
Using Scenarios throughout the User-Centered Design Process

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Overview

Veterans Health Administration (VHA) Human Factors Engineering (HFE) group has developed a robust usability engineering process to develop and improve the care provided by the VA with a specific emphasis on health technology. Currently, VHA's HFE group is working to implement best practices for the utilization of human-centered design or user-centered design (UCD) to optimize the usefulness, usability, and satisfaction of a new health information technology (HIT).

An important part of the UCD process is taking into account real-world situations and contexts of use, and enabling this perspective to inform HIT design, development, and assessment. These real-world situations can be represented as 'scenarios' – narrative descriptions of user's goals in a particular situation, as well as important sociotechnical factors that could impact the human-computer interaction.

HFE has developed resources for creating effective scenarios intended for HIT project teams and each project's intended users. Scenarios are flexible tools that allow the capture of the most important contextual information about a real-world situation. Scenarios describe (at varying levels of detail) the intended user's perspectives, goals, and tasks related to that real-world situation. A scenario's unique and accessible storytelling format facilitates communication between diverse clinical and non-clinical users, administrators, HFE, and analysts or IT personnel, and supports the development of shared perspectives within the highly complex healthcare environment.

The purpose of this document is to provide guidance on creating scenarios that will support various activities across the software development lifecycle. Representations of 'real-world situations' can, for example, help to specify or clarify user needs, inform user interface design decisions, and enable usability testing. In addition, various types of scenarios can also be used to simulate or 'walk through' new workflows. Specifically, this document focuses on how to develop and use scenarios throughout the UCD process to facilitate technology upgrades or transitions, ensuring that capabilities meet users' needs and Veterans receive optimal care.

This report presents suggestions for the development and application of clinical scenarios across a robust UCD process. Throughout this process, it will be important to think about and utilize scenarios that encompass the continuum of care, from those that are very "run of the mill" and typical to those that stretch the limits of the system (i.e., edge cases), in order to ensure that maximum flexibility is achieved and risks to HIT safety minimized. Furthermore, the potential uses for scenarios described are not limited to clinical tasks and clinical roles, but applicable to the full range of EHR users, tasks and contexts (e.g., patients, administrative and other support roles and activities). The UCD process shown in Figure 1 describes the six stages that are widely accepted across the industry (ISO, 2010).

