Don’t Forget About Human Factors!

Lessons from COVID-19 Point-of-Care Diagnostic Testing

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Georgia Tech

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Georgia Tech HomeLab

Georgia Tech Center for Advanced Communications Policy

Overview

1. **Introduction to human factors**

1. **What is HomeLab?**

1. **RADx Usability overview**

1. **Lessons learned**

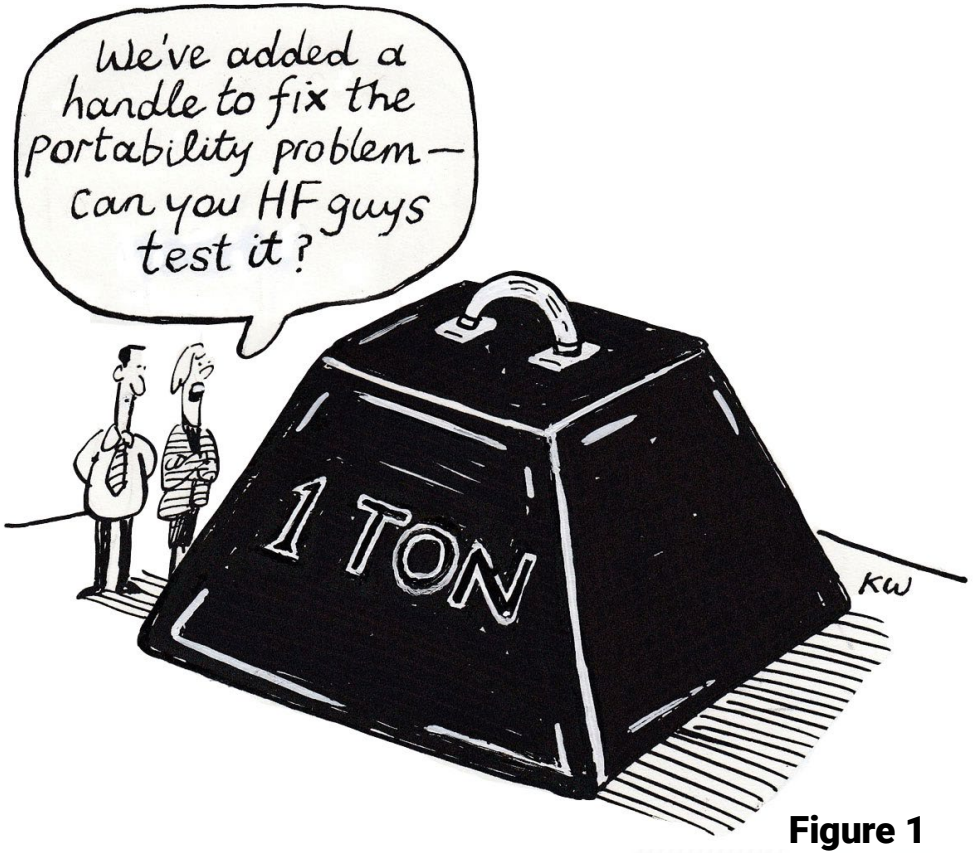
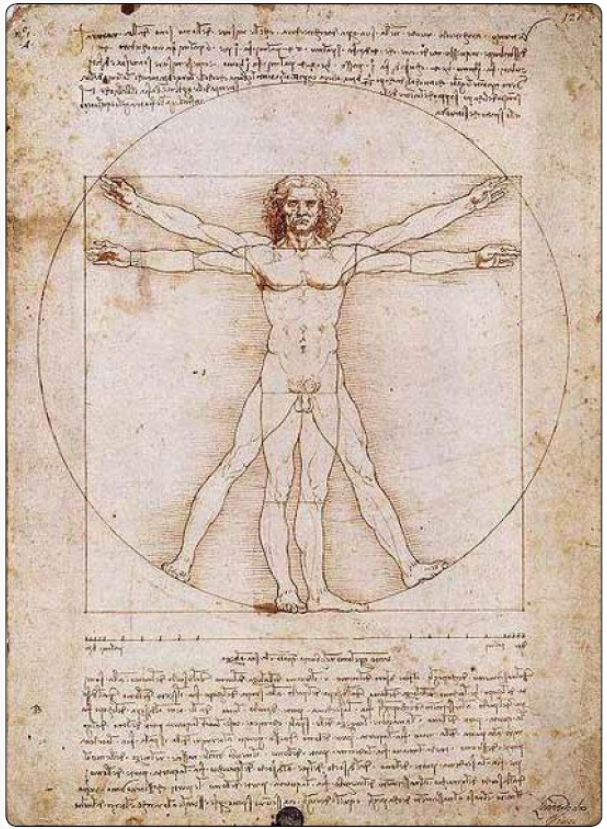


