HFES

Systems That Work for Humans

HFES

INTERNATIONAL SYMPOSIUM

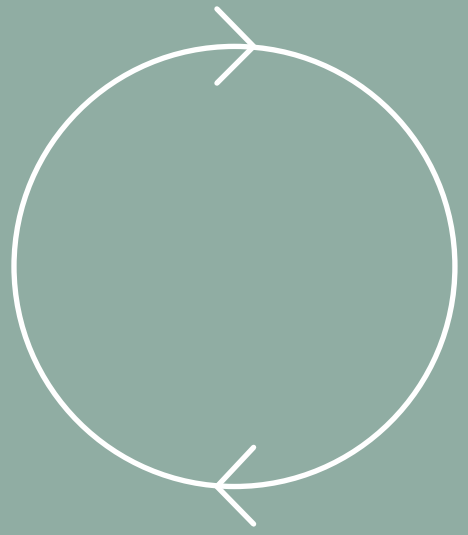
on Human Factors and Ergonomics in Health Care

2022

Don’t Underestimate the Value of Task Analysis

Agenda

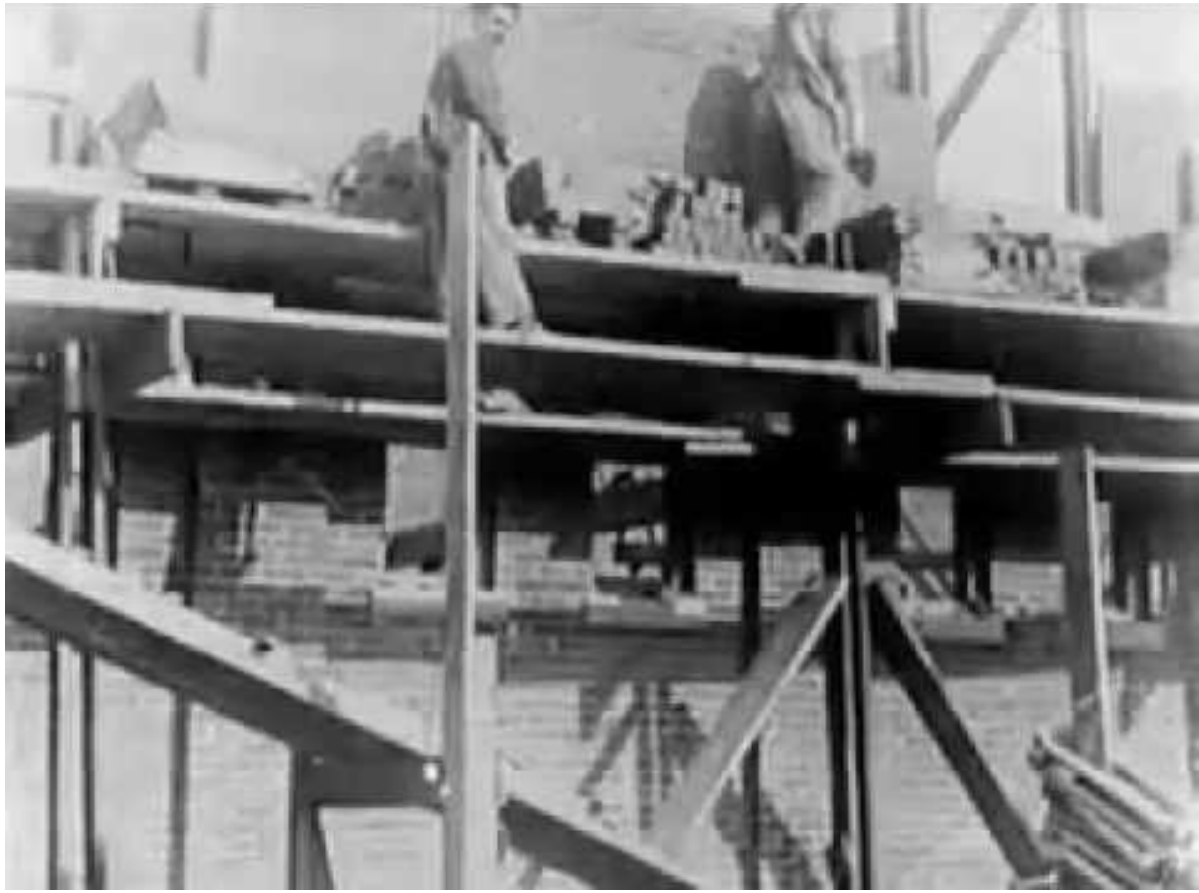
- Background
- Purpose
- Methods
- Applications
- Q & A



Background & Purpose

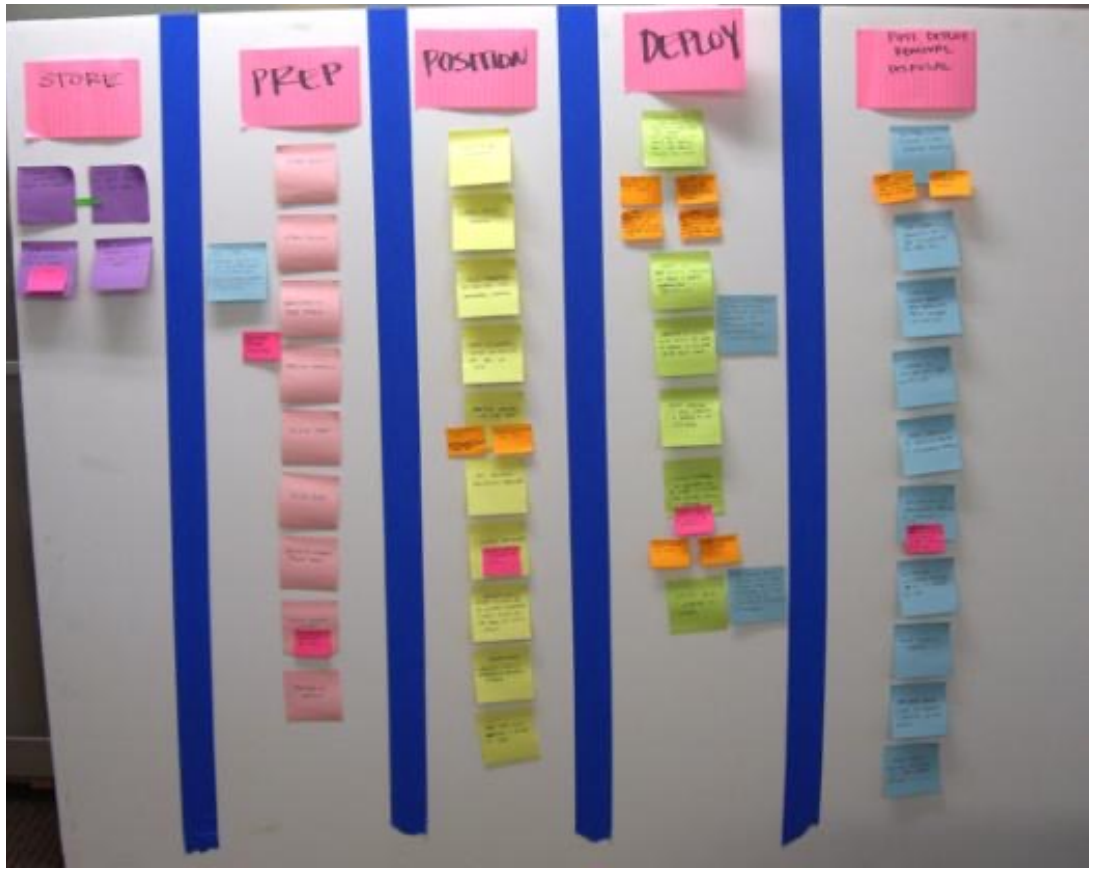
Background

- **Task analysis** definition (Kirwan & Ainsworth):
  - *"The study of what an operator is required to do, in terms of actions and/or cognitive processes, in order to achieve a system goal."*
- Classic human factors tool, first introduced in the early 20th century
- Keen interest in studying workplace efficiency during the Industrial Revolution
- Taylor and the Gilbreths' Time & Motion Studies (early 1900s)
- Break down the work into predefined steps, observe and time a worker performing the steps, evaluate pace and performance, then compute the standard time to complete the goal