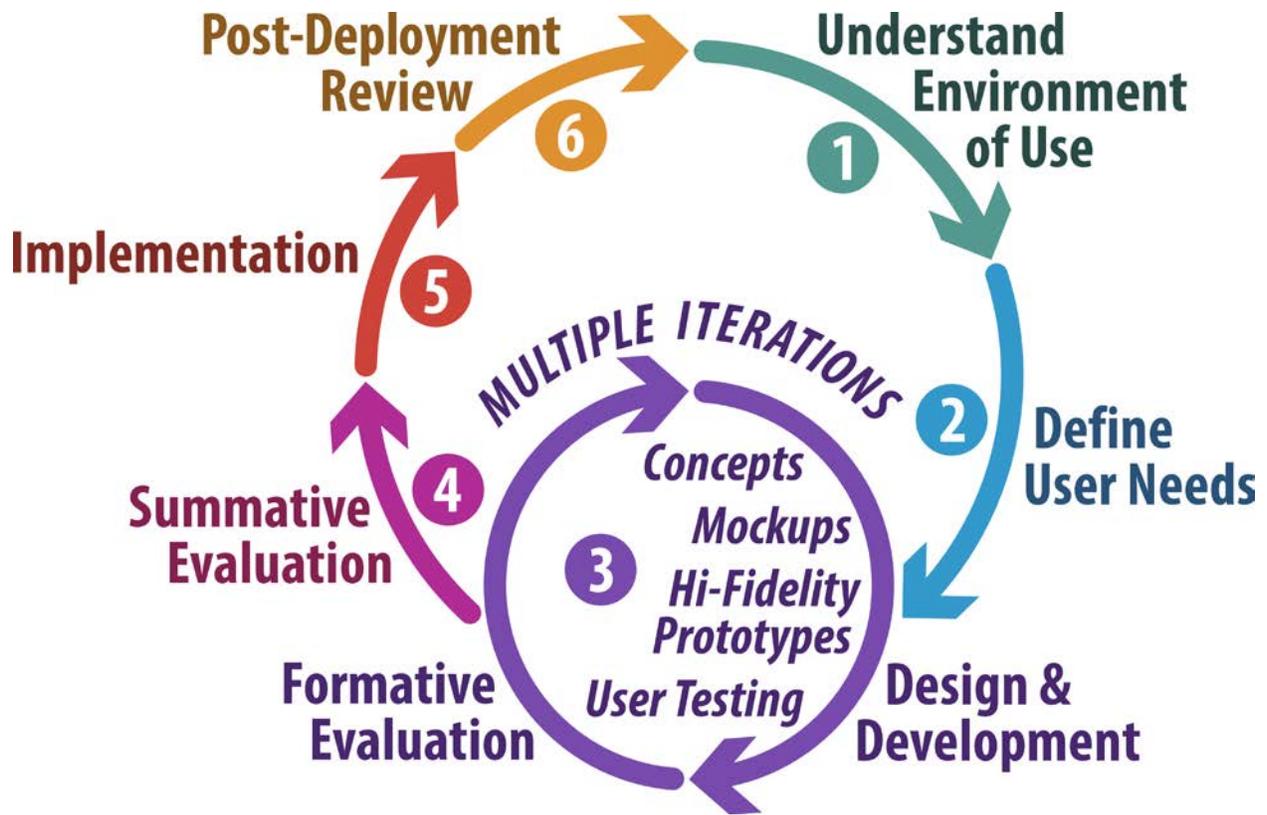


Figure 1. The User-Centered Design (UCD) Process

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The following document describes how different types of scenarios may be used across the UCD process at each point and the rationale for their use. We also discuss key aspects that would be included in that specific type of scenario. Each section also describes how to modify a scenario for one specific aspect of the UCD to be utilized in another aspect. Examples of what scenarios may include are presented in each of the six stages. Each example is about a nurse completing the first step (i.e., obtaining and documenting a patient’s current medication history) in the clinical task of medication reconciliation in an outpatient clinic. This example was selected because of its complexity and the potential patient safety issues that it encompasses. While these example scenarios are largely based on prior field observations and usability evaluations, they include fictionalized components and thus are intended for illustrative purposes only.

Prior to implementation in UCD activities, one or more subject matter experts should validate the scenarios by reading through them and ensuring that the scenario is realistic. This validation process will ensure that the scenario accurately represents the real-world work processes and environment and all clinical details are appropriate to the context.

Phase 1: Understanding the Environment of Use

In the user research phase, typically a scenario would be used to highlight current work and work processes, as discovered through contextual inquiry, which involves observing and interviewing people while they work in their natural environment. Thus, it is an illustration of the understanding of the environment of use and an output of a contextual inquiry study. For example, after observing in an outpatient clinic for several hours and during several patient visits, an engineer might create a scenario about a prototypical patient visit, in which the clinician must review the patient chart, order laboratory tests, refill medications, and interact with the patient about an acute issue. Such a scenario would aggregate or highlight what was learned during observations and can further be augmented to fill gaps in the engineer's understanding.



Scenarios in this phase may also be used as a way to gain feedback about the engineer's or scenario designer's understanding of the current tasks that users engage in. The scenario developer can use these scenarios to ensure that they are adequately capturing the challenging tasks or barriers that users encounter during their work that may benefit from system re-design.

Specific uses for this type of scenario are:

- Current illustrations of a workflow
- Illustrating the context of use and environment where the work takes place
- Describing workflow barriers and potential opportunities for improvements

Conversion to other sections.

If done correctly, the scenarios developed during the understanding the environment of use phase (i.e., Phase 1) have the potential to guide the UCD process throughout the rest of the phases. The scenarios developed here may serve as the foundation for scenarios tailored to later UCD phases, especially those that illustrate the challenges or barriers encountered during users' interaction with the system.

Example scenario.