Figure 1

A Brief History of Human Factors



Introduction to Human Factors

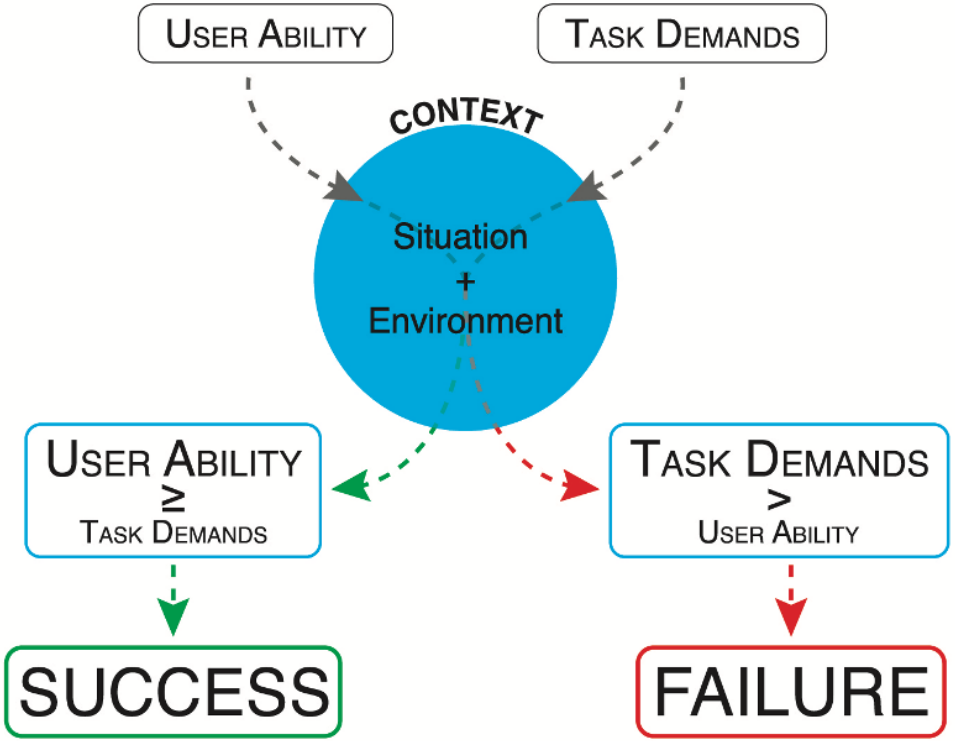
Human Factors is concerned with the application of what we know about people, their abilities, characteristics, and limitations to the design of equipment they use, environments in which they function, and jobs they perform.

-Human Factors and Ergonomics Society

Introduction to Human Factors

Primary Goals:

1) **Document task demands**
2) **Understand the user**
3) **Understand how context interacts with both the user and task demands**