Background

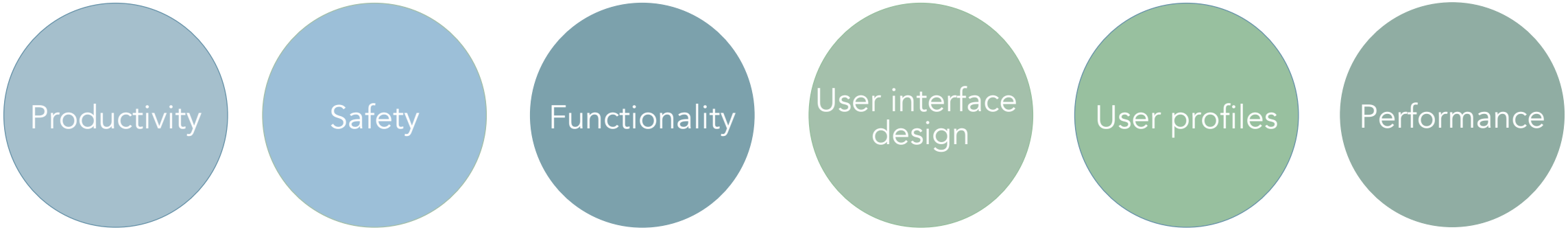
- Psychologists began developing strategies for representing work in the form of flow charts and task decompositions in the 1930s.
- This became known as ‘traditional’ or ‘behavioral’ task analysis.
- Because tasks can be defined in a number of ways (based on observable physical actions, cognitive demand, and decision making) and described from many different perspectives (according to hierarchical relationships, information flow, task sequence, or location / environmental conditions), there are many approaches to performing a task analysis.
- Kirwan and Ainsworth’s A Guide to Task Analysis (1992) describes 41 different methods for task analyses!



Purpose

Why Do Task Analysis?

To develop a blueprint of human involvement in a system from the human perspective to help more fully integrate the human element into design, specifically around the following areas:



Methods

Overview of Task Analysis Methods

Traditional / Behavioral Task Analysis

- Most basic task analysis method
- Capture overt actions by observing and recording a user performing the task.
- The output can be simply a list of steps laid out in order of how they are typically performed to achieve the desired goal.
- Encompasses steps and sequence.

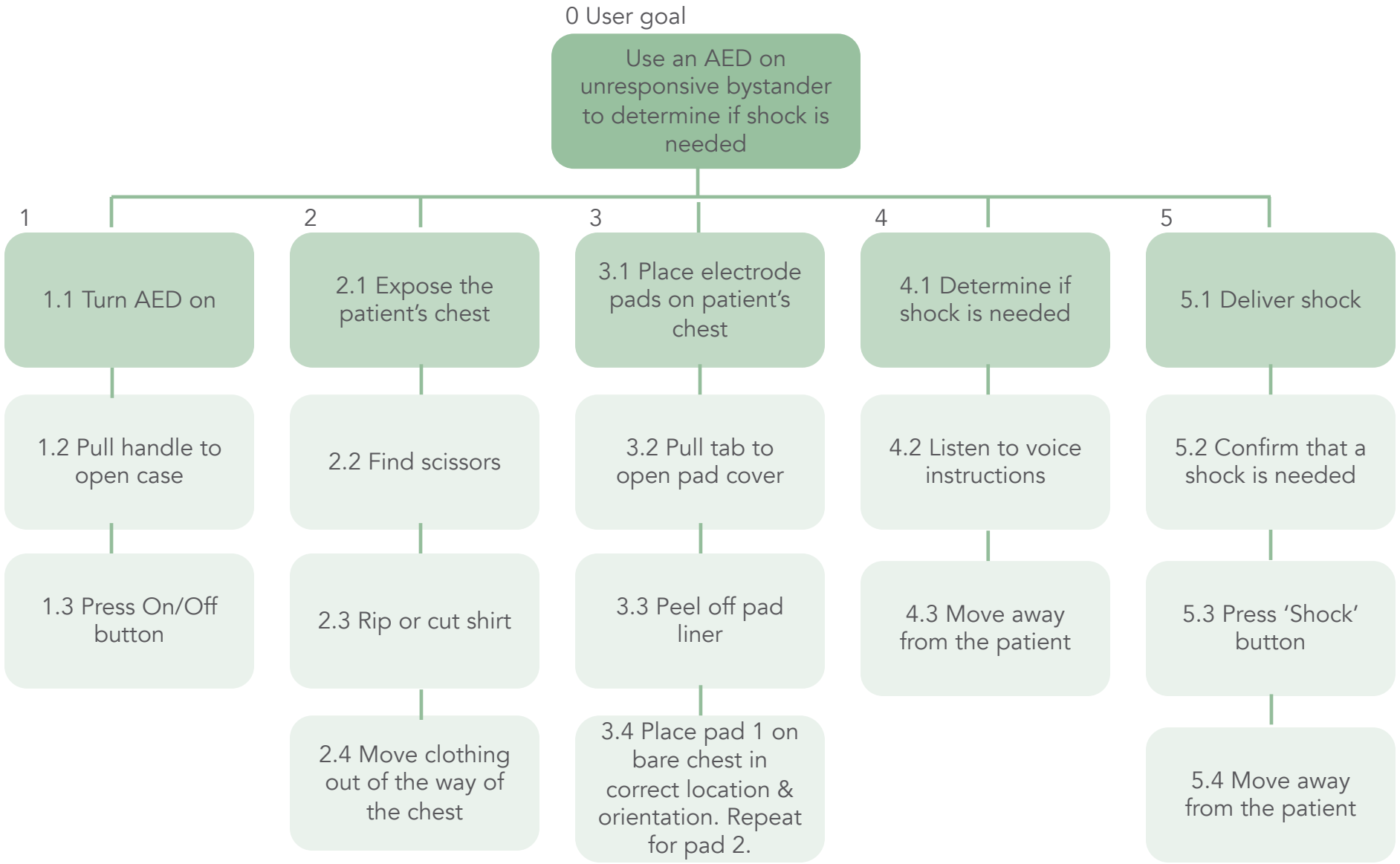
Hierarchical Task Analysis

- Top-down method with a strict hierarchical structure.
- Present overall goal of the task, then the various sub-tasks and the conditions under which they should be carried out to achieve that goal.
- Complex tasks are represented as a hierarchy of operations - different things that people must do within a system and plans - the conditions which are necessary to undertake these operations.

