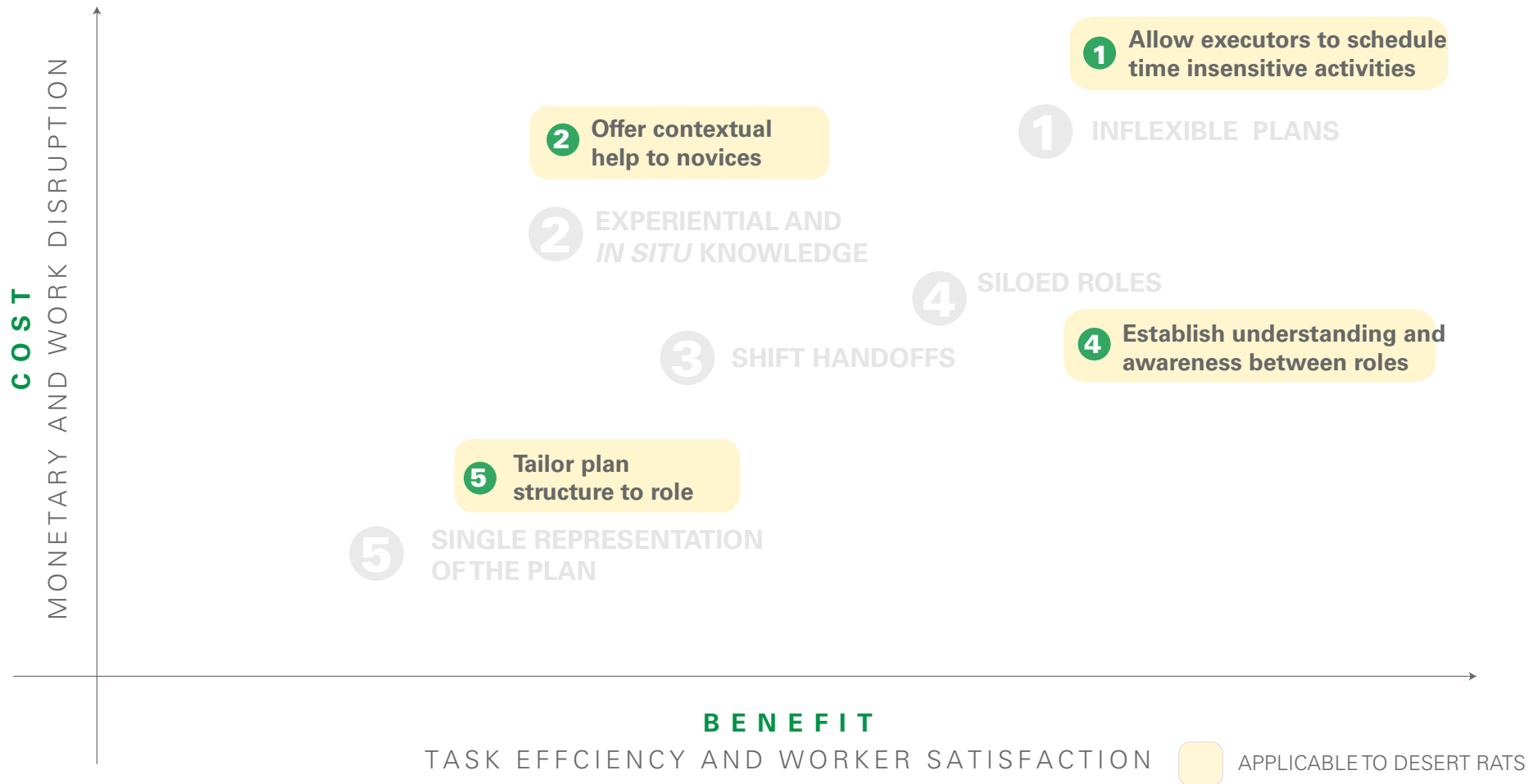
# COST-BENEFIT COMPARISON



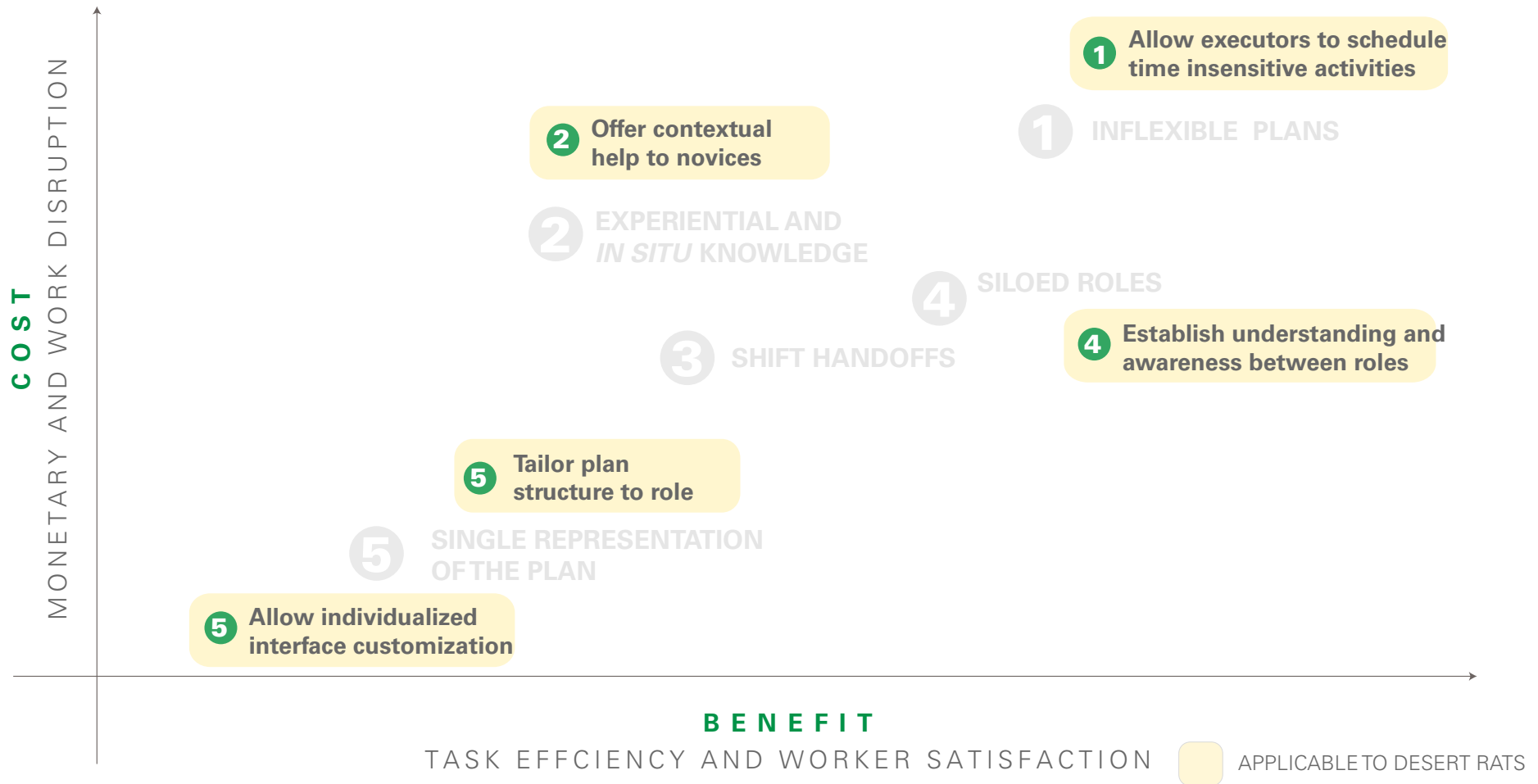
# COST-BENEFIT COMPARISON



# COST-BENEFIT COMPARISON

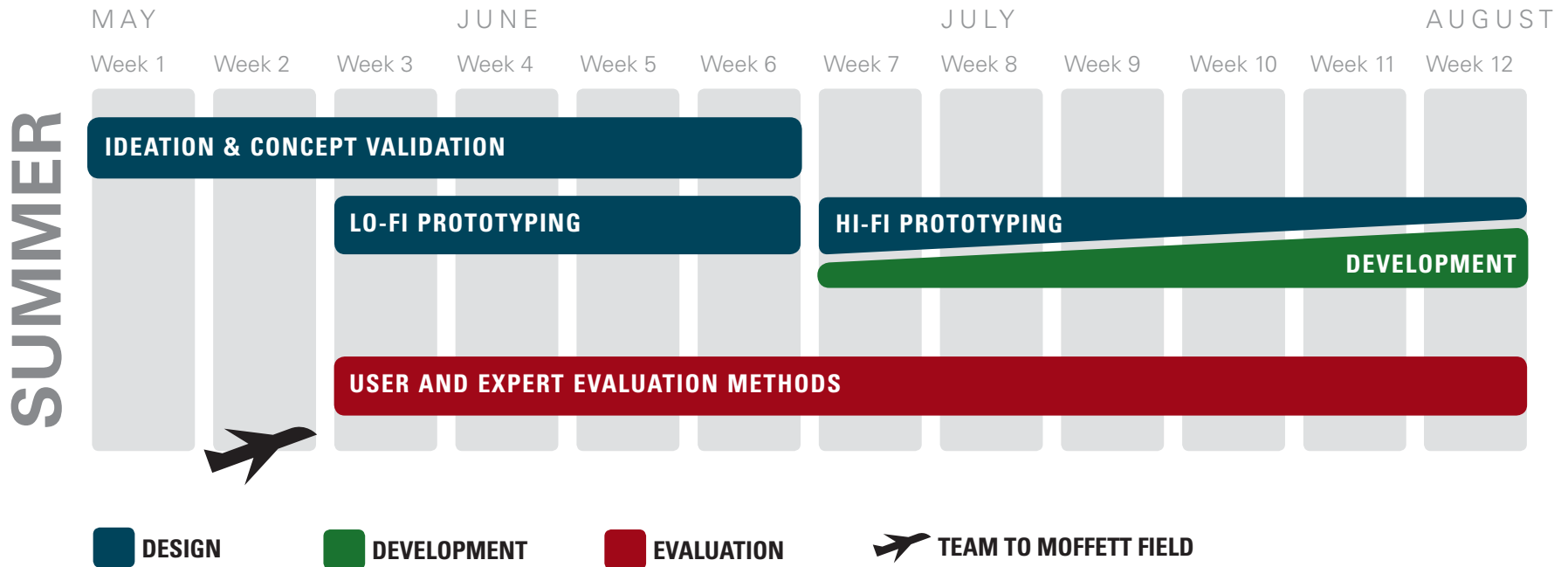


# COST-BENEFIT COMPARISON





# SCHEDULE



# THANK YOU!

Questions?