User Error

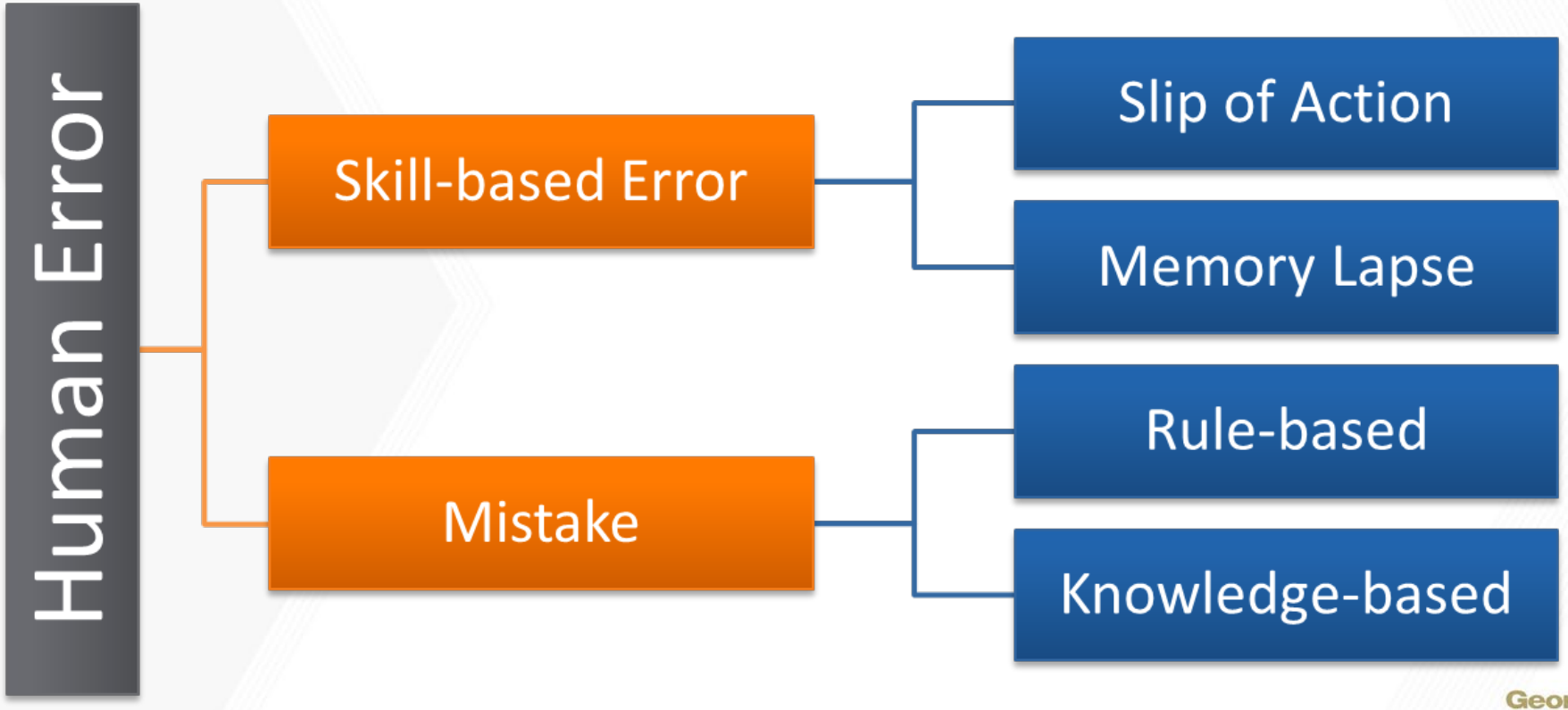


Figure 2

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Design-Induced Error

Usability Heuristics

Visibility of System Status

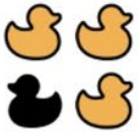
1

Match Between System & Real World

2

User Control And Freedom

3

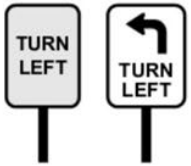


Consistency And Standards

4

Error Prevention

5

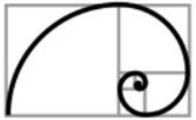


Recognition Rather Than Recall

6

Flexibility And Efficiency of Use

7



Aesthetic And Minimalististic Design

8

Help Users With Errors

9

Help And Documentation

10

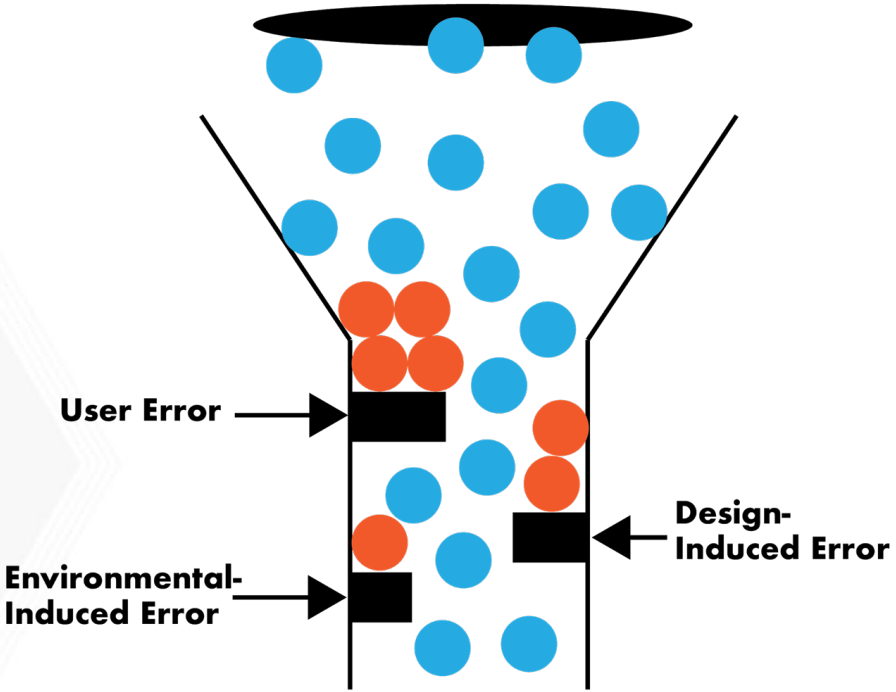
Systems Theory

Systems engineering is an interdisciplinary approach to the design, integration, and management of systems throughout their life cycles

In other words: systematic approach to the “cradle to grave” development and implementation of products or processes

Systems theory states that when considering interrelated parts of a system, changing one part will affect the others.