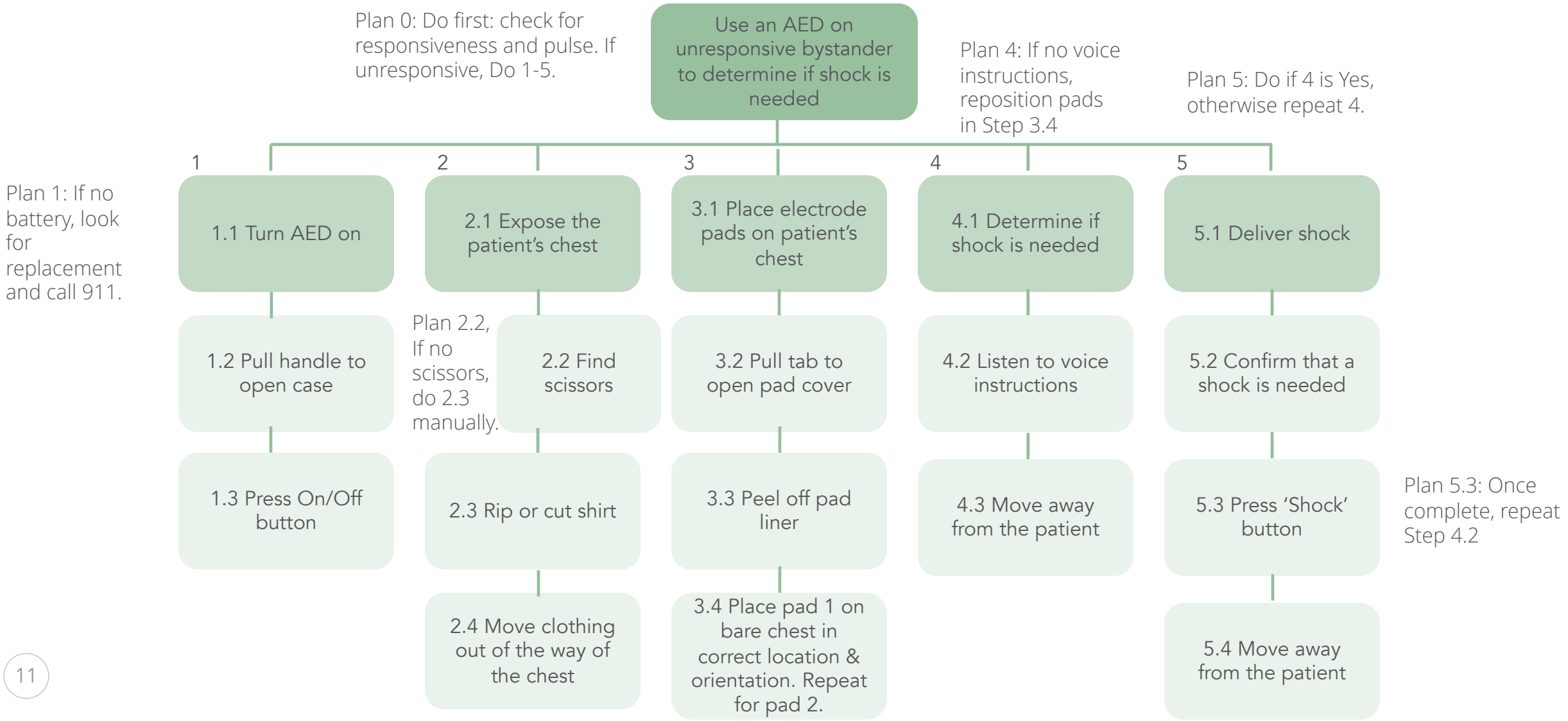
Cognitive Task Analysis

- Places focus on understanding and defining the breakdown of mental processes and demands involved in completing tasks.
- These include processes such as perception, information processing, decision making, memory, and attention.
- Identifies areas of a system that demand increased cognitive load from users.