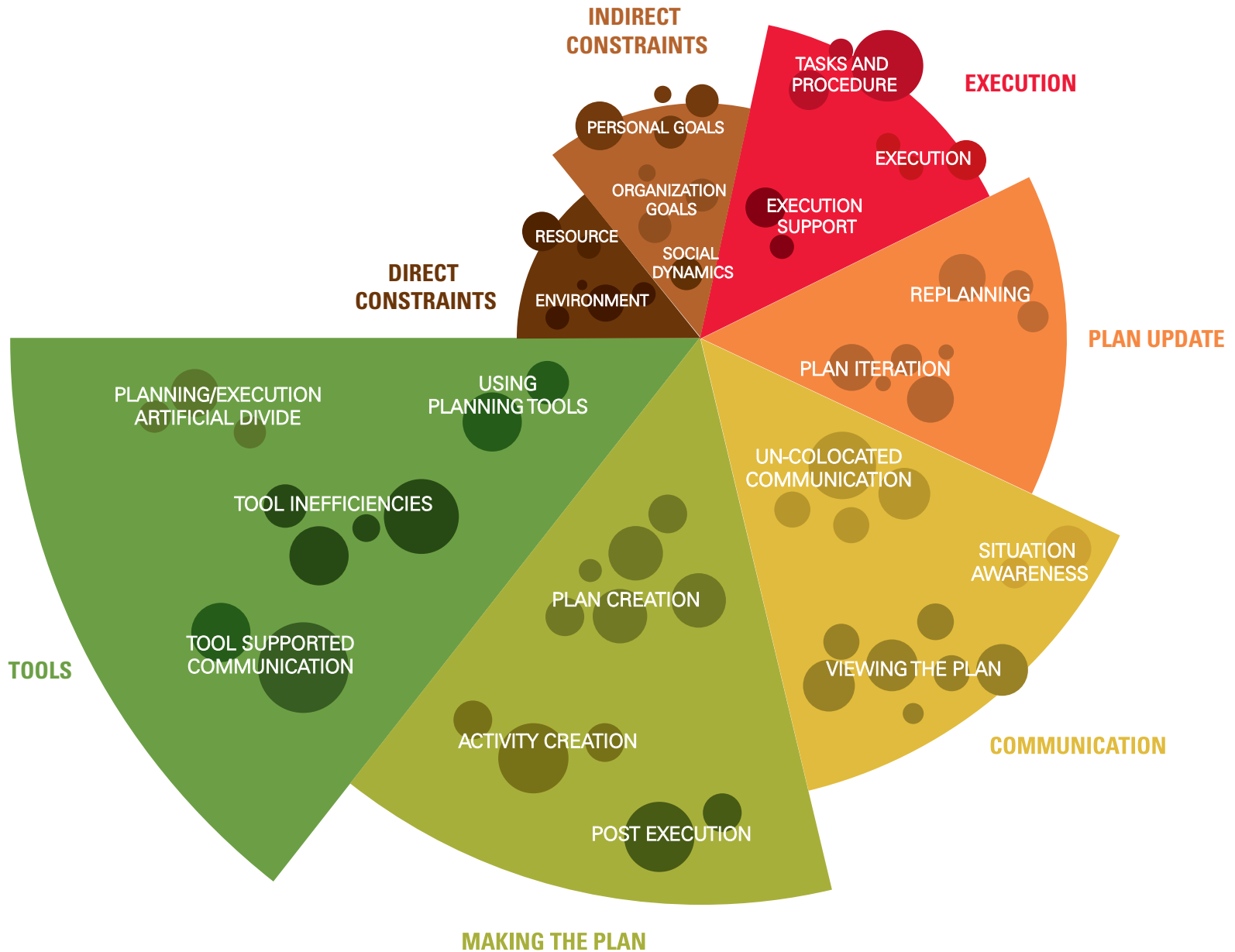
[teamlumina2010.com](http://teamlumina2010.com)

[info@teamlumina.com](mailto:info@teamlumina.com)