Patient Data



Community Data

Human Behavior

Work Attendance

Policy

Resource Allocation

Employment/Unemployment

Health Management Plan

Mental Health

Economy

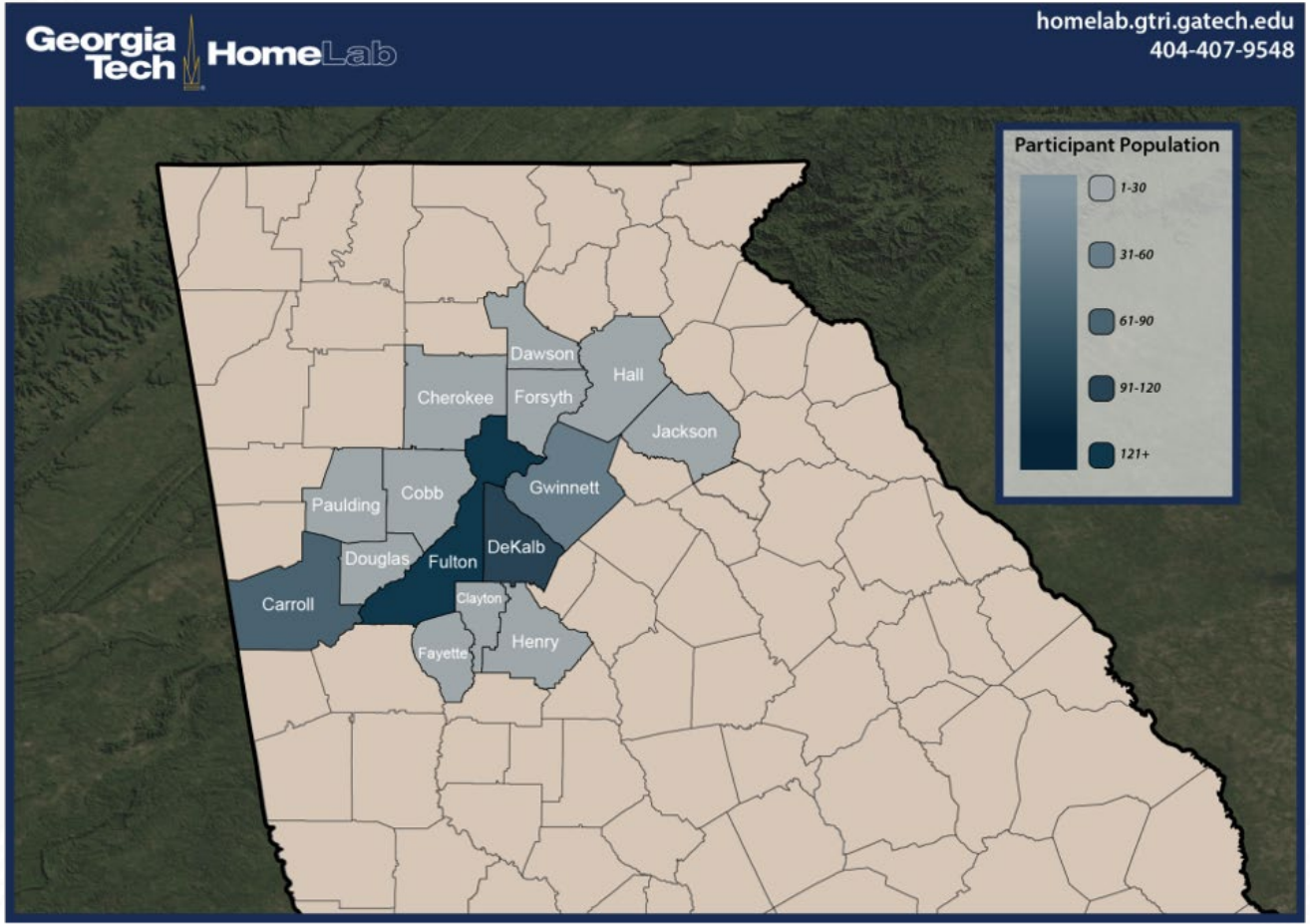
Housing

Risk Management

What is HomeLab?

- Home health testbed of older adults who have agreed to participate in research studies in their home
- Ages 56-100; demographics represent the diversity of the population of Georgia; additional age groups will be added as needed using the HomeLab recruitment infrastructure
- In addition to health participants, a variety of medical conditions are represented, with oversampling of COPD, diabetes, congestive heart failure, arthritis, and other normative age-related declines