Traditional / Behavioral Task Analysis Example



Hierarchical Task Analysis Example

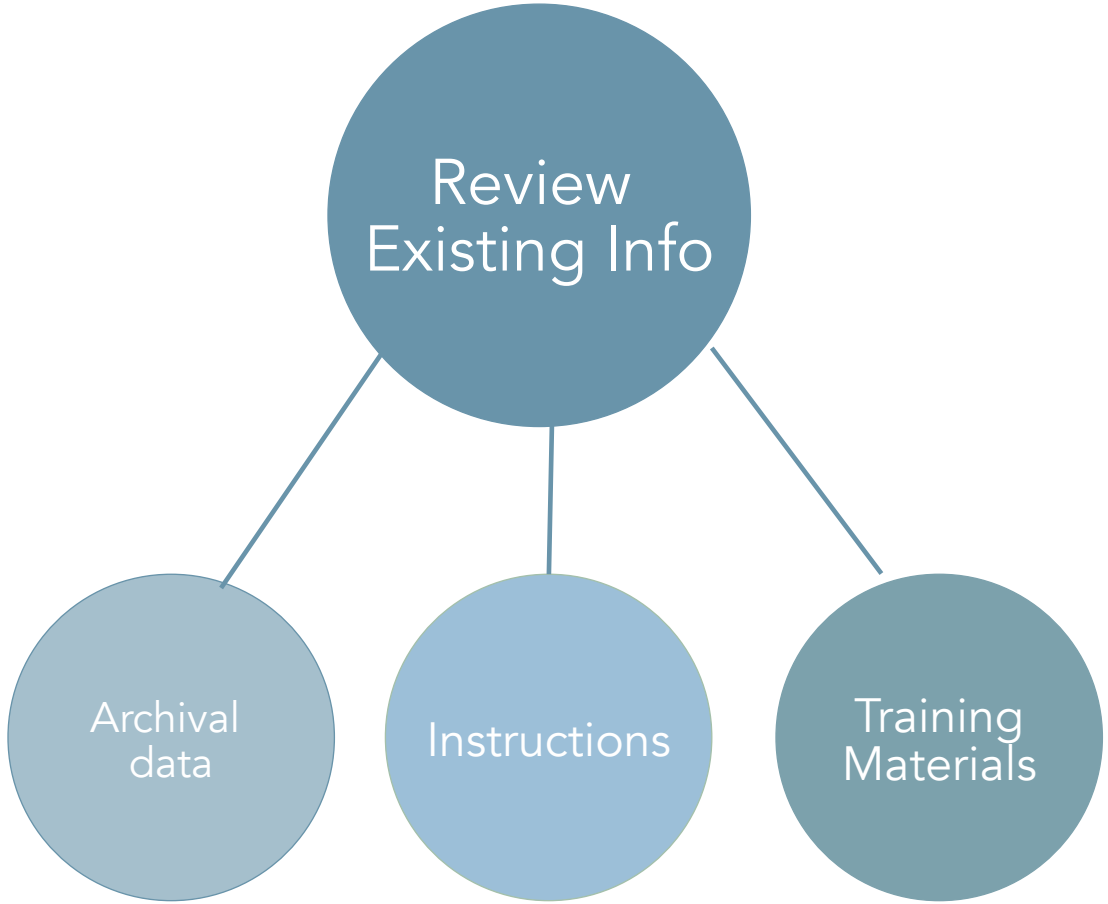


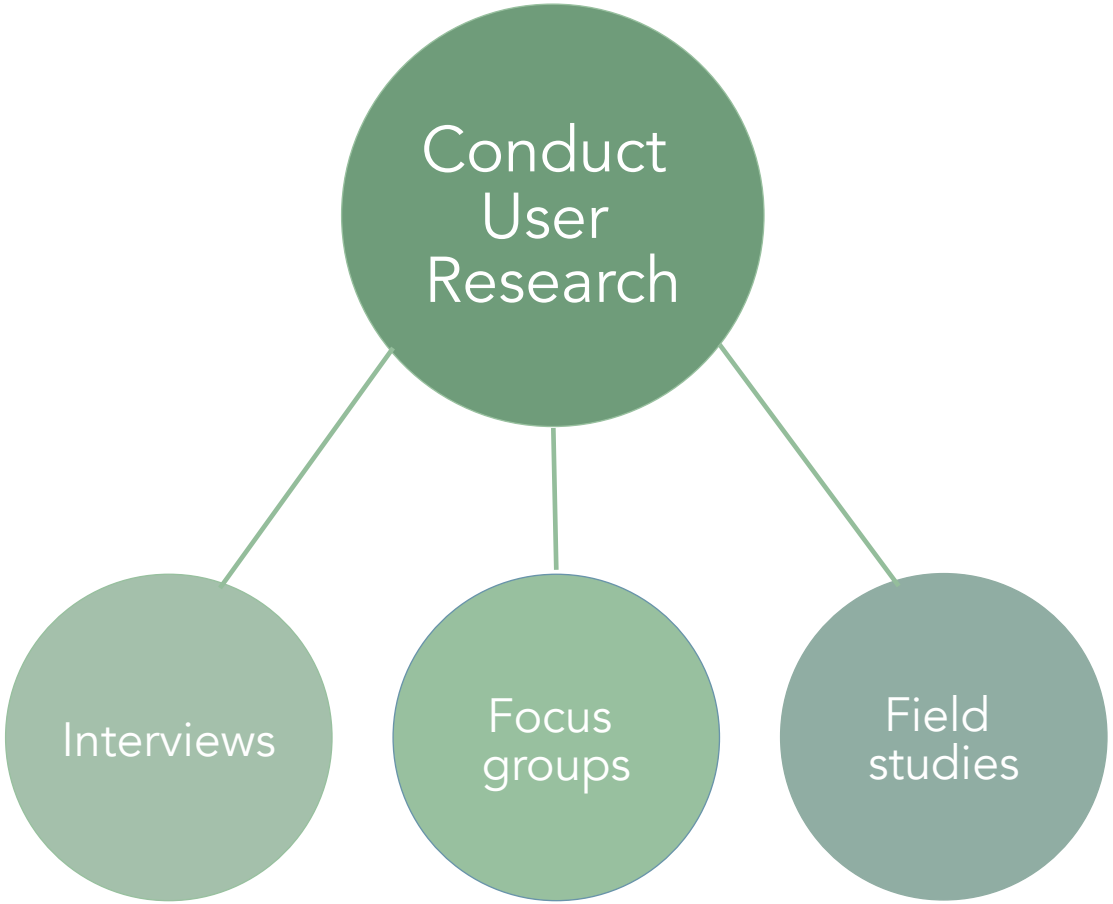
Cognitive Task Analysis Example

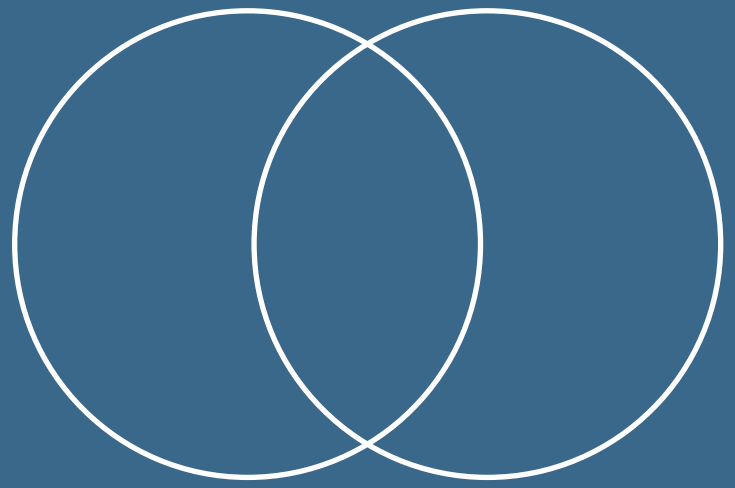
Step	Perception	Cognition	Action
1. Turn AED on	Visually inspect power LED	Interpret whether the device is in a ready state	Pull handle to open case and press power button
2. Expose the patient's chest	Feel patient's clothing	Determine best method for removal	Cut shirt with scissors and remove
3. Place electrode pads on patient's chest	Visually identify correct pad orientation	Understand correct pad orientation	Peel off pad liners and place pads on chest
4. Determine if shock is needed	Listen to AED voice instructions	Interpret voice instructions	Move away from patient
5. Deliver shock	Listen to AED voice instructions	Confirm that shock is needed	Press shock button

Task Analysis Process

Task Analysis Source Data







Applications

Task Analysis Applications

01 Evaluate perceptual, cognitive, emotional & physical demands

02 Develop empathy for the user

03 Kickstart conceptual design

04 Create a framework for use-related risk analysis

05 Evaluate time & efficiency

06 Draft requirements & specifications

07 Compare one system to another

08 Compare user experience between user groups

09 Develop framework for a digital user interface

10 Develop training & user documentation

11 Investigate a use-related incident

12 Develop performance criteria

Task Analysis Applications

01 Evaluate perceptual, cognitive, emotional & physical demands

- While working through the breakdown of tasks and subtasks, project teams can explore what the user needs to notice in order to achieve the task, the level of memory and attentional resources required to accomplish the task, what emotions they might be experiencing at the time, and the level of physical exertion mandated by the task.
- These task requirements can be compared to known information about human capabilities in order to identify gaps.
- Enables the development team to prioritize areas of the process or user interface that require most attention.

Task Analysis Applications

01 Evaluate perceptual, cognitive, emotional & physical demands

	1. Turn AED On	2. Expose Patients Chest	3. Place Electrode Pads on Patient's Chest	4. Determine if Shock is Needed	5. Deliver Shock
Perceptual & Cognitive Demands	Understand that turning AED on is first step. Perceive device is in ready or unready state.	Determine what kind of clothing is being worn and best way to remove it.	Visually interpret pad placement images and understand how that translates to patient.	Listen to and interpret voice instructions.	Listen to and interpret voice instructions.
Emotions	Panic, anxiety, concern over whether they will be able to help and act quickly.	Sensitivity toward exposing patient, concern over harming them.	Frustration that they don't understand, wariness of electrodes.	Uncertainty over whether device is working or will help.	Apprehension to press button and shock someone's heart.
Physical Demands	Must be able to physically pull handle and press On/Off button.	Dexterity required to cut shirt off or strength required to rip it off.	Fine motor skills required to peel off pad liners while user may be shaky.	Move from crouching over patient to standing up position.	Must be able to physically press shock button.
Potential Pain Points	Method for opening device and powering on is unclear.	User may not immediately understand removal of shirt is necessary.	Misinterpretation of pad placement, difficulty pulling liner off.	User may be tempted to adjust system while it is working.	User could confuse another button for shock button.
Considerations for Functionality	Must have simple and obvious way to open and power on system.	Provide clear instructions that pads need to go on bare skin/chest.	Provide explicit images of pad placement; add easy pull tabs to liner.	Provide loud and clear instructions to stay clear of patient.	Shock button should feature distinguishable design features.