# BACK-UP SLIDES





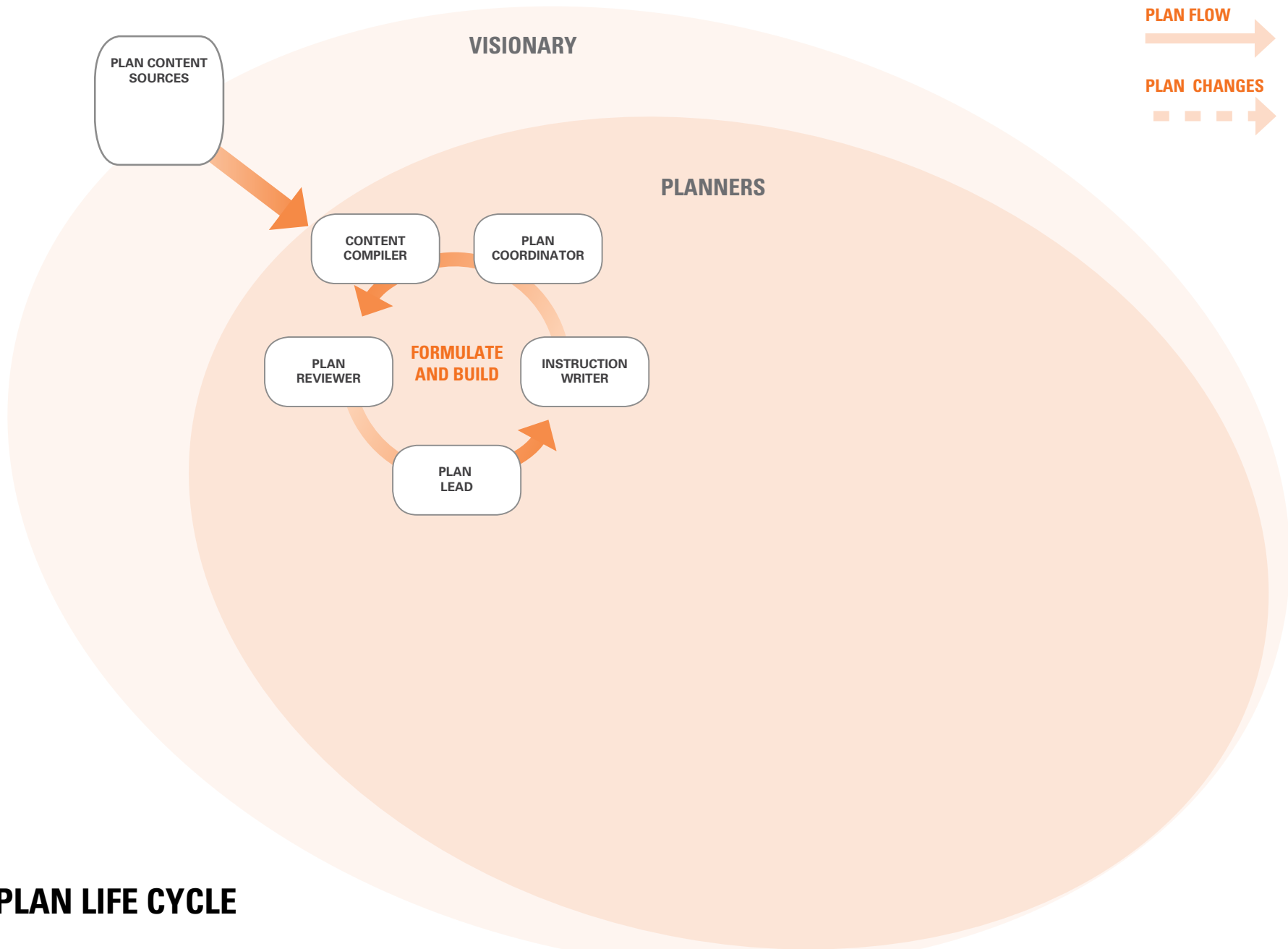




PLAN CONTENT  
SOURCES

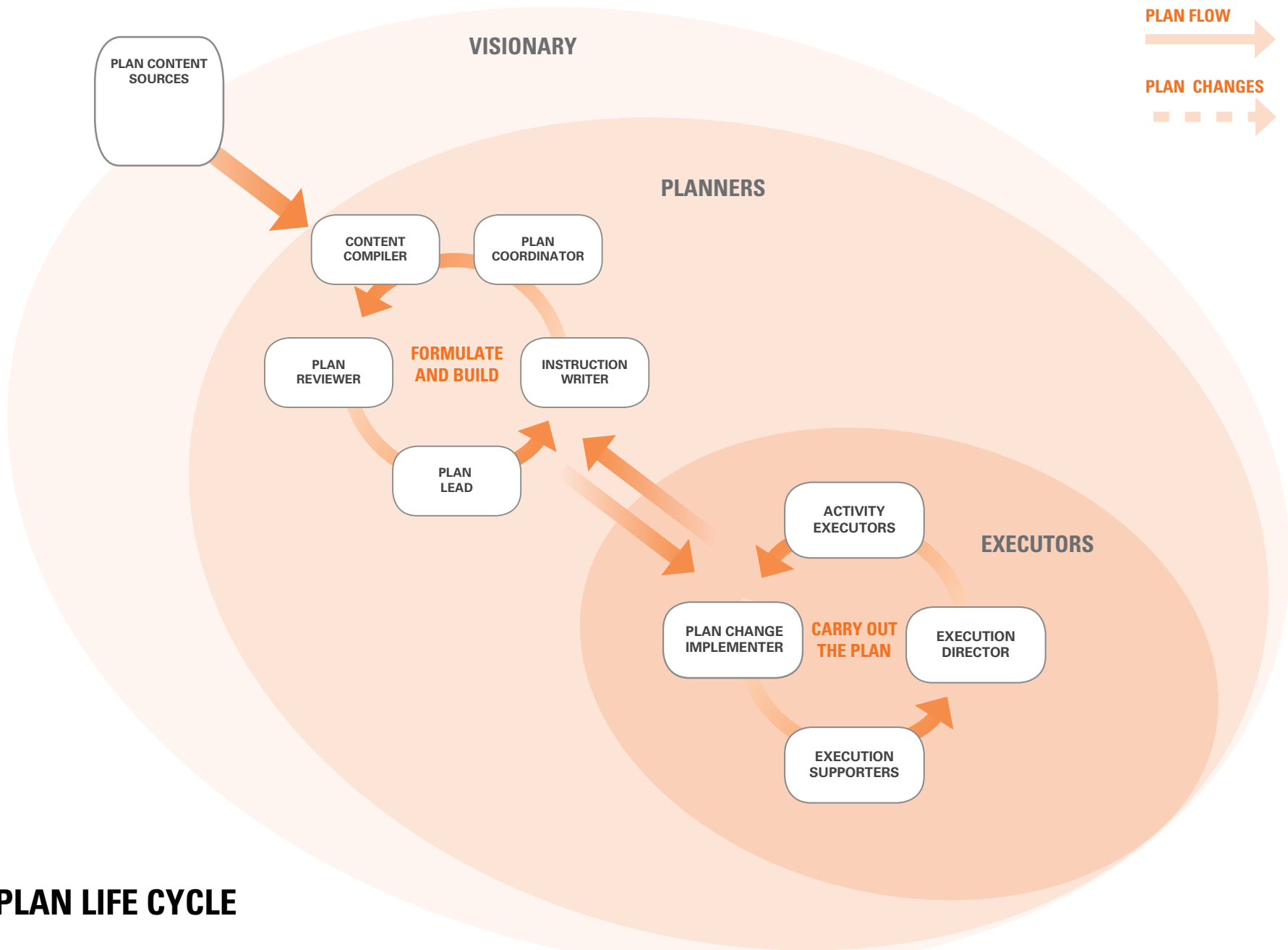
VISIONARY

# PLAN LIFE CYCLE



# PLAN LIFE CYCLE

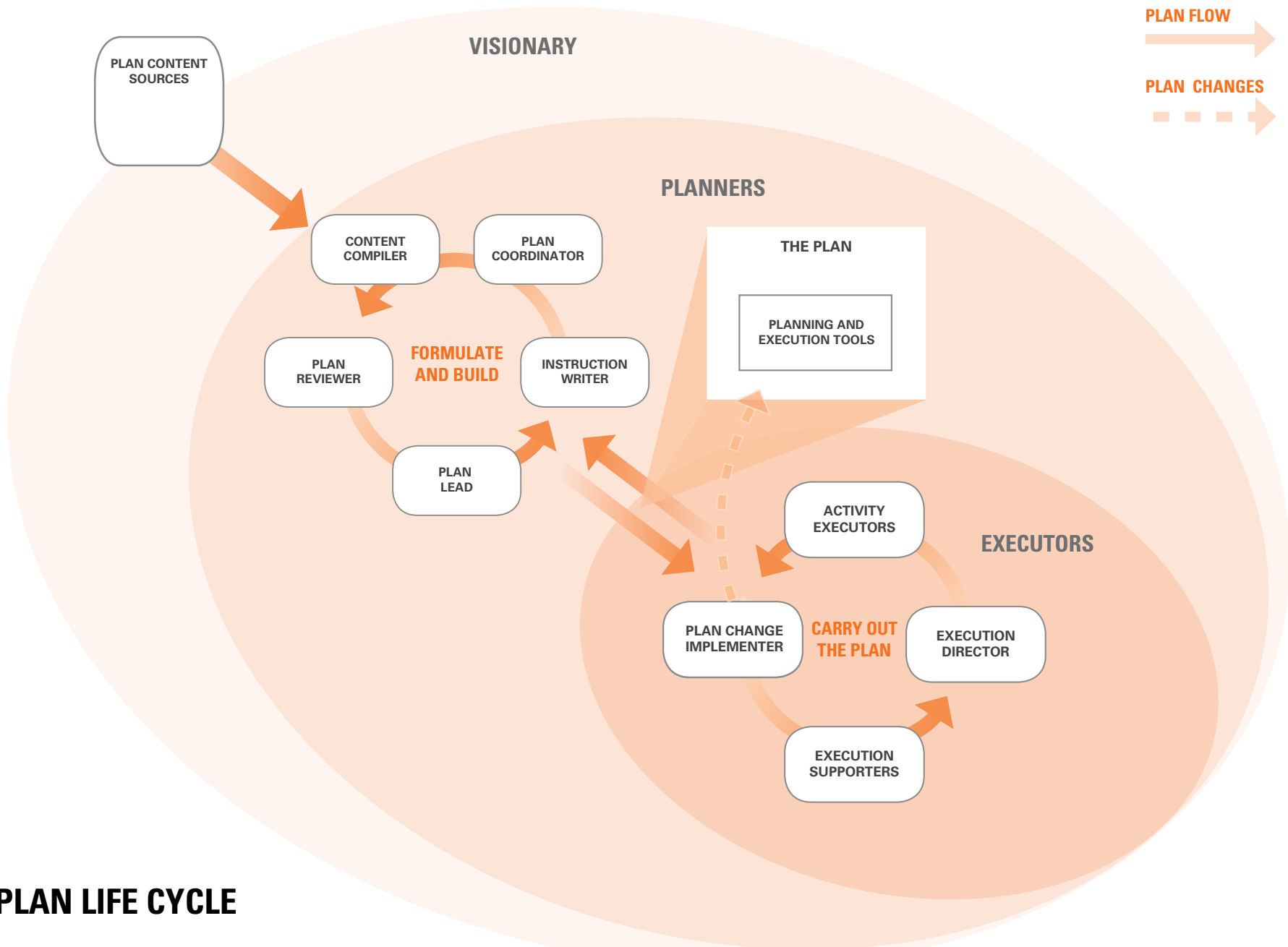




# PLAN LIFE CYCLE

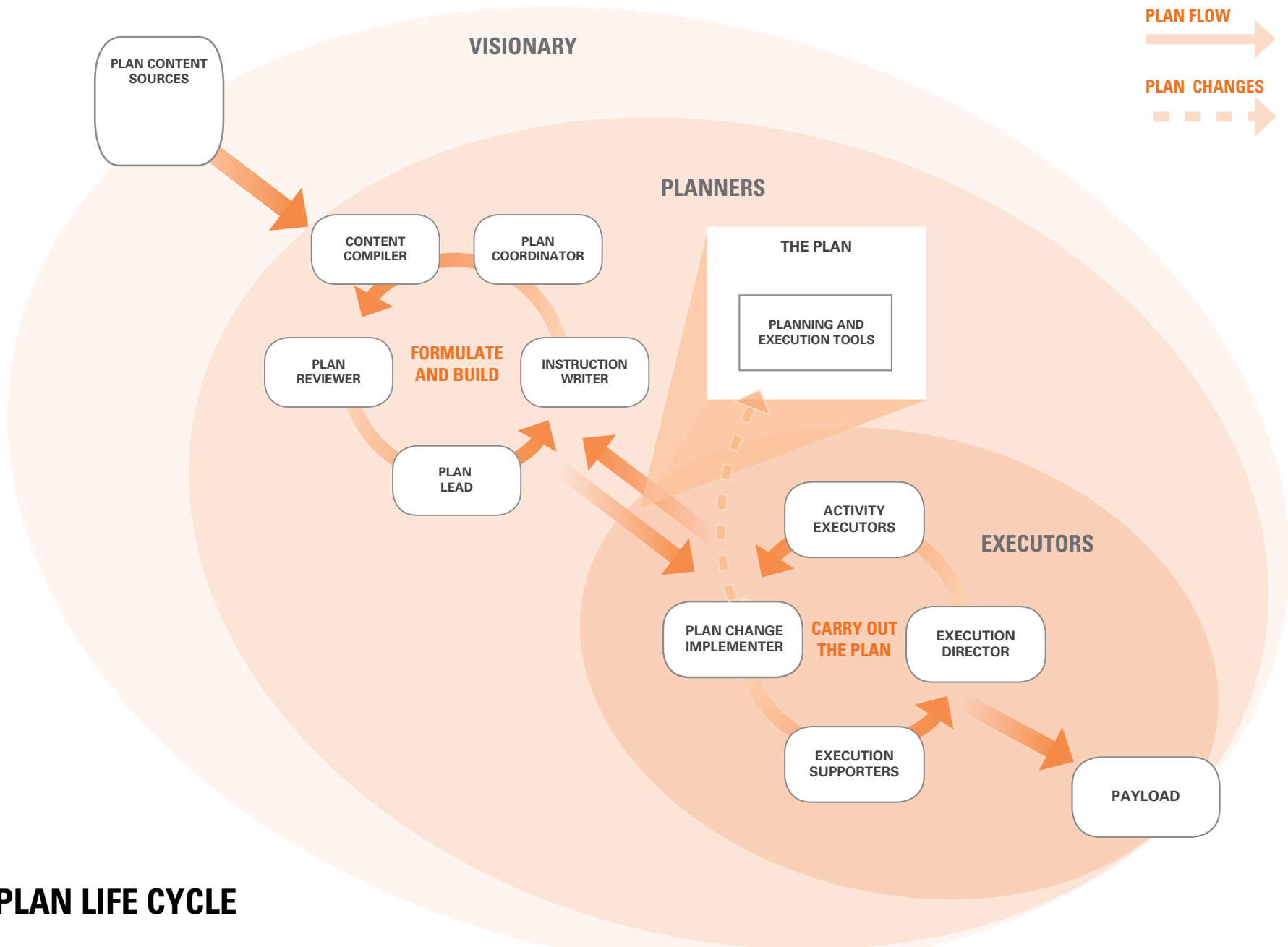






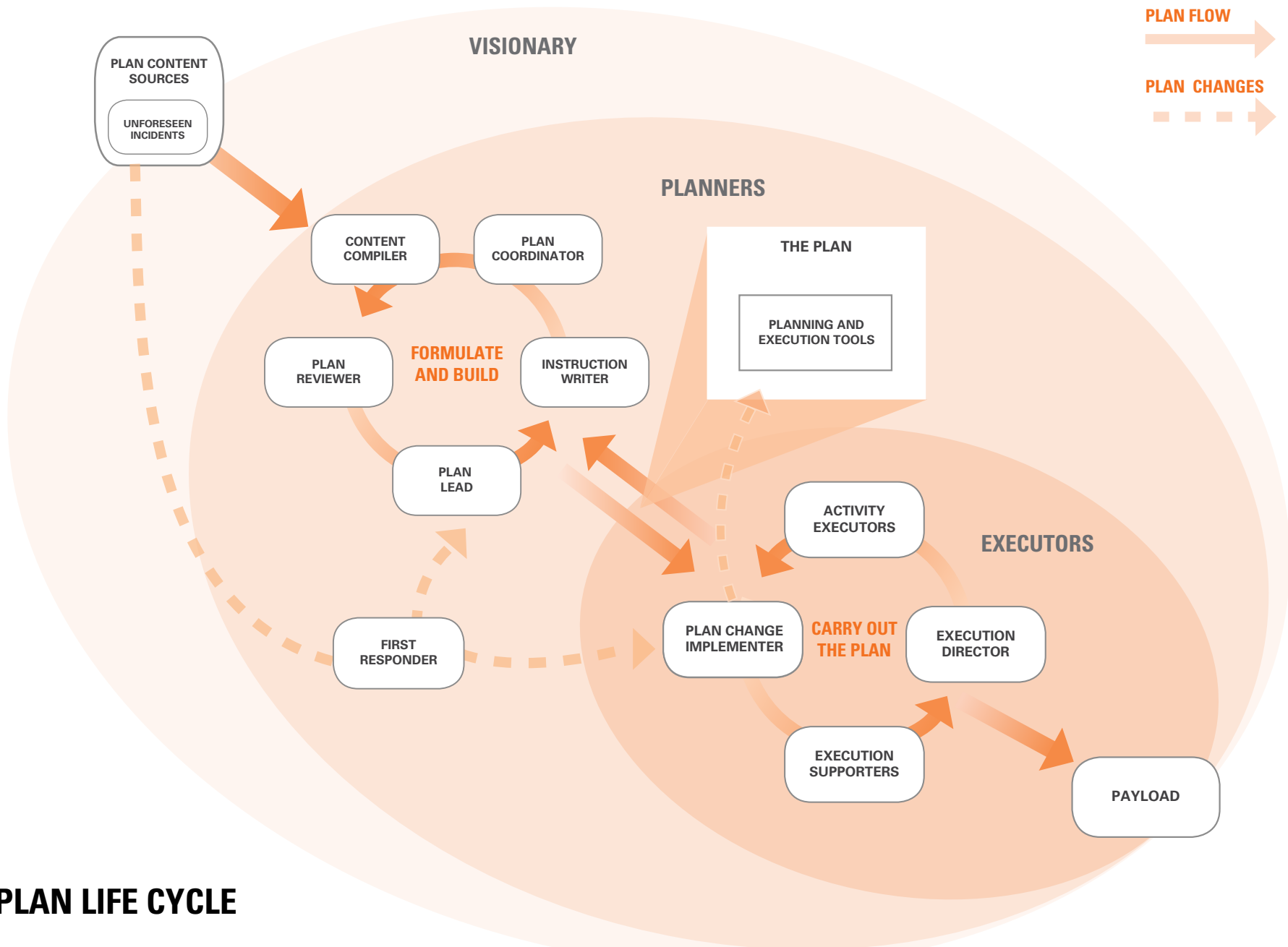
# PLAN LIFE CYCLE





# PLAN LIFE CYCLE





# PLAN LIFE CYCLE



NEWS SOURCES