It's another busy day at the primary care clinic. Mary is a nurse working in patient intake and assisting the physician, Dr. Jones, with appointments. Dr. Jones has a full day of appointments scheduled with two exam rooms available, and by mid-morning the team is running about 30 minutes behind, as is often the case. As Tom, the patient care technician, finishes cleaning room 2, Mary reviews the patient schedule in the electronic health record system (EHR) on the computer at the nurse's station. She sees the next patient is Mr. Munroe, a 50-year-old male with a history of diabetes and kidney transplantation. Mary logs out of the computer and heads to the

waiting room to find Mr. Munroe and bring him back, but is interrupted when a nurse asks her for help locating the correct patient education materials for a new ultrasonic nebulizer for the patient in room 4. Mary logs back in to the EHR, locates the patient handout, and prints it for the other nurse. As the nurses briefly review the handout, Mary shares a few quick teaching tips from her prior experience with this specific device. She logs back out of the EHR, and then retrieves Mr. Munroe from the waiting room. Mr. Munroe has brought all of the medications he takes at home with him in a large bag, which he hands to Mary as they enter room 2. Mary pulls up Mr. Munroe's chart in the EHR and reviews his current medication list. Mary starts pulling medication bottles from the bag, comparing them to the medication information in the system, and reviewing them with Mr. Munroe. She knows an accurate medication history is critical to safe patient care, so she tries to be as thorough as possible. This is a time-consuming task and she already feels the pressure of being behind schedule.

Between medication questions, Mr. Munroe chats amiably about his recent vacation. Mary loses her place on the med list a few times and has to double back to confirm meds she has already reviewed. She alphabetizes the medication bottles to match the EHR's display and grabs a scratch sheet of paper to jot notes about medications that are in the EHR list but missing from the bag to better help her keep track of this complex task. Medication history information is entered into the EHR as free text, which Mary finds time-consuming and error prone. Several of the medications in Mr. Munroe's bag are listed by the generic drug name only; Mary thinks they are equivalent to meds listed by brand name only in the EHR but she is not certain. She looks these medications up on the Internet to confirm and makes sure she does not add duplicates to the list. When complete, Mary saves her medication history documentation in the EHR for Dr. Jones to review and finalize during the visit. (The Joint Commission, 2018).

Phase 2: Defining User Needs

The phase in which users' needs are defined (i.e., Phase 2) is where user requirements are developed during the system design or re-design process. Within this context, it may be helpful to use scenarios as a way to help solidify the requirements for the new or re-designed system. In this phase, scenarios tend to be about the envisioned or "to be" future state of the system that could be used during the development of requirements, as system developers identify such things as: how the system is going to actually work; how users will interact with it; what the mismatch or gaps may be between work as imagined and work as actually done; and the system's various key pieces of functionality. In this context, scenarios will likely be just one piece of information from usability engineering techniques that would contribute to the design of system requirements. Thus, scenarios generated in this phase would be used in conjunction with other artifacts like workflow and information flow diagrams.



Scenarios in this phase may also be used as a way to gain feedback about proposed changes to the system (e.g. the future system or system that is to be iteratively designed, evaluated and implemented). In this manner, rather than focusing on the current understanding of how tasks are accomplished within the current system and work environment (as in the previous phase), the scenario developer would take this a step further to create an envisioned world with each scenario. This type of scenario would still incorporate the numerous tasks that are required of users when doing their work but would re-imagine how that would occur; thus, users would be able to comment about the work as envisioned. An envisioned system will be based upon multiple trade-offs and development of priorities, based upon the types of needs gathered during other UCD phases.

Specific uses for this type of scenario are:

- Envisioned or "to be" design of work
- "To-be" scenarios can optimize the changes to be made, based on expected impacts
- Describing priorities for requirements development
- Gaining early feedback from users on proposed changes

Conversion to other sections.

These types of scenarios may be useful for ensuring that the development of a system, or the modifications of an existing system is meeting the users' needs throughout the UCD process. Scenarios that highlight user goals with the system can be modified into "testable" scenarios for future phases. An engineer might want to make an inventoried capability matrix with each functionality coded being linked to a test case or specific

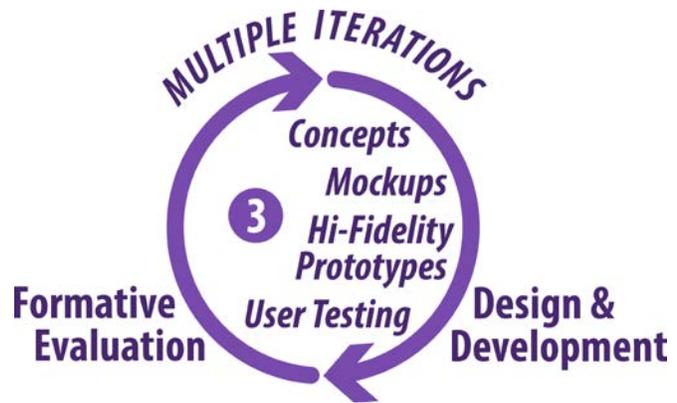
scenario. The scenarios from this phase would have to be modified to include specific actionable items and may not focus as much on the specific users for Phases 3 and 4.