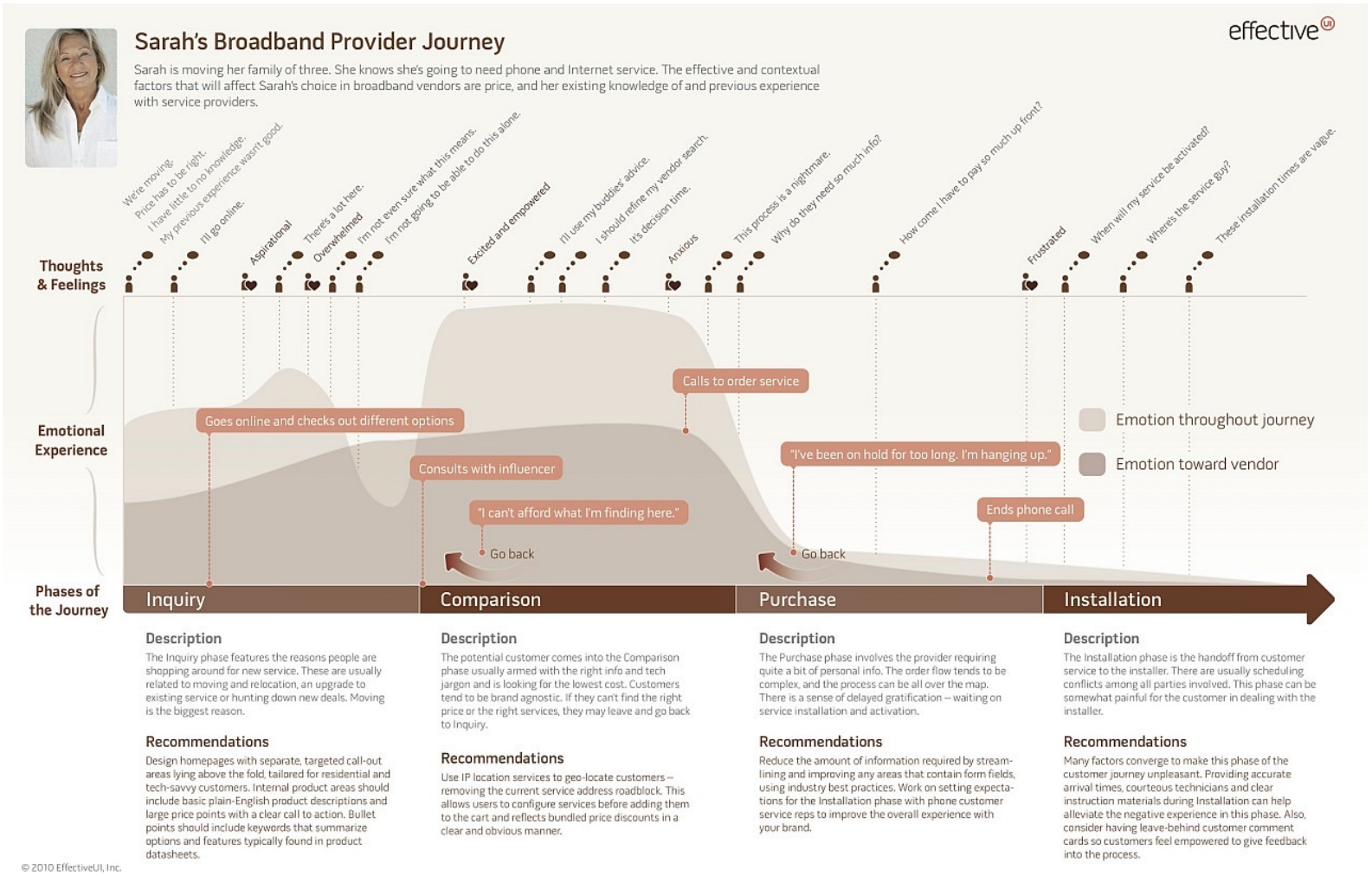
Task Analysis Applications

02 Develop empathy for the user

- Placing oneself in the user's shoes and taking on their perspective while exploring all of the steps required to complete their goals is a fantastic way for project team members to develop empathy for the user, a key aspect of user-centered design.
- This kind of deeper understanding of user needs and challenges is the foundation for empathic design and typically results in the creation of a superior user experience.
- Designers attempt to see the world through the user's eyes and develop an understanding of their emotional and physical needs, the way they see, understand, and interact with technology.

Task Analysis Applications

02 Develop empathy for the user



Taken from: uxforthemasses.com
Effective UI

Task Analysis Applications

03 Kickstart conceptual design

- A comprehensive understanding of task complexity can lead to great ideas about how to modify design to reduce demands on the user and optimize the user experience.
- Throughout the task analysis process, it is natural to start solving use-related problems identified along the way. Teams often notice areas where tasks can be streamlined or automated, and where alternative design solutions might help better mitigate risk. For these reasons, it is often fruitful to integrate brainstorm sessions into the task analysis process or to hold them soon afterward.
- At this stage, it is also useful to employ the 'Allocation of Function' method to determine which tasks are best done by humans, and which are best done by machines.

Taken from: http://marikoproduct.com/HeartRead

Task Analysis Applications

04 Create a framework for use-related risk analysis (URRA)

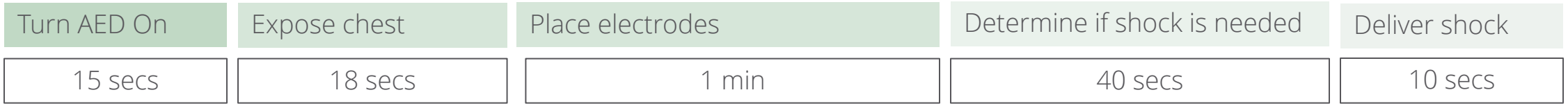
- While there are many different methods for capturing use-related risks for a device or system, teams can save time by leveraging the task analysis as a framework.
- These two activities can even be conducted simultaneously, so that while you are exploring each task and subtask you are also brainstorming and documenting what use-related issues could arise at each step.

Task	Sub-task	Potential Use Error	Potential Harm	Severity	Critical Task?
Place electrode pads on patient's chest	Pull tab to open pad cover	User cannot find tab	Delay of treatment	5	Yes
	Peel off pad liners	User does not pull entire liner off pad	Insufficient therapy	3	Yes
	Place pads on bare chest	User places pads in wrong location	Insufficient therapy	3	Yes

Task Analysis Applications

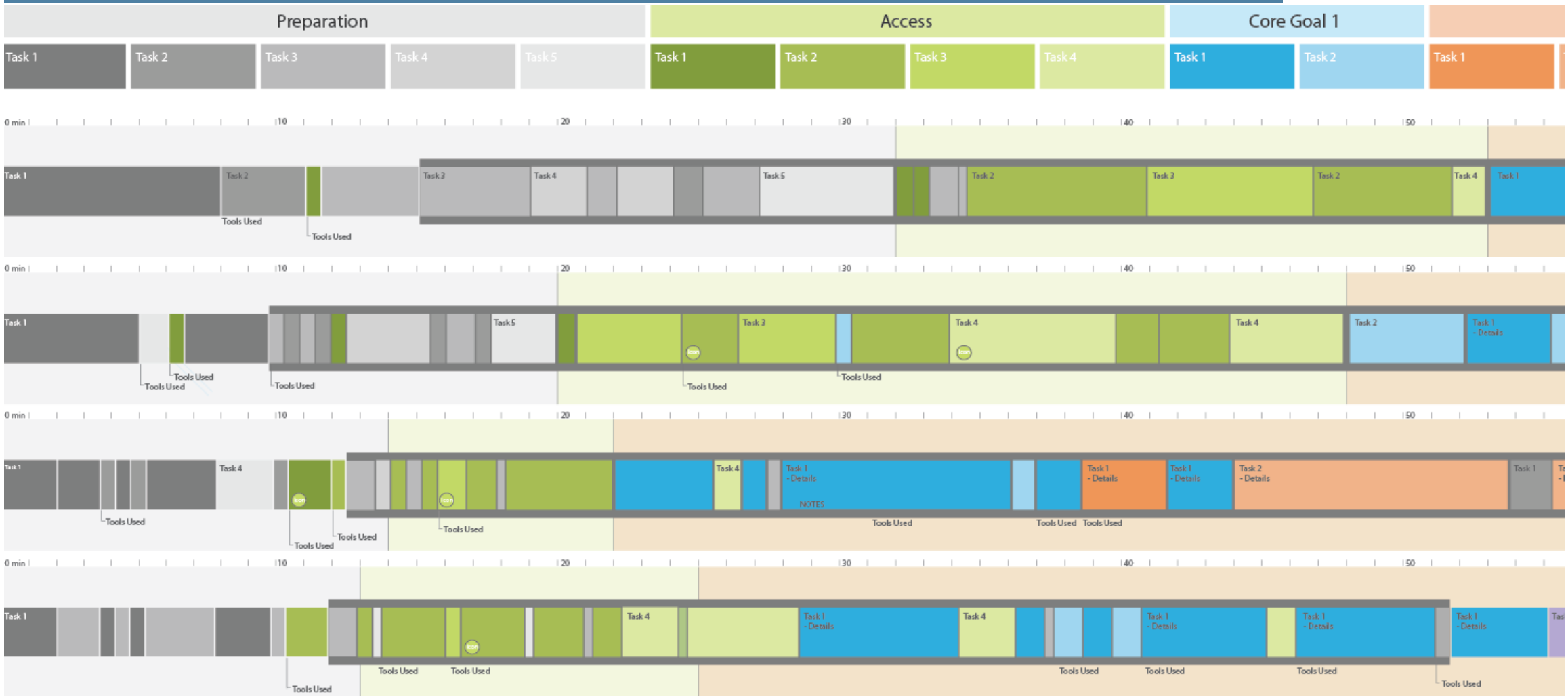
05 Evaluate time & efficiency

- When the traditional task analysis methodology was developed, it was rooted in time and motion studies and was used to help improve workplace efficiency.
- Task analysis can still be used to capture how long it takes users to complete tasks and subtasks, and this in turn can be utilized to identify areas of the workflow that can be streamlined or automated. Evaluation of time on tasks is especially important when the device serves a time-critical function (such as a defibrillator or emergency autoinjector).
- A method called Activity Sampling can be used to provide info about the proportion of time spent on different activities.