- Supports research and technology evaluations in a realistic testing environment with simplified recruitment process
- HomeLab Kids is made up of child participants, with a focus on childhood medical conditions (asthma, juvenile diabetes, special dietary needs, ADHD, Autism spectrum disorder, and chronic diseases)

HomeLab Demographics



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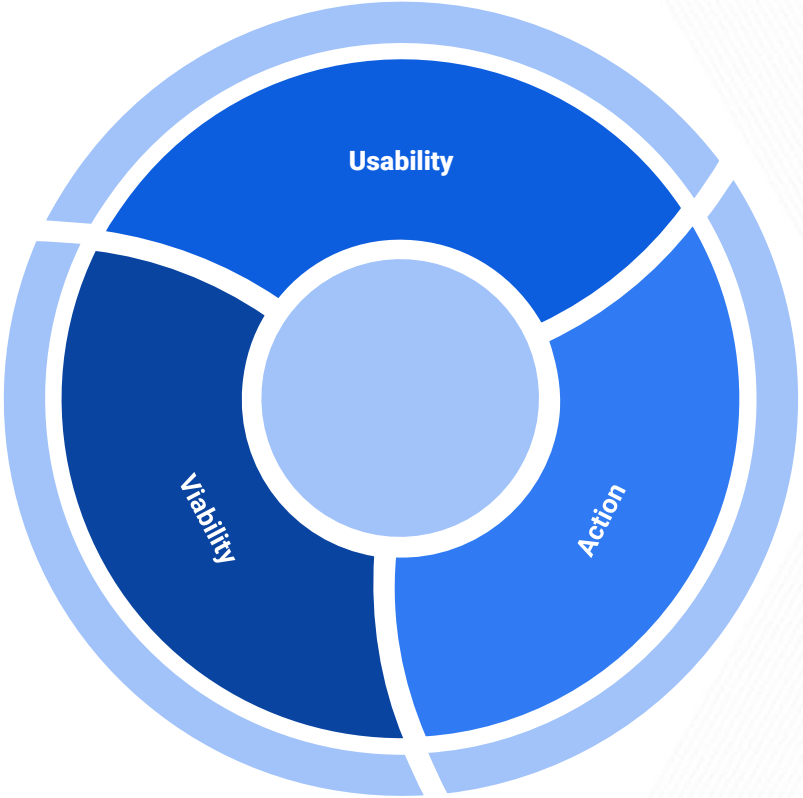
HomeLab Summary

- **Simplification of recruitment/selection process**
- **Lab environment vs. home environment**
- **Outcomes of aging in place (or other scenarios) over time**