PLAN CONTENT  
SOURCES

VISIONARY

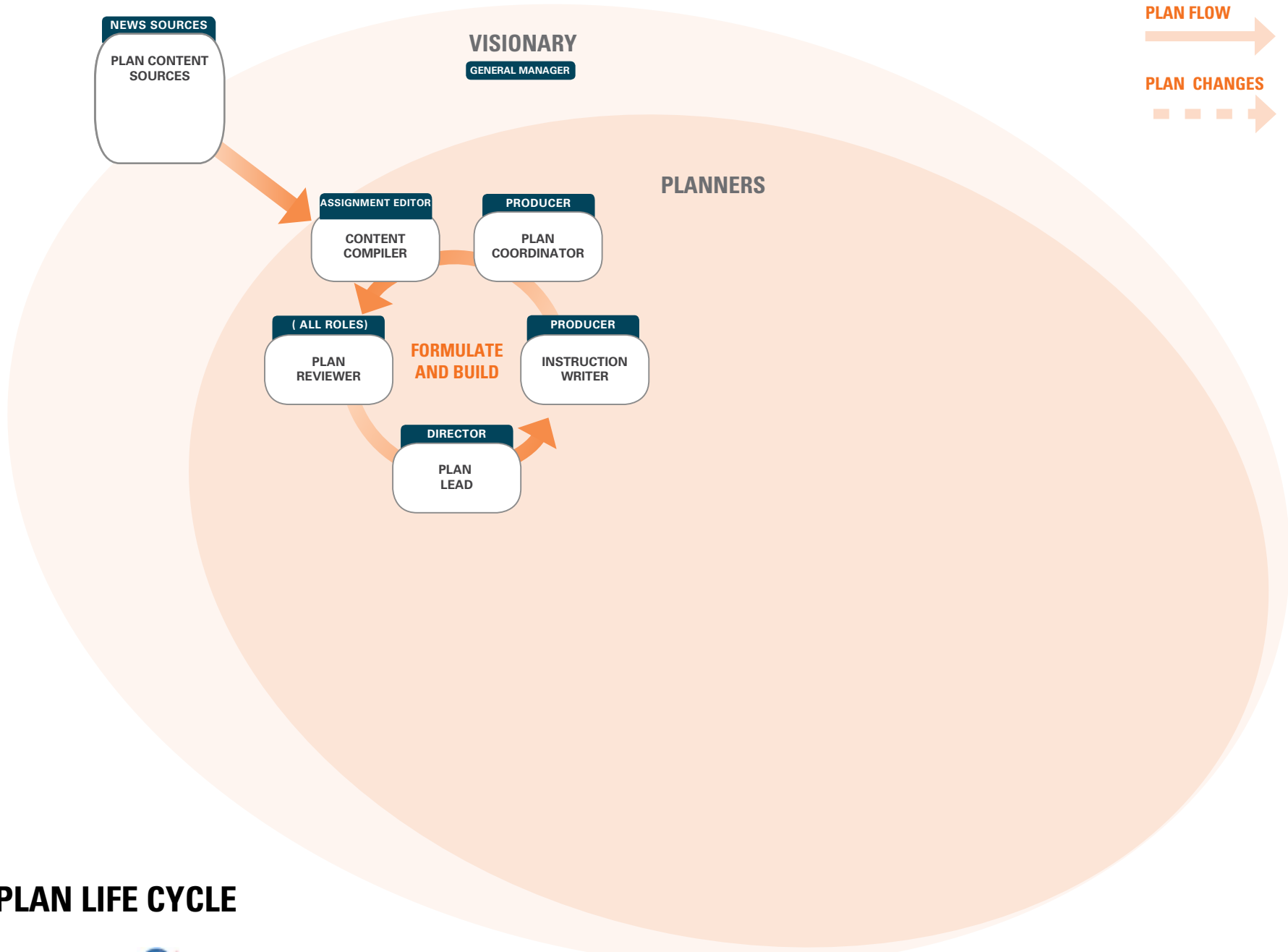
GENERAL MANAGER

PLAN FLOW



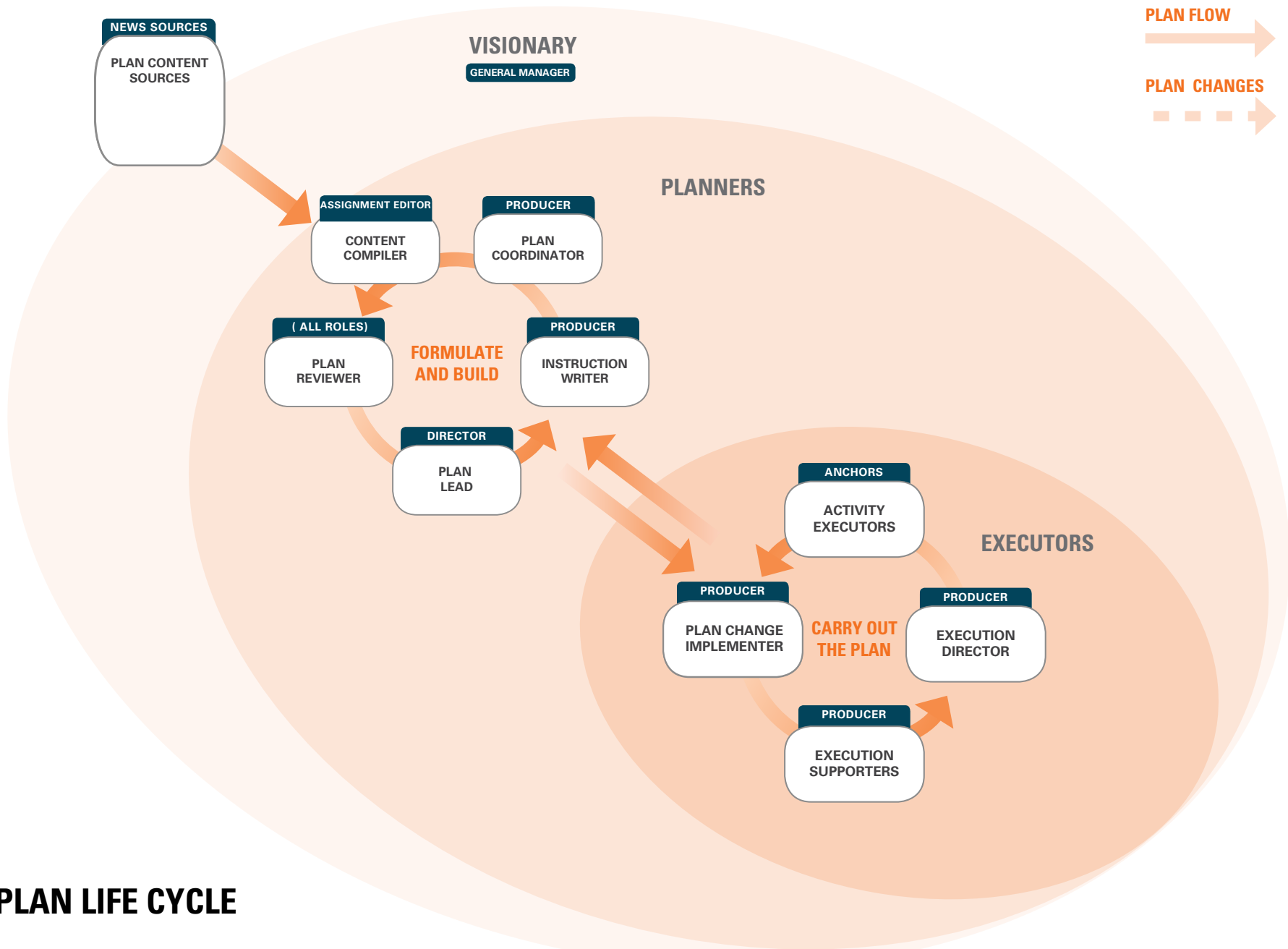
PLAN CHANGES





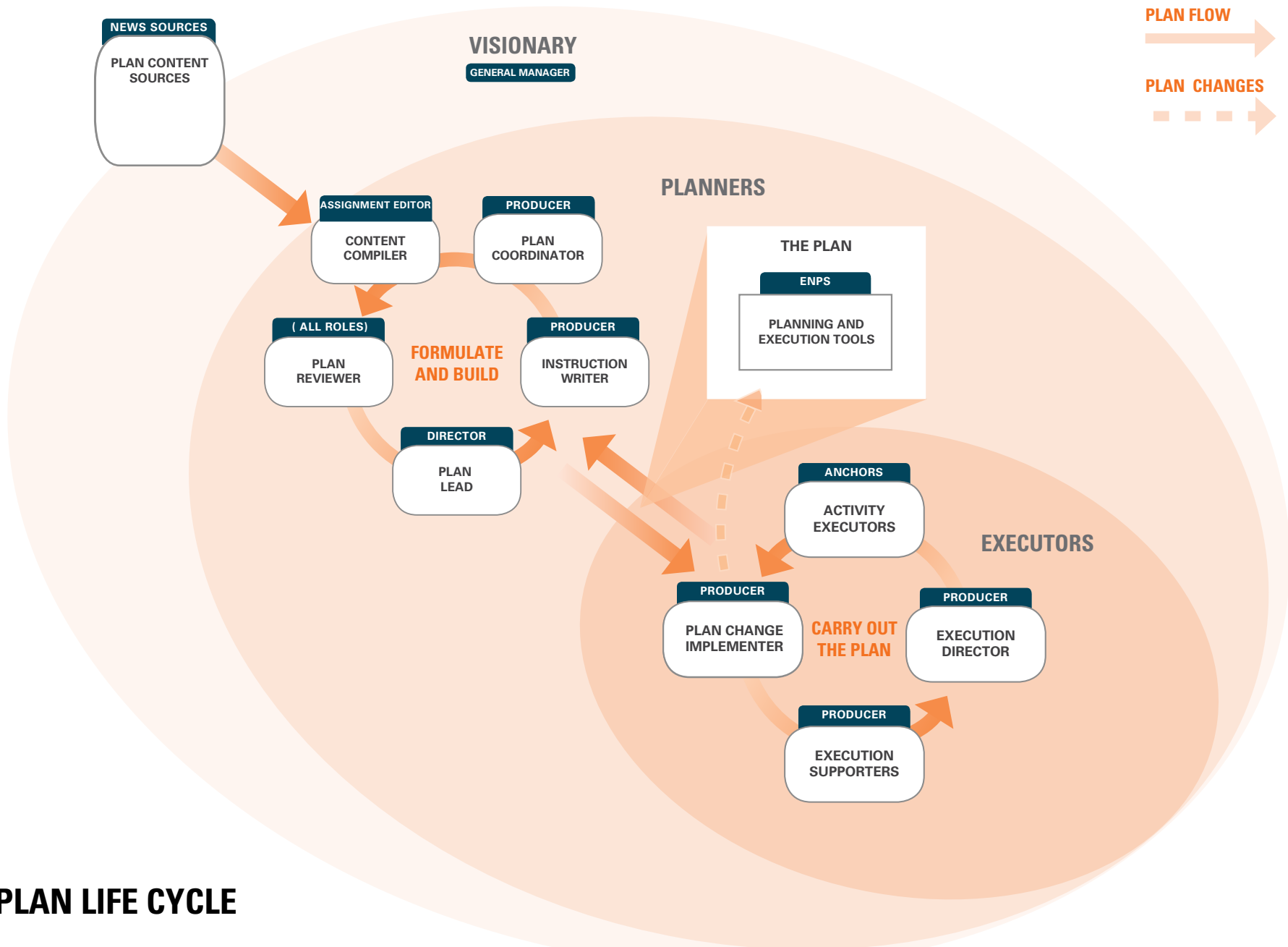
# PLAN LIFE CYCLE



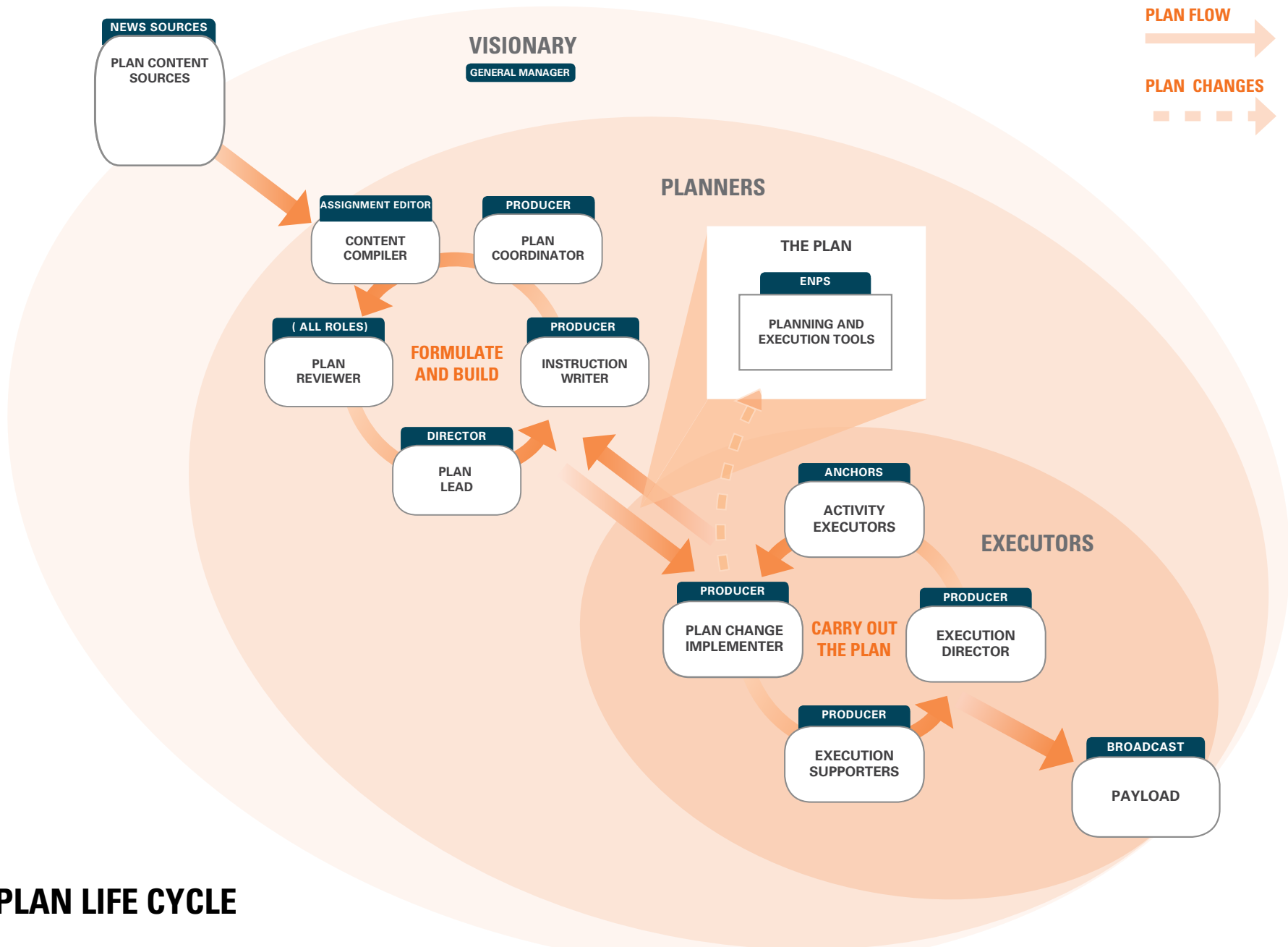


# PLAN LIFE CYCLE





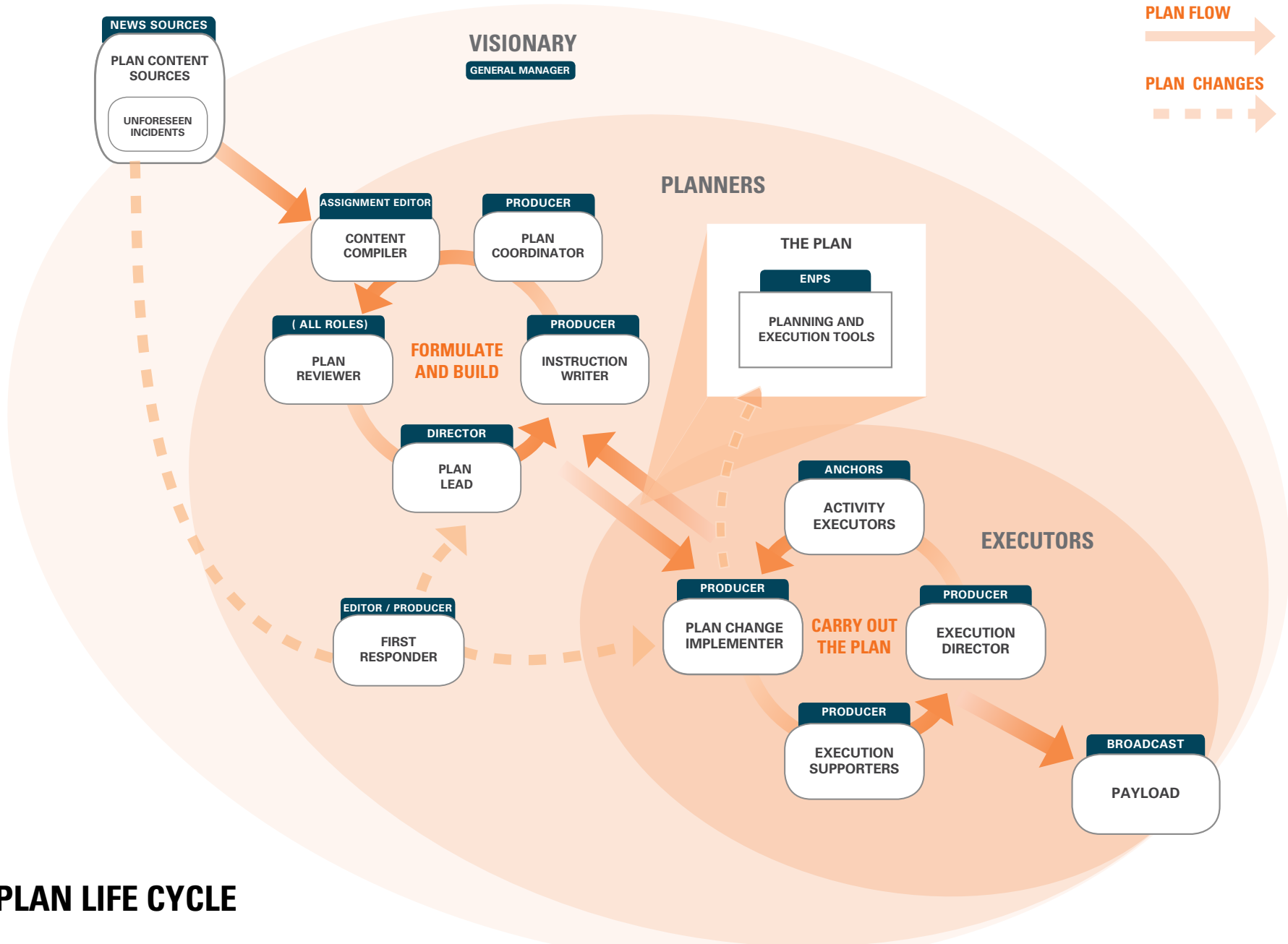