Example scenario.

Mary is a nurse working in a busy primary care clinic, performing patient intake activities and assisting the physician, Dr. Jones, with appointments. Mary taps her ID badge to quickly log in to the electronic health record system (EHR) on her mobile workstation and reviews the patient schedule. She sees the next patient is Mr. Munroe, a 50-year-old male with a history of diabetes and kidney transplantation. Mary stops by the waiting room to retrieve Mr. Munroe and takes him to a patient room to complete her intake process using the mobile workstation. Mr. Munroe has brought all of the medications he takes at home with him in a large bag, which he hands to Mary as they enter the patient room. Mary pulls up Mr. Munroe's chart in the EHR and reviews his current medication list. Mary pulls medication bottles from the bag, comparing them to the medication information in the system, and reviewing them with Mr. Munroe. She knows an accurate medication history is critical to safe patient care, so she tries to be as thorough as possible. She uses the medication list's scratch pad feature to keep track of medications as she reviews them. This allows her to temporarily "check off" medications within the long onscreen list as she confirms them with Mr. Munroe, instead of having to hold this information in her working memory throughout the task. Using this feature, Mary is able to interact more naturally with Mr. Munroe as he chats amiably about his recent vacation between medication questions. Medication history information is entered into the EHR in structured fields (e.g. pick lists) with medication appropriate completion match suggestions, which saves Mary valuable time typing and reduces the risk for transcription errors. Since the EHR provides both the brand and generic name equivalents on the patient's medication list, Mary is able to quickly verify that the generic medications in Mr. Munroe's bag match medications already listed in the EHR. When complete, Mary saves her medication history documentation in the EHR for Dr. Jones to review and finalize during the visit.

Phase 3: Iterative Design, Development, and Formative Evaluation

The use of scenarios to facilitate the iterative design, development, and formative evaluation phase (i.e., Phase 3) of the UCD process is a key component of this phase. Throughout the iterative design phase, the scenario developer will want to develop and utilize various scenarios that will illicit system use of various system functions. The key would be to utilize a capability matrix map to articulate the high value scenarios or pieces of functionality that need to be included in an evaluation. High-risk tasks and edge cases (i.e., those that push the capabilities of the system) should be included to ensure evaluation of performance across the spectrum of use. In addition, scenarios may be developed to evaluate multiple design ideas by framing a problem (or question) that the user would need to interact with the system to solve. During this phase, it is imperative to tailor scenarios to specific functionality or expected workflows that show how the user would interact with the prototype (e.g., mockups, wireframes, workflows or even existing operational systems that are in need of customization). Several of these scenarios may be used to assist with the iterative design process, especially the formative evaluations, and may be repeated over several design iterations in succession. The crux of scenarios for this phase is that they should require the user to interact with the mockups of the system in order to meet the user's goals. For example, scenarios may ask the user to look up a piece of information in the medical record or document a patient's vital signs in the correct location. This type of evaluation session may be conducted with multiple designs for comparison, in order to ascertain the most optimal design.



When implementing a vendor's commercial off-the-shelf (COTS) product, the design and development activities in this phase are analogous to the configuration and customization activities typically employed in preparing a vendor's system for use at a specific organization.

Specific uses for this type of scenario are:

- Guiding design and the customization of user interfaces
- Creating and understanding users' performance on completion of various work supported by different systems
- Comparative evaluations of multiple potential design solutions
- Helping identify which workflows will change with implementation of the new system to inform change management and training in later phases, particularly in cases where implementation of a COTS product limits modifications to the user interface

Conversion to other sections.

Scenarios used in this phase may take a specific task or sequences of events illustrated in the previous phases (i.e., Phase 1 and 2) and modify them to support the user interacting with mockups of the system. During the current phase, the scenario developer may also ensure that design requirements are met. Therefore, scenarios from Phase 2 may be useful for this task. However, the scenarios utilized in the current phase (i.e., Phase 3) will tend to be more simplistic than Phase 2 scenarios and not necessarily focused on the environment in which the future system will be used. These types of scenarios developed during the formative evaluations may be combined or used individually in the next phase, which involves summative usability evaluations (i.e., Phase 4).