RADx Evaluation Aims

- **Evaluate the usability of incoming technology**
- **Assess viability of potential use cases**
- **Provide actionable recommendations to project teams**



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Evaluation Considerations

Usability Evaluations are not all the same. The method of the evaluations and feedback provided are based on a number of considerations:

- **Timeline**
- **End Use Case**
- **Device Development Stage**
- **Device Availability**

Evaluation Methods

- **Expert Review**
- **Expert In-Depth Evaluation**
- **Design Failure Modes and Effects Analyses (DFMEA)**
- **Heuristic Analysis**
- **Use Case Simulations (arthritis, low vision)**
- **User Observations**
- **User Testing**

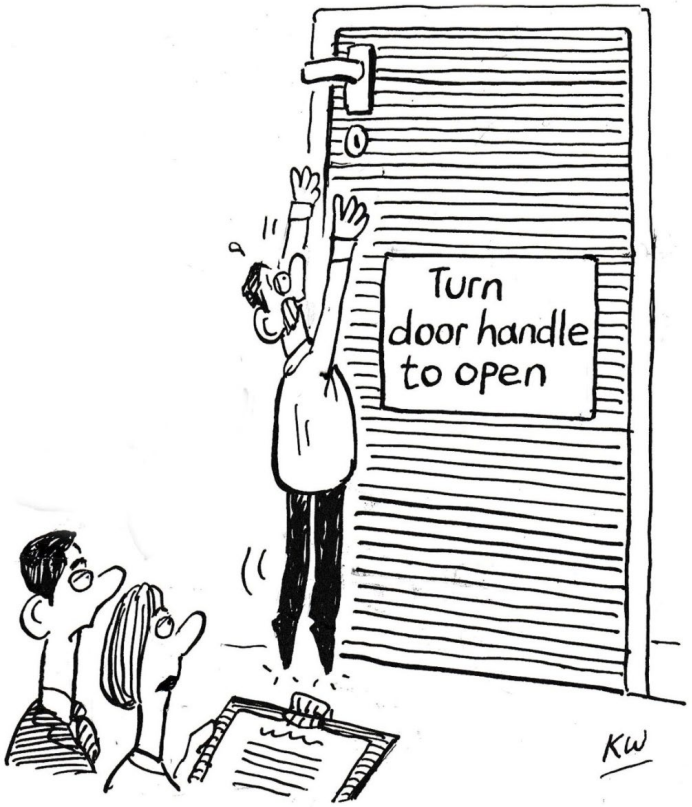


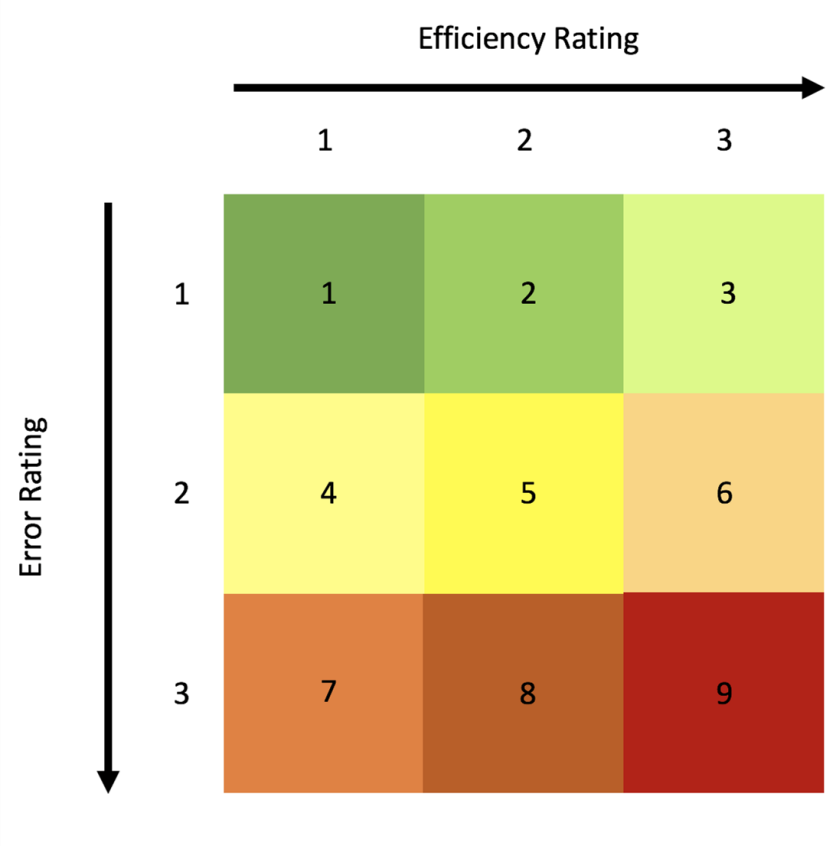
Figure 3

Deliverables

A usability report was compiled for each system.

- **Human factors analysis**
- **Results of simulations**
- **Accessibility measurements**
- **User feedback**
  - **Likert-style usability questions**
  - **The Systems Usability Scale**
  - **Recorded times on each task**
  - **Qualitative feedback (likes, dislikes, challenges)**

F&F Usability Score



- Error
- Risk of design-induced errors
- Frequency and severity of potential errors

1. Low risk of errors; unlikely to cause system failure
2. Moderate risk of errors; may cause system failure
3. High risk of failures; likely to cause system failure

- Efficiency
- Number of steps required
- Amount of time required to complete steps
- Amount of resources expended to conduct test
- Including required attentiveness to IFU/order of steps

1. High efficiency; unlikely to require large expenditure of resources to avoid system failure
2. Moderate efficiency; may require moderate expenditure of resources to avoid system failure
3. Low efficiency; system failure likely without large expenditure of resources

RADx
Lessons Learned

Instructions

Instructions help users avoid knowledge-based errors.

Instruction material formats:

- **Instructions for Use**
- **Quick Reference Guides**
- **Video Guides**
- **Interface Instructions**
- **On-Device Labeling**