# PLAN LIFE CYCLE



# PLAN LIFE CYCLE







# PLAN LIFE CYCLE



PATIENTS

PLAN CONTENT  
SOURCES

VISIONARY

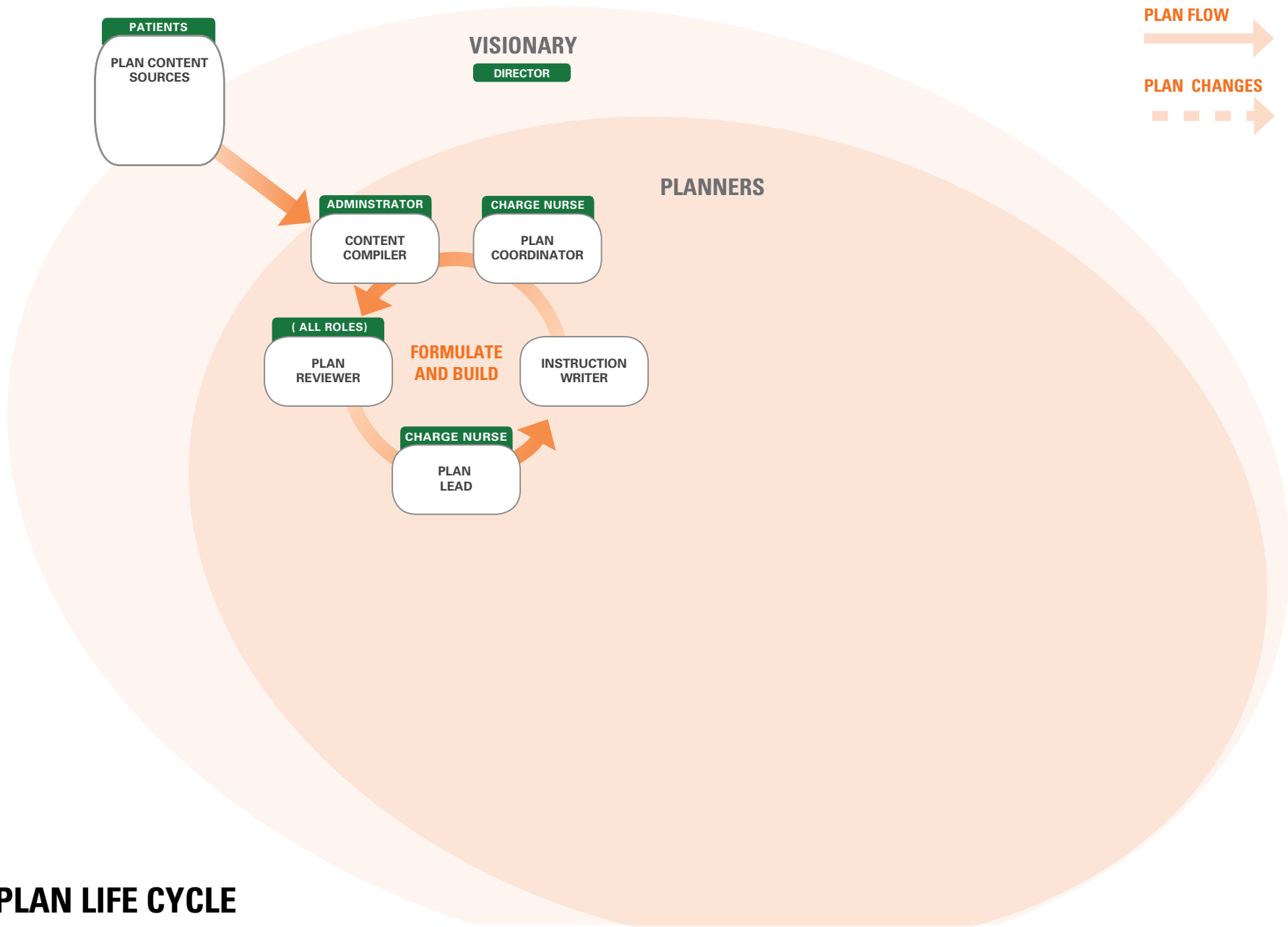
DIRECTOR

PLAN FLOW

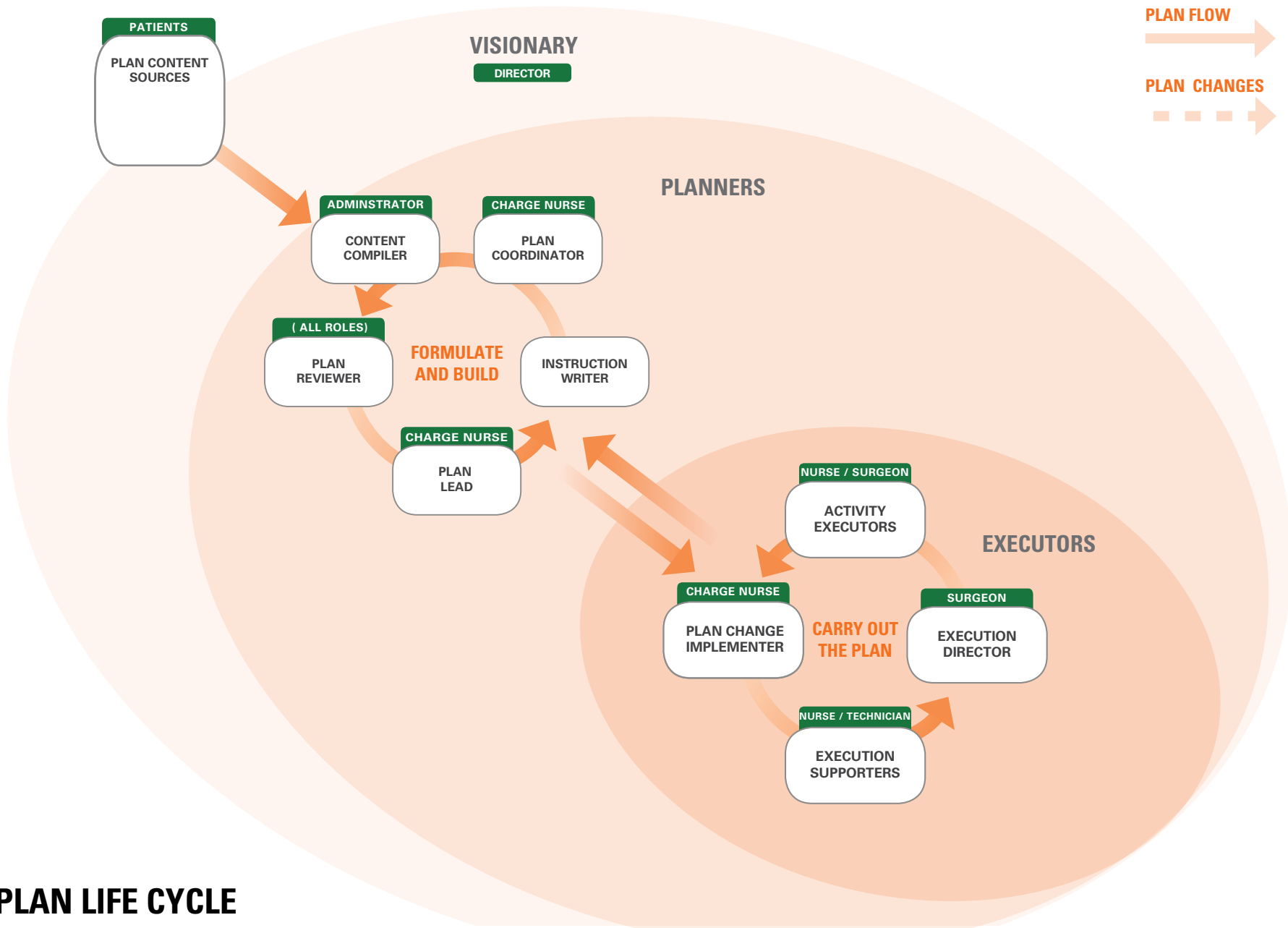
PLAN CHANGES

# PLAN LIFE CYCLE



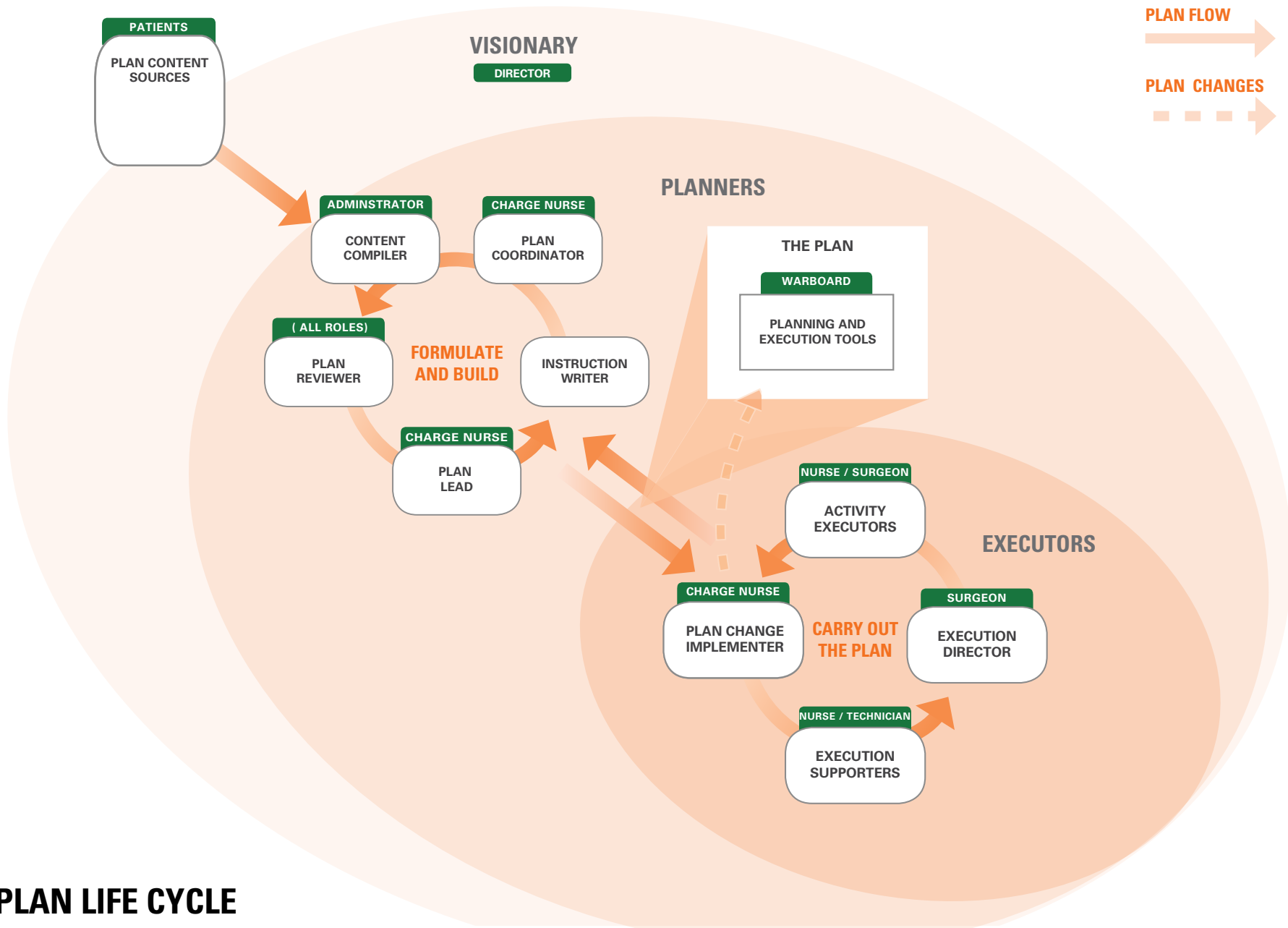


# PLAN LIFE CYCLE



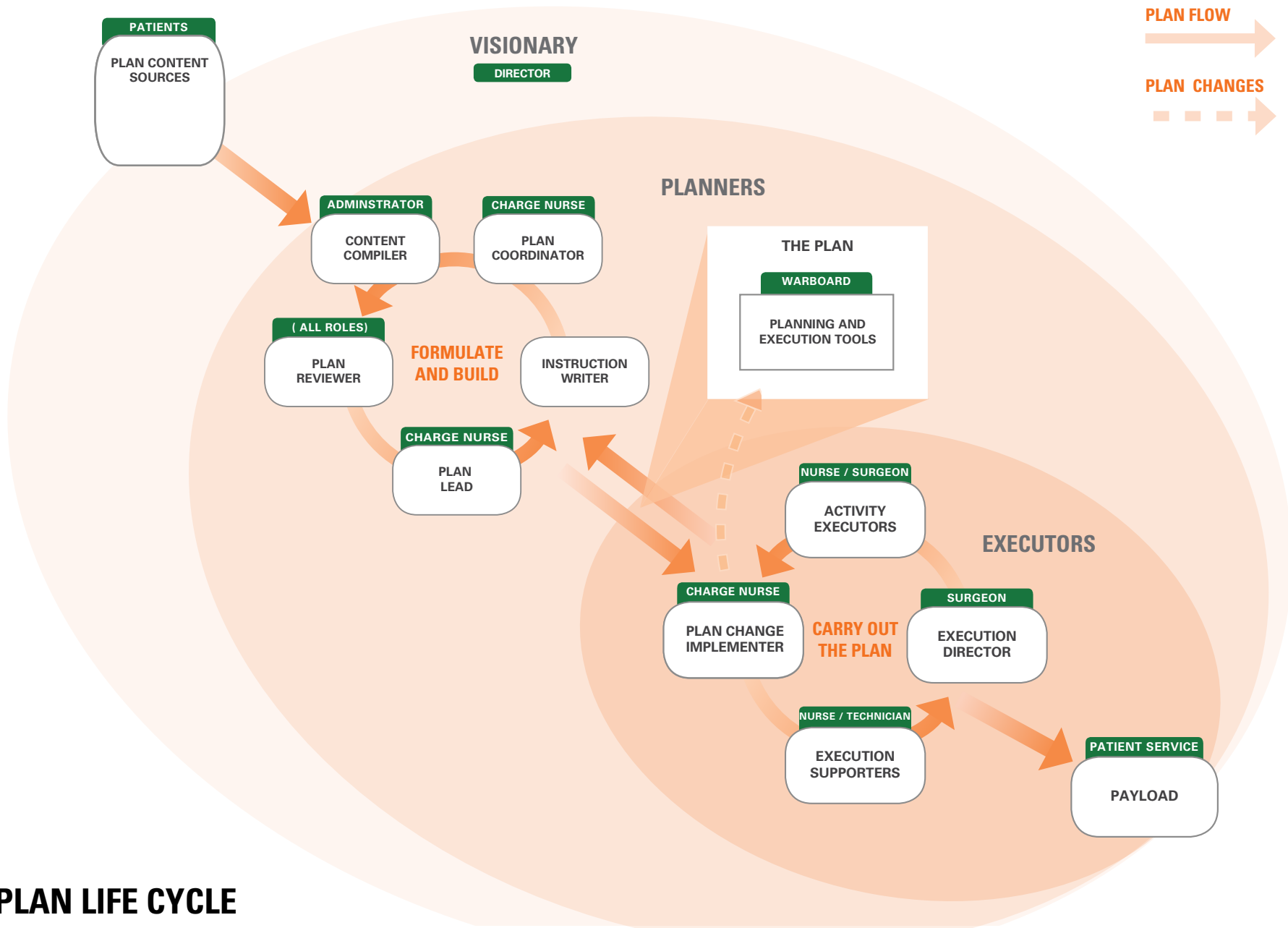
# PLAN LIFE CYCLE





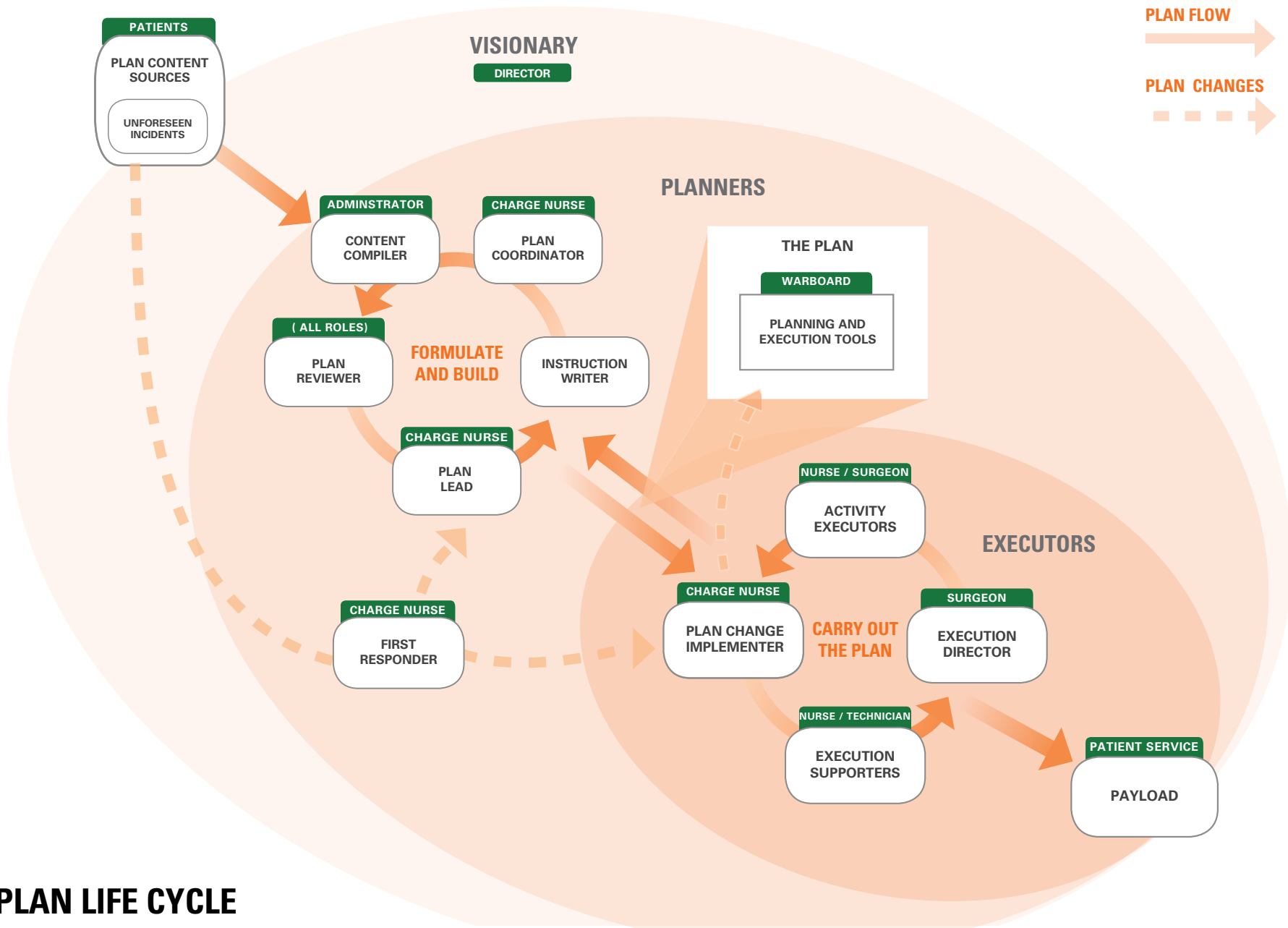