Example scenario. (Nurse focused and task-based, rather than understanding what the workflow will be.)

Imagine you are working in the primary care outpatient clinic, assisting with patient intake. Mr. Munroe, a 50-year-old male with a history of diabetes and kidney transplantation, arrives for his appointment. As you review Mr. Munroe's medication history in your normal intake process, Mr. Munroe states that he takes blood pressure medicine once a day. He isn't sure of the name but says that it's a "little white pill." How would you document this information in this screen?

Phase 4: Summative Usability Evaluation

Scenarios for summative usability evaluations illustrate or provide a frame of reference for the user to then interact with the system being evaluated. In this context, the scenario has to have a task (or several tasks) that would need to be completed by using a fully functional version of the system. Scenarios may focus on key pieces of functionality that have been re-designed, or in the case of EHRs, may be inherently more of a risk to patient safety (e.g., medication management process, patient selection, allergy documentation, etc.). During this phase, the scenarios focus largely on providing context and goals for the user that will be interacting with the system. There may be several steps that the user would have to go through in order to complete the scenario. Several scenarios may be used during a summative usability evaluation. Additionally, the passage of time may be used to divide a scenario into several interactions throughout the evaluation. A focus of this evaluation is the use of different measures that are taken on task performance, which may also include safety-related use errors, task efficiency (e.g. time on task), task learnability, and user satisfaction.



In addition to the development of the scenario, for this phase scenario developers also need to consider what constitutes the successful completion (e.g. task performance measures) of that scenario when interacting with the system. Is there an optimal path through the system that the scenario developer expects all users to take? Which specific actions are required for safe completion of a task? Finally, the scenario developer will want to ensure that the tasks or interactions with the system that they are expecting the user to take match the user's role. For example, it would be appropriate to have administrative staff, in a scenario-based summative usability evaluation, complete patient check-in procedures but not have them prescribe the patient's medications since that may not be appropriate.

Specific uses for this type of scenario are:

- Evaluating a system that has been redesigned
- Conducting a comparative evaluation between the current and new (re-designed) system
- Evaluating specific performance measures about scenarios and the related tasks that are necessary to complete the work

Conversion to other sections.

Summative usability scenarios may be broken apart into scenarios for Phase 3 that would focus on a specific aspect of the system. During Phase 4, the scenario developer may also continue to ensure that the design requirements are being met, which should be done prior to moving on from Phase 3. Thus, scenarios from Phase 2 may be useful. Additionally, the Phase 4 scenarios can be amended and combined to use for

post-deployment reviews (i.e., Phase 6), if they are modified to be able to collect data about how the new or modified system is working and use the scenario to illustrate any gaps that are found in the new system when it is initially implemented (i.e., Phase 5).

Example scenario. (Nurse focused)

You are working in the primary care outpatient clinic, assisting with patient intake. Mr. Munroe, a 50-year-old male with a history of diabetes and kidney transplantation, arrives for his appointment. When you ask Mr. Munroe about the medications he takes at home, he hands you a bag of medications* that he brought with him. As you review these medications with Mr. Munroe, he reports that last week he increased his Humulin dose to 24 units in the morning and 20 units at night because his blood sugar was high. He is currently taking two of the CellCept pills twice a day because his transplant doctor told him to increase his dose until the current prescription runs out. Mr. Munroe says that he just started the prednisone last week. He also asks if it's possible to switch to a cheaper generic medication instead of the Prograf because it's too expensive. As you finish up, Mr. Munroe remembers that he also takes blood pressure medicine once a day and that bottle isn't in his bag because he needs to pick up a refill on his way home. He isn't sure of the name but says that it's a "little white pill." You update the patient's medication list to reflect the information you've gathered.

*Participant provided with a physical bag of simulated medication bottles

Phase 5: Implementation

Just prior to implementation or during the implementation phase (i.e., Phase 5), scenarios can be used in a number of ways that may ease the transition of a new software system. In this sense, scenarios may be used to facilitate training of users by providing example patients and tasks to be completed (McAlearney et al., 2012). In the same manner, scenarios may be used to highlight the differences between the current system and the new system to be implemented. Thus providing valuable information to users about how and where their workflows will be changed.