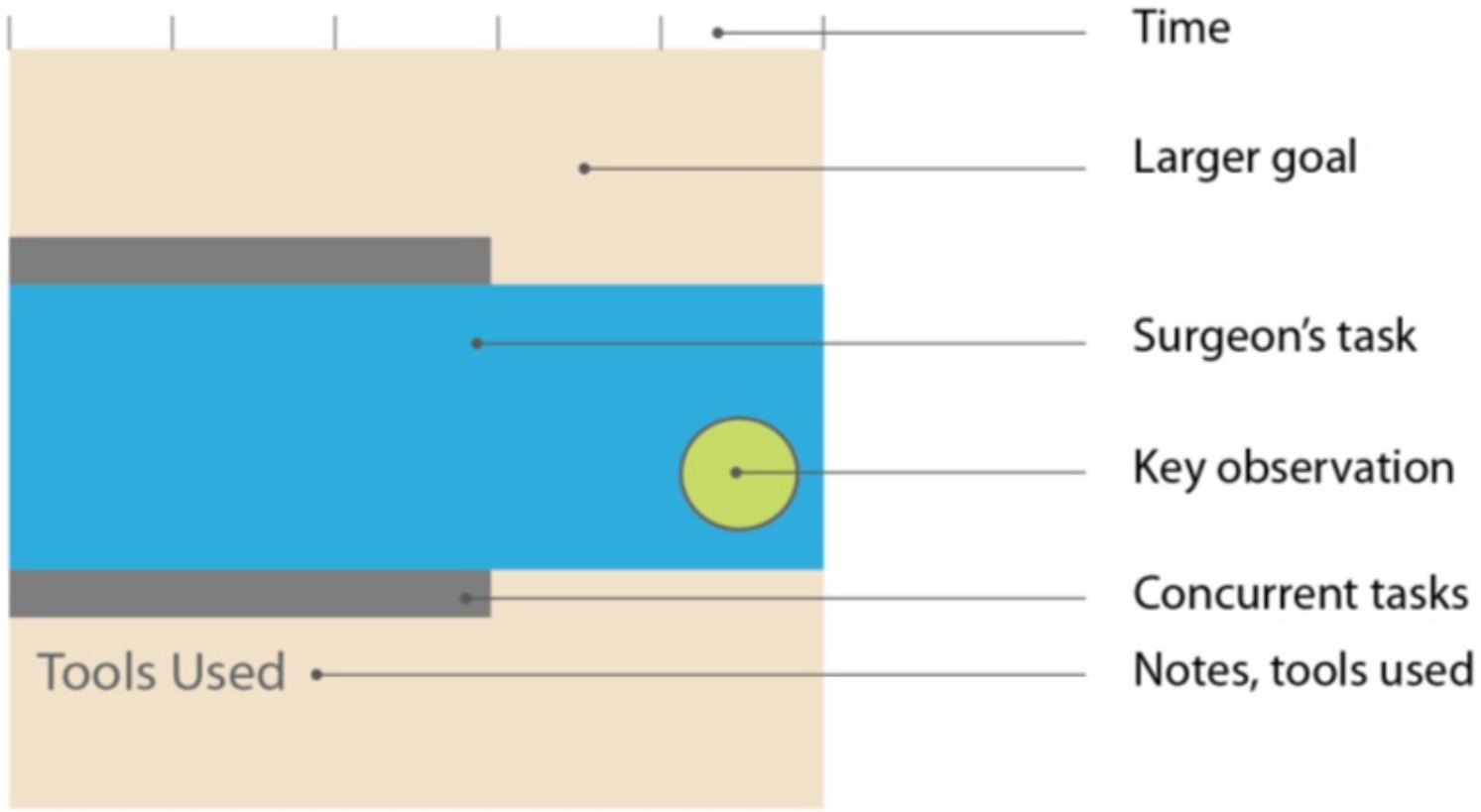
Task Analysis Applications

05 Evaluate time & efficiency



Task Analysis Applications

05 Evaluate time & efficiency



Task Analysis Applications

06 Draft requirements & specifications

- User research is typically conducted to obtain the inputs necessary to draft a task analysis, and observational research also naturally enables a better understanding of who the intended users are, what use environments they are performing tasks in, their use scenarios, and their underlying needs.
- All of this information is required for the creation of user requirements and usability engineering documents like the Use Specification and the User Interface Specification.

Intended Use
Intended Patient Population
User Profiles
Intended Conditions of Use
Operating Principle
User Interface Characteristics Related to Safety

User Interface Requirements
Accompanying Documentation
Training

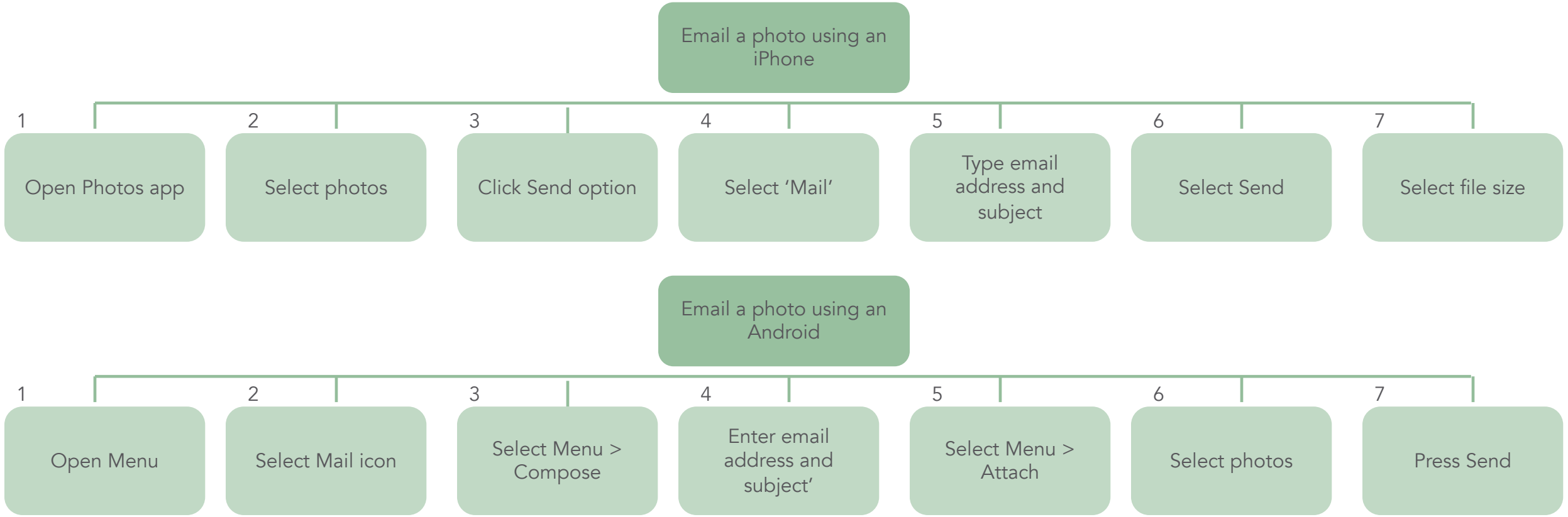
Task Analysis Applications

07 Compare one system to another

- Often times in product development we wish to compare how one version of a system compares to its predicate (generation 1 vs. generation 2, for example) or how a given system compares to its market competitors.
- While a comparative usability test methodology is often employed in these cases (and typically yields rich findings), comparative task analyses could also be employed to gather additional objective data such as the number of steps required to accomplish the same task on both systems.