Instructions

Common Problems

- Small font
- Too few images
- Unclear images
- Unnumbered steps
- Inconsistency in terminology
- Listing warnings only at the beginning of the instructions

Common Suggestions

- Image improvement- good contrast, realistic
- Minimum of 14pt font
- Consider the audience in language
- Cohesive, comprehensive
- Images paired with every step
- On-device labeling
- Include troubleshooting

Physical Considerations

Consider users with arthritis, reduced dexterity/strength, low vision, and low hearing.

Common Problems

- **Difficult to open packaging**
- **Small fonts**
- **Low contrast**
- **Small components**
- **Soft audible “beeps”/ sounds**

Common Suggestions

- **Use easy to open packaging with notches or overhanging tabs**
- **Enlarge components to graspable sizes**
- **Provide buffer tube racks or design tubes that won’t tip over**
- **Avoid using color-only indicators**
- **Add grips to caps**

Streamlined Protocol

Designing a simple, streamlined process can often reduce error.

Common Problems

- **Mixing solutions by pipetting**
- **Transferring samples or solutions from one component to another**
- **Messy sample collection**
- **Measuring**

Common Suggestions

- **Pre-measured solutions**
- **Fewer components (i.e., funnel built into collection tube, saliva collection built into the device)**
- **Pre-measured volumes**
- **Provide holders/ stands to prevent spilling**
- **Minimizing steps for sample collection to sample processing**

Process Indicators

Process indicators provide feedback to the user that assures them the system is working as planned. This prevents user frustration and errors.

Examples:

- **Progress Bars**
- **Components “clicking” into place**
- **Color changes**
- **Audio cues/ “beeps”**
- **Confirmation screens**
- **Countdown/ timer**

Results Interpretation

Any time the user has to discern the presence of lines or spots, or determine a color change, there will be error.

The user should be able to clearly tell if the test was positive, negative, or invalid.

Results Interpretation

Clear, concise results are critical for providing results to a user.