Specific uses for this type of scenario are:

- Training and learning of new or modified versions of systems
- Understanding gaps and spaces for improvement
- Reinforcing and validating key workflows (e.g., edge cases or high risk tasks) during implementation processes and training

Conversion to other sections.

Scenarios from Phase 1, when engineers attempted to understand the environment of use, might be updated and compared with new or updated scenarios that are representative of the new system. Thus, a comparison can be made between previous workflows and workflows involving the new system. Phase 3 and 4 scenarios might be modified and used for training purposes to ensure that adequate training has been conducted as well as used for task-oriented or self-directed learning. For this type of self-guided critical thinking exercise, the use of scenarios can reinforce classroom training for known difficult tasks or workflows that will change substantially in the new system.

Example scenario. (Nurse focused; for use as a self-guided exercise in a training environment)

You are working in the primary care outpatient clinic, assisting with patient intake. Mr. Munroe, a 50-year-old male with a history of diabetes and kidney transplantation, arrives for his appointment. You ask Mr. Munroe what medications he currently takes, and he provides you with a piece of paper containing the following information that he wrote down based on his pill bottles at home:

- **Novolog Flexpen** 100 unit/mL subcutaneous Novolog Flexpen 100 unit/ml use to inject 16 units in the morning with breakfast sub q, inject 12 units lunch sub q, inject 20 units sub q supper, PLUS 1 unit for increase of glucose of 15 above 100, except take extra 1 unit for every increase of 10 above 100 when sick
- **Humulin N KwikPen** 100 unit/mL (3 mL) subcutaneous 20 units subcutaneously every morning and 16 units subcutaneously every evening

- **Nifedipine** ER 60 mg 24 hr Tab 1 tablet by mouth once a day
- **losartan** 100 mg tablet 1 tablet by mouth daily
- **prednisone** 5 mg tablet 1 tablet by mouth daily
- **CellCept** 500 mg tablet 1 tablet by mouth every 12 hours
- **Tenormin** 100 mg tablet 1 tablet by mouth twice a day
- **aspirin** 81 mg by mouth daily
- **Lasix** 80 mg tablet 1 tablet by mouth twice a day
- **Prograf** 1 mg capsule 2 capsules by mouth twice a day. No substitutions allowed
- **simvastatin** 20 mg tablet 1 tablet by mouth at bedtime

As you discuss these medications with Mr. Munroe, he reports that last week he increased his Humulin dose to 24 units in the morning and 20 units at night because his blood sugar was high. He is currently taking two of the CellCept pills twice a day because his transplant doctor told him to increase his dose until the current prescription runs out. Mr. Munroe says he just started the prednisone last week. He also asks if it's possible to switch to a cheaper generic medication instead of the Prograf because it's too expensive. As you finish up, Mr. Munroe remembers that he also takes blood pressure medicine once a day. He isn't sure of the name but says that it's a "little white pill."

Practice updating the patient's medication list to reflect the information you've gathered.

How would you document the variance in how the patient is currently taking his Humulin and Cellcept medications?

How would you document the start date for his prednisone?

How can you communicate the patient's request to switch to a cheaper generic medication?

How would you handle the unidentified blood pressure medication?

Phase 6: Post-Deployment Review

Post-implementation surveillance provides an opportunity to create scenarios that would envision the next generation or future optimization of a system. More importantly, it is a way to now illustrate how the system is faring after implementation and adoption. Most of these scenarios could be created in the spirit of the first phase of the UCD process (i.e., understanding environment of use), which would afford the creation of new scenarios based on observations.



Perhaps more useful is the development of scenarios that will allow users, developers, and human factors professionals to illustrate and highlight gaps in the implemented system that could negatively impact patient safety or core business functions. Thus, scenario developers may opt to modify summative evaluation scenarios into empirical observable scenarios that take into account the context of use.

Specific uses for this type of scenario are:

- Identifying workflow adaptations and workarounds that have emerged after the new system or technology was implemented.
- Assessing the success of workflow adaptations required for the new system
- Uncovering gaps in the new system that were previously unknown
- Understanding the new context of use and how technologies interact with it

Conversion to other sections.

Scenarios from Phase 1 might be updated with new data uncovered during post-deployment surveillance. Phase 2 scenarios might be modified to ensure that design goals set out during that phase have been met.

Example scenario.