Task Analysis Applications

07 Compare one system to another



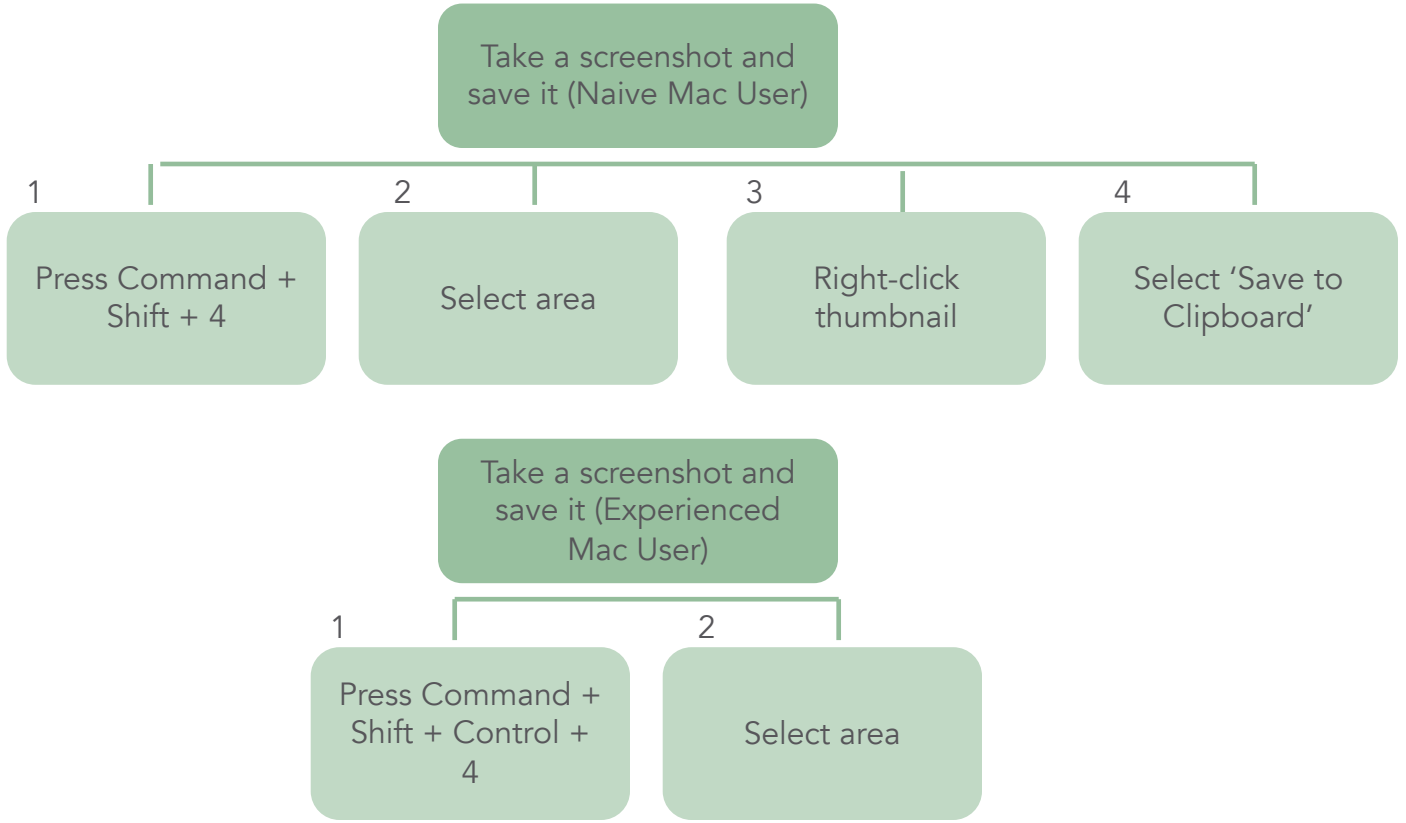
Task Analysis Applications

08 Compare user experience between user groups

- Similar to the way we can compare different systems using task analysis, we can also compare the experiences of different types of users with this tool.
  - For example, the way in which an experienced user interacts with a system to achieve their goals may be quite different from the way a naïve user does, just as the way a caregiver approaches a task might be different from the way a patient does.
- Understanding the various approaches different users might take in completing tasks is critical to ensuring that the product is safe and effective for all users.

Task Analysis Applications

08 Compare user experience between user groups



Task Analysis Applications

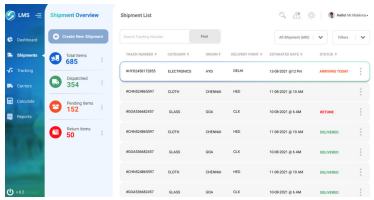
09 Develop framework for a digital user interface

- When creating a digital UI, the design team must have a clear and complete understanding of possible users and use case scenarios in order to determine how to best design the system.
- Task analyses are used by UI designers as the basis for developing the system's information architecture, workflows and navigation schemes.
- This is especially helpful when converting a product that did not historically have a digital UI to a new release with a digital UI or app: you can use the task analysis created for the physical product as a baseline for the UI workflow map.

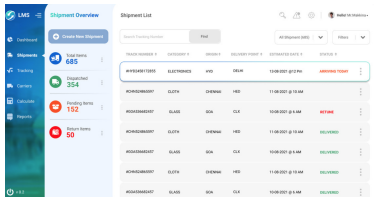
Task Analysis Applications

09 Develop framework for a digital user interface

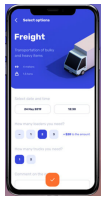
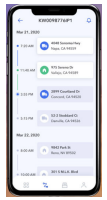
Backend Portal & Physical Interactions



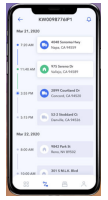


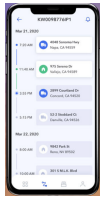


App Screens







Workflow

Task Analysis

Call to deploy

Warehouse

- All supplies kept in warehouse (heated, no AC)
- COMMS equipment kept in Pelican cases
- When prepping for deployment, equipment is pulled out and placed outside on palettes for inventory
- Execute a complete inventory before loading for transport
- If we have time we set it up ahead of time and do a full check
- Can sometimes get some settings programmed in to save time but there's not a lot you can do ahead of time except for the software side of things like that.

Transport

- Following inventory, palletize it ourselves on to the airline pallet
- Load off airplane onto truck
- Drive to site

Survey the Site

- Survey first, then unload.
- Typically very coordinated; they have orders and know where they are going before they get there.
- Sometimes will send a team ahead to do a site survey, not just for this but for other IT equipment as well. The advance team scouts everything out, once on site we can hone it in a little more based on the conditions we find when we get there.

Set Up

- Unload truck
- Carry pelicans to site
- Prop pelicans open
- Set up the main equipment: base & antenna(s)
- Connect the cords.
  There are typically threaded screw on type or have.
  A connector plug on them as well.
  Make sure they are water tight, important they are not loose or spotty signal.

In Use

- Preventative maintenance - make sure things are tight, clean things off, blow things out, give it a good look over so it doesn't go down.
- Check for new occurrences of weather issues noted below: wind, direct sun, sand, rain
  Adjust as necessary
- Once a day we call in our support and give them your signal strength, weather, power outage, info they can record in the file.

Event Complete

- Obtain notification that event is complete
- Stop transmitting high powered amp
- Power everything down
- Wait for things to cool, if necessary

Tear Down

- Take everything down and disassemble
- Execute a complete inventory before loading for transport
- Pack up, clean up

Transport

- Following inventory, palletize it ourselves on to the airline pallet
- Load airplane
- Drive to site