# PLAN LIFE CYCLE





# PLAN LIFE CYCLE





# PLAN LIFE CYCLE

SPECIALISTS

PLAN CONTENT  
SOURCES

VISIONARY

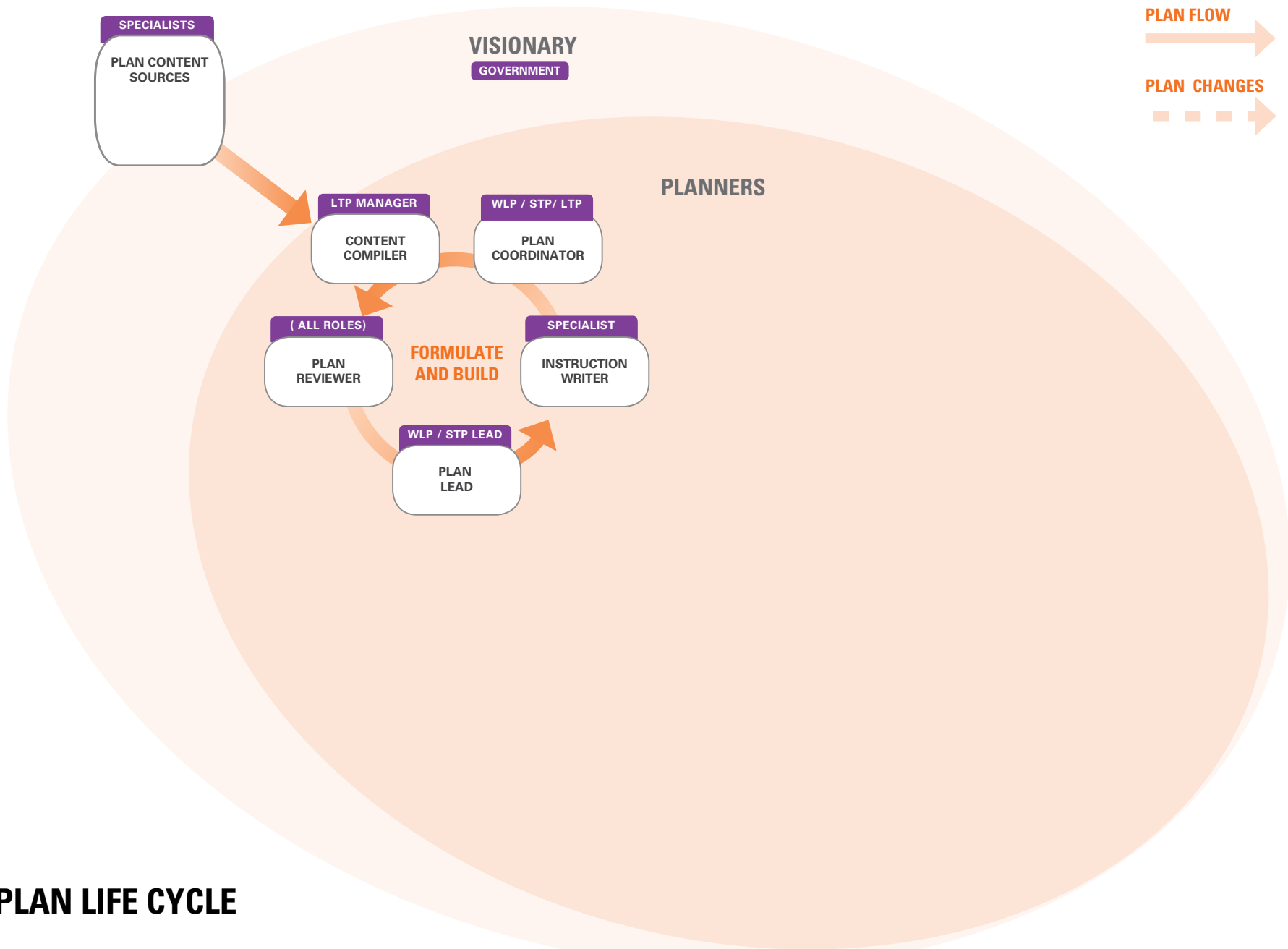
GOVERNMENT

PLAN FLOW

PLAN CHANGES

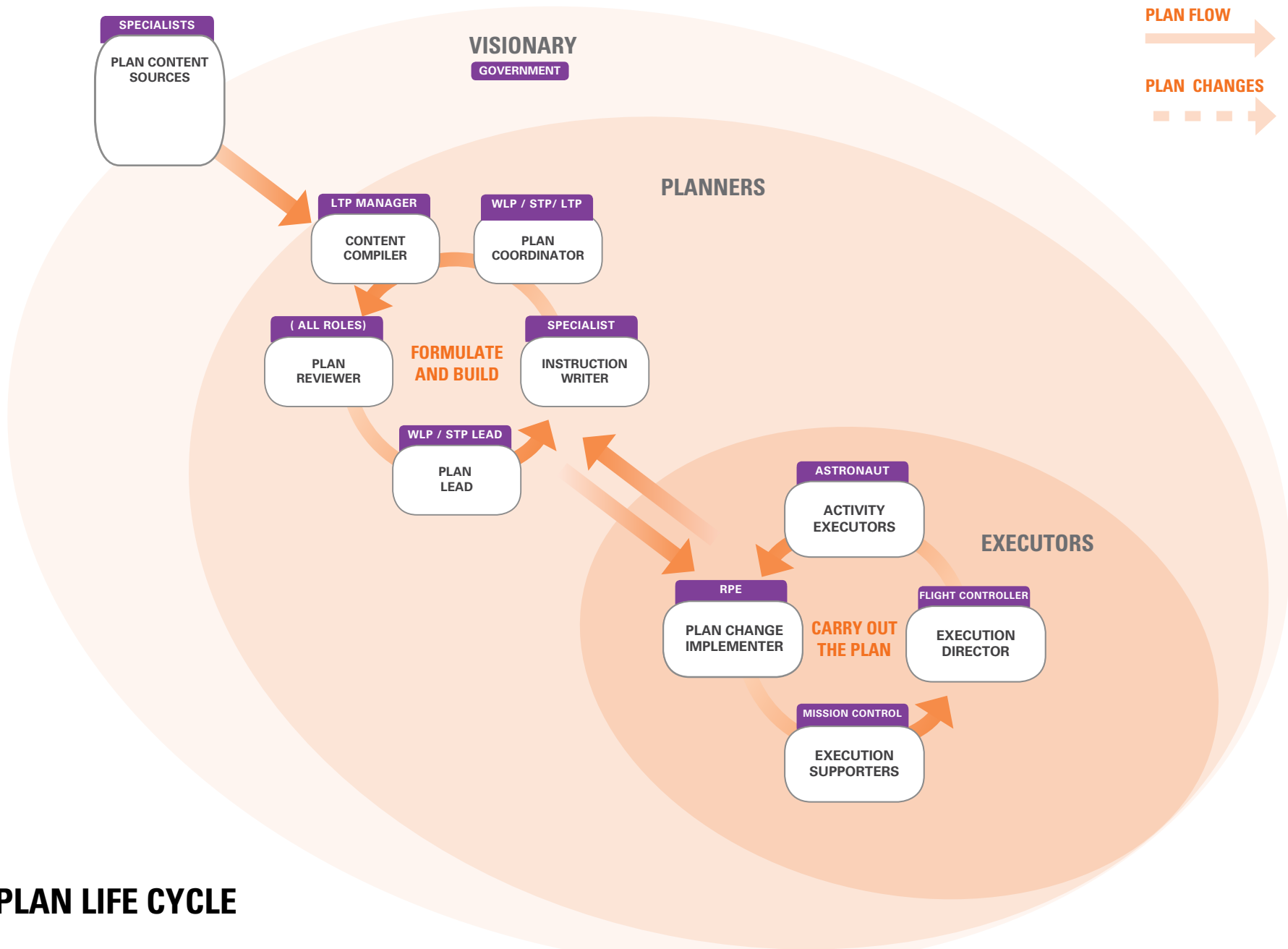
## PLAN LIFE CYCLE





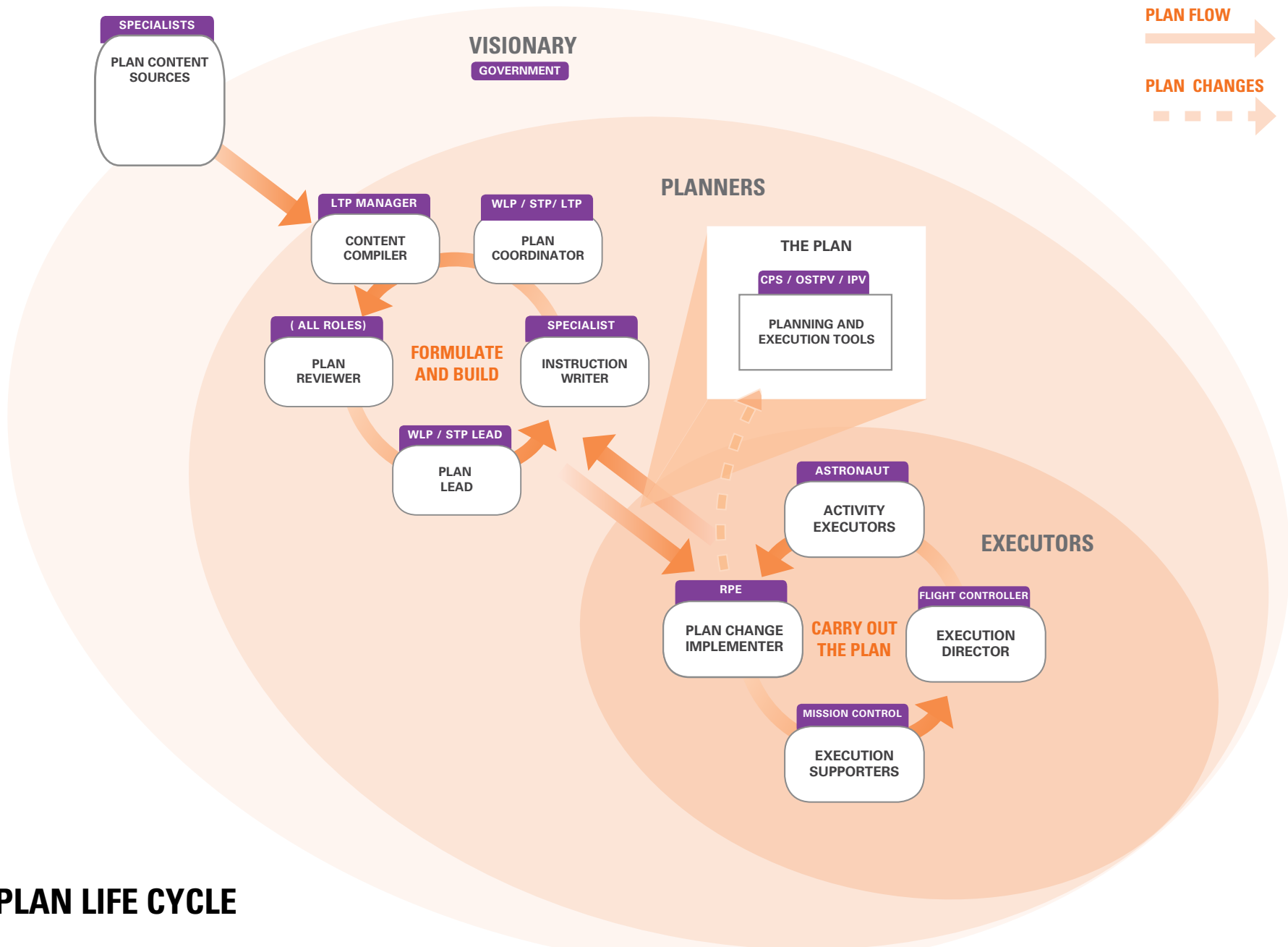
# PLAN LIFE CYCLE





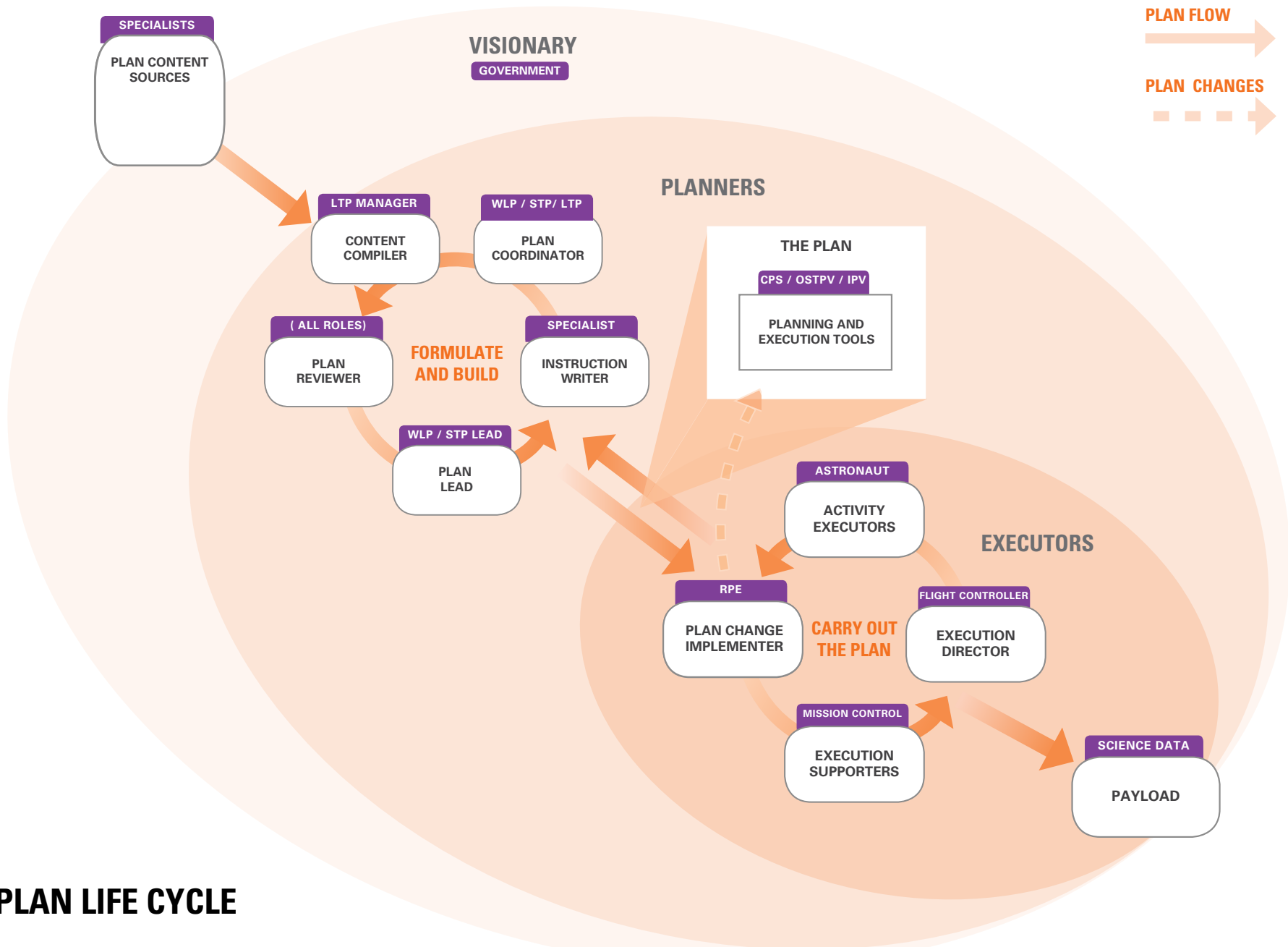