Mary is a nurse working in a busy primary care clinic, performing patient intake activities and assisting the physician, Dr. Jones, with appointments. Mary is gathering a medication history from Mr. Munroe, a 50-year-old male with a history of diabetes and kidney transplantation, as part of the normal clinic intake process. Mr. Munroe has brought all of the medications he takes at home with him in a large bag. Mary pulls up Mr. Munroe's chart in the EHR and reviews his current medication list. Mary removes medication bottles from the bag, comparing them to the medication information in the system, and reviewing them with Mr. Munroe. She values the medication list's new scratch pad feature, which allows her to temporarily "check off" medications within the long onscreen list, as she confirms them with Mr. Munroe because it allows her to quickly work through the medications in the bag without having to alphabetize them first or repeatedly go back over the list to make sure she hasn't missed anything. Mary adds new medications to the list, using the structured

data entry fields efficiently, until she encounters a brand medication that does not match the available structured options. After several search attempts, Mary selects one of the generic matches and makes a free text note to indicate the actual brand the patient is taking. As she finishes up, Mr. Munroe remembers that he also takes blood pressure medicine once a day and that bottle isn't in his bag because he needs to pick up a refill on his way home. He isn't sure of the name but says that it's a "little white pill." Mary does not know how to enter this unknown medication in the list's structured fields, so she writes it on a post it note and plans to call Mr. Munroe's pharmacy to confirm details after she completes the intake process. Mary saves her medication history documentation in the EHR for Dr. Jones to review and finalize during the visit. As Mary leaves the room, she passes Dr. Jones in the hallway. She verbally tells Dr. Jones about the unknown blood pressure medication, and asks her not to finalize medication reconciliation until she has had a chance to call the pharmacy. While Dr. Jones is in the exam room with Mr. Munroe, Mary calls the pharmacy to track down the blood pressure medication information. She writes the details on a post-it note and takes it into the room to Dr. Jones.

Key Components of Scenarios

Scenarios can be used across the six phases of UCD, but different components should be included depending on the intended use case. Table 1 below summarizes the key components in each of the phases.

Table 1. Key components for scenario development across each of the UCD phases.

Component	Phases					
	1	2	3	4	5	6
User (roles)						
User Job Goals	X	X		X	X	X
Focus on key users	X		X	X		
How individuals accomplish goals	X	X			X	X
Work (tasks)						
Illustrative examples of how work occurs	X					X
Focus on barriers or challenges	X					X
Envisioned world where gaps in current work filled		X				
Captures use of functionality of interest			X	X		
Tasks to be completed by user			X	X	X*	
How tasks are completed	X	X			X	X
Environment						
Hardware and software interactions	X	X				X
Environment of use	X			X	X	X
Relevant system goals		X				X
State of items (e.g. patient, system, etc.) in scenario			X	X	X	
Regulation and policy	X	X				X
Used in conjunction with						
Lower fidelity prototypes or wireframes			X			
Threats to patient safety	X		X	X	X	X
High fidelity prototypes/ beta software				X	X	

*This would likely be embedded in training scenarios, but not other scenario uses in this phase.

Summary

Across the phases of the UCD process, scenarios have the potential to strengthen and inform the design of systems, especially EHRs. Even when considering the design process in the context of purchasing a commercial product, scenarios can help ensure key functionality is not lost and that potential gaps between the system and the users' understanding of the system are highlighted and addressed in a meaningful way. Scenarios provide a framework for envisioning and evaluating a complex system from the perspective of the key stakeholders most impacted by the system. Finally, scenarios (or the representation of work shown through multiple variations of a particular scenario) are an illustration of work that can provide continuity across a product lifecycle.

References

- International Organization for Standardization (ISO). (2010). *Ergonomics of human-system interaction – Human-centred design for interactive systems* (ISO Standard No. 9241-210). Retrieved from <https://www.iso.org/standard/52075.html>
- McAlearney, A.S., Robbins, J., Kowalczyk, N., Chisolm, D.J., & Song, P.H. (2012). The role of cognitive and learning theories in supporting successful EHR system implementation training: A qualitative study. *Medical Care Research and Review*, 69(3) 294 –315.
- The Joint Commission. (2018). *National Patient Safety Goals: Ambulatory Health Care Accreditation Program*. Retrieved November 29, 2017 from https://www.jointcommission.org/assets/1/6/NPSG_Chapter_AHC_Jan2018.pdf.