Warehouse

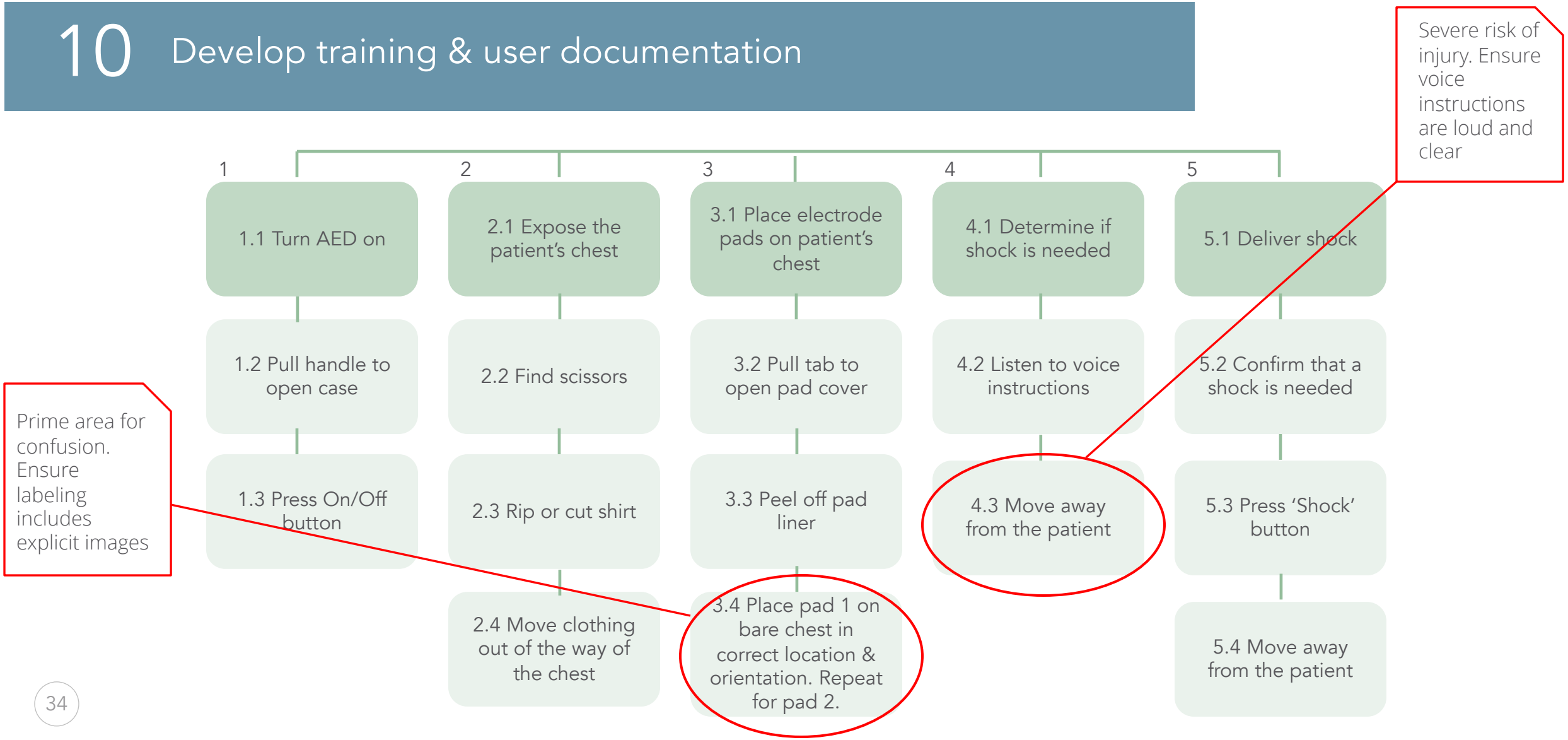
Task Analysis Applications

10 Develop training & user documentation

- The outputs of a task analysis can be very useful in helping to develop training programs, Instructions for Use, and Quick Reference Guides.
- Through task analysis, one can naturally glean groupings of information that need to be learned, areas of the workflow that require high cognitive demand, and critical steps that could cause harm if one were to commit a use error.
- All of these insights can and should be used as inputs into the development of training and user documentation.

Task Analysis Applications

10 Develop training & user documentation



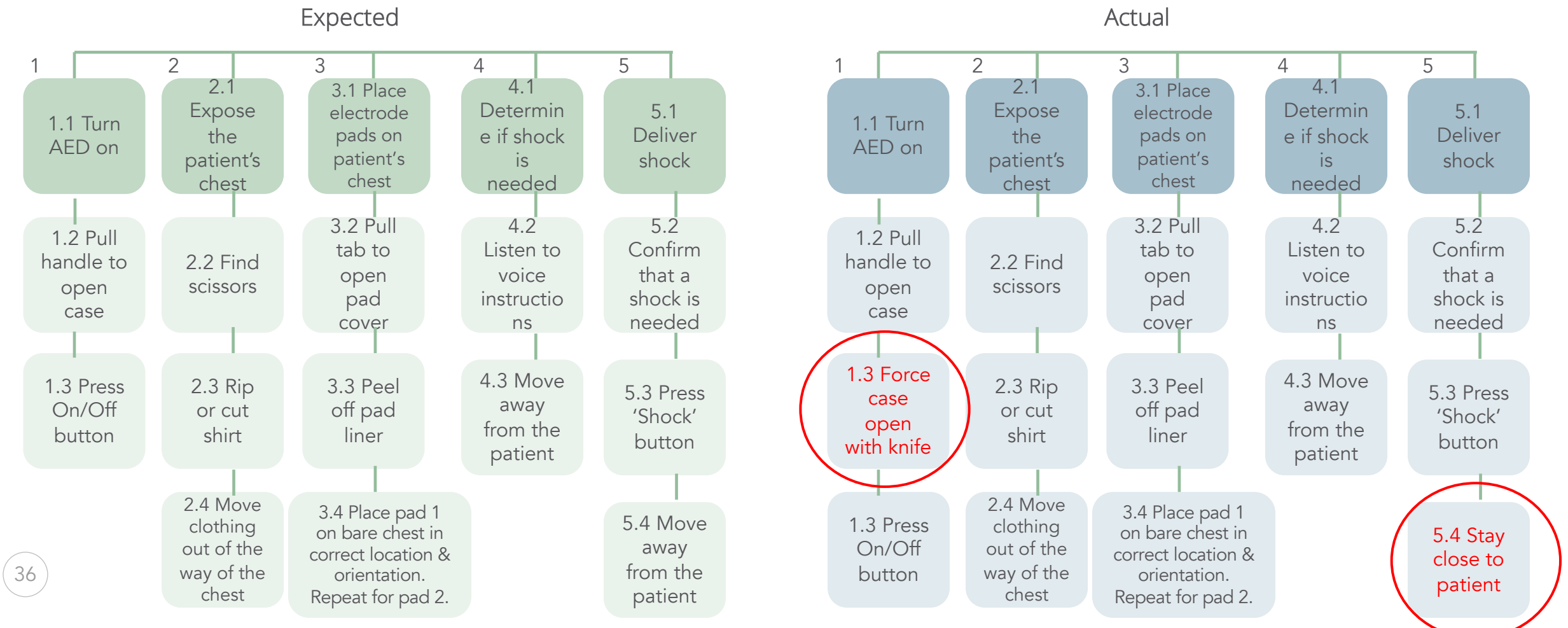
Task Analysis Applications

11 Investigate a use-related incident

- Task analysis can also be used in a retrospective mode for the detailed investigation of major incidents with the overall goal of defining what went wrong and how to prevent recurrence.
- The starting point of this type of investigation is the systematic description of the way in which the task was actually carried out when the incident occurred.
- This may differ from the prescribed way of performing the operation, and TA provides a means of explicitly identifying such differences. These types of comparisons are valuable in identifying the immediate causes of an accident.
- This can be combined with Critical Incident Technique (ask operator to describe incident using recall) to yield richer data.

Task Analysis Applications

11 Investigate a use-related incident



Task Analysis Applications

12 Develop performance criteria

- With a comprehensive understanding of the system and its intended functions, management teams can define what successful and unsuccessful performance entails.
- This attempts to ensure that personnel carry out their tasks as intended and trained and can include the use of continuous performance monitoring, audits, and analysis of incident reports.
- Actual performance is checked and compared with pre-set expectations.
- If performance differs, consider reasons for discrepancy and determine whether solutions should involve re-training, development of job aids, or re-design.

Performance Goal	Description
1	Trained users will be able to open device and apply pads within 2 minutes.
2	Untrained users will be able to open device and apply pads within 2.5 minutes.

Task Analysis Applications

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Q & A

Citations & Additional Reading

- "A Guide to Task Analysis" by Kirwan & Ainsworth, 1992.
- "User and Task Analysis for Interface Design" by Hackos & Redish, 1998.
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Thank you!

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