# PLAN LIFE CYCLE





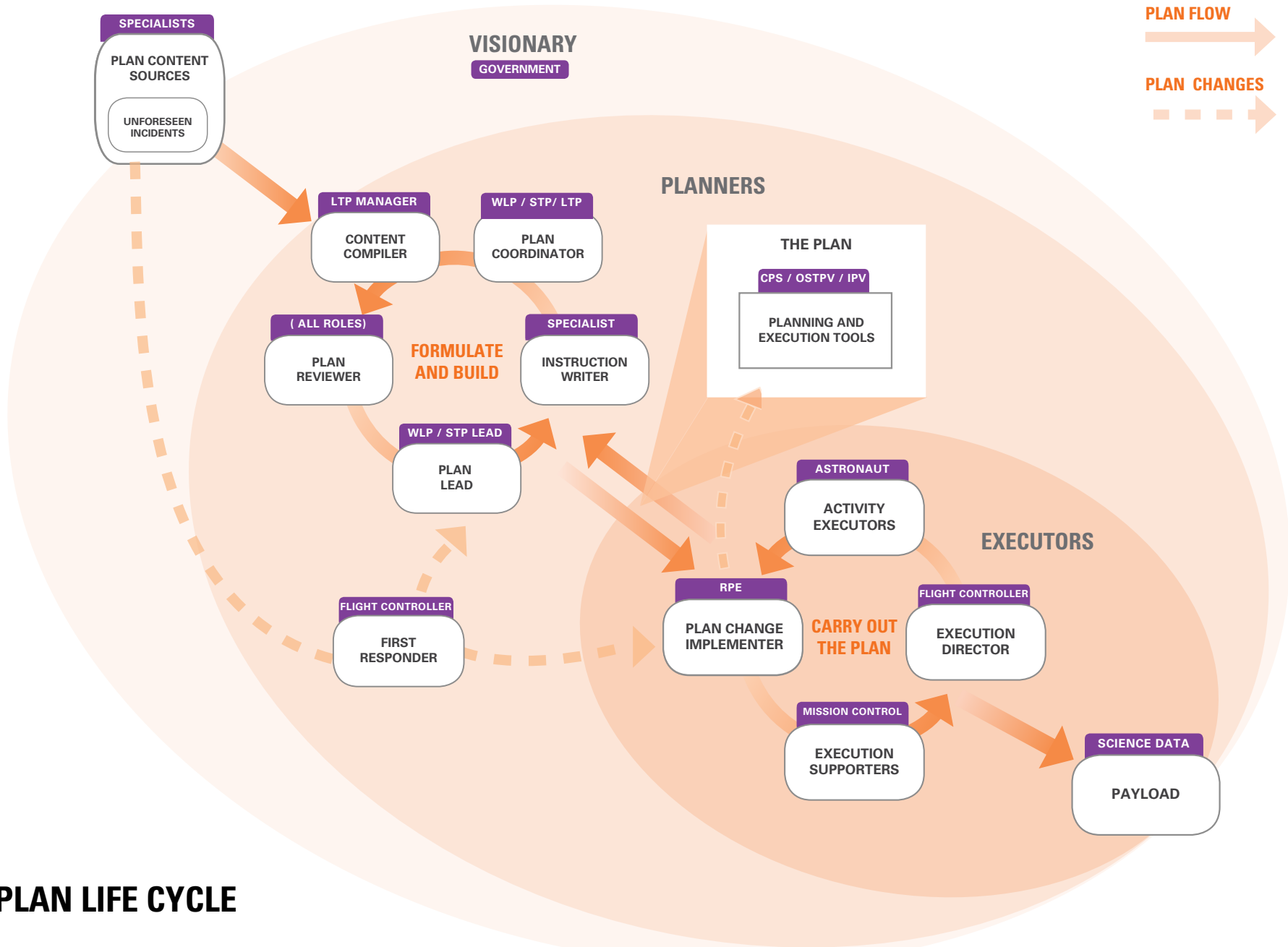
# PLAN LIFE CYCLE





# PLAN LIFE CYCLE





# PLAN LIFE CYCLE



# APPROACH

Literature Review  
Competitive Analysis  
Field Research



# KEY OBSERVATIONS

- Project Management Tools
  - Focus on task dependencies
  - Resource Management
  - Critical Path



# KEY OBSERVATIONS

- Project Management Tools
  - Focus on task dependencies
  - Resource Management
  - Critical Path
- Industry Specific Tools
  - Incorporate constraints
  - Bridge the gap between planning and execution



# KEY OBSERVATIONS

Use of **historical booking** to forecast data

# KEY OBSERVATIONS

Use of **historical booking** to forecast data  
Public / collaborative **artifacts** increase **situational awareness**