Common Problems

- **Color-only interpretation**
- **Lack of labels for test line indicators**
- **Confusing language**
- **Faint lines**

Common Suggestions

- **For digital tests - provide a clear “positive” or “negative” result**
- **Provide images of results comparison in the instruction materials**
- **On-device labeling**

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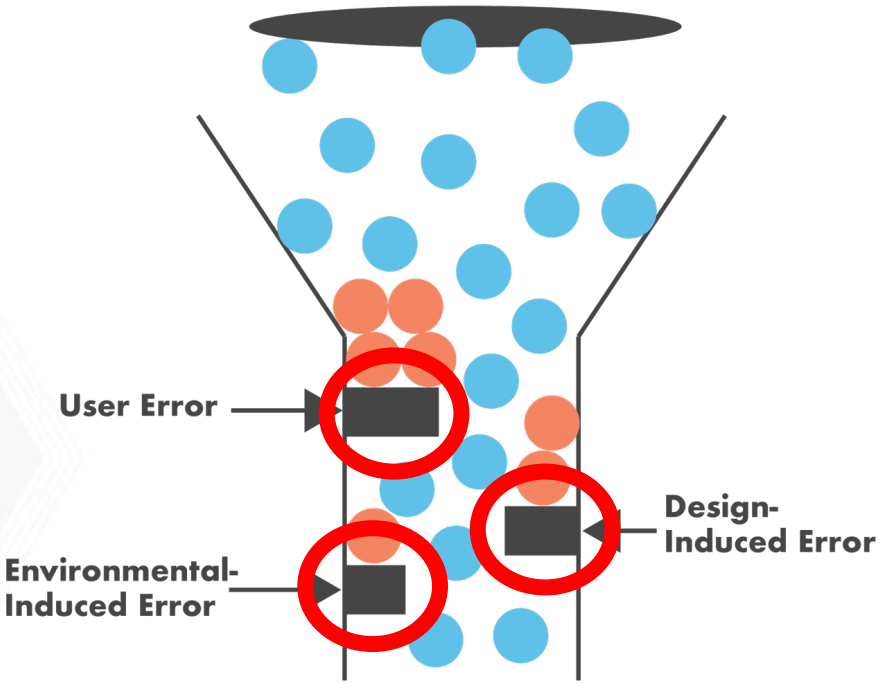

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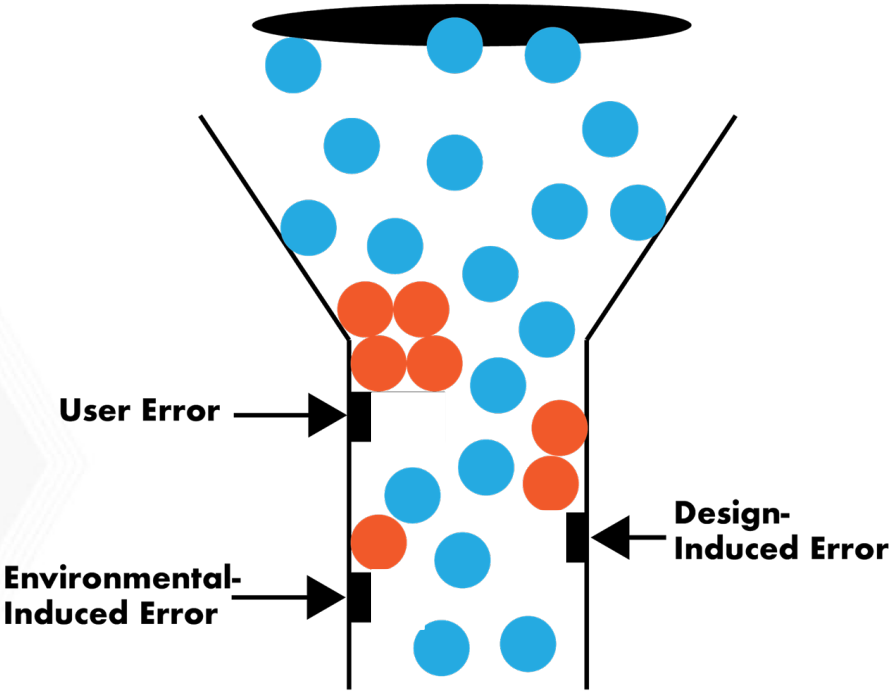

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Figure 2. Human error. From *Human Error* by National Offshore Petroleum Safety and Environmental Management Authority. Retrieved from: https://www.nopsema.gov.au/resources/human-factors/human-error/

Figure 3. Human factors comic. From *10 human factors study myths: 1 to 5* by Rob Fernall. Retrieved from: https://www.team-consulting.com/insights/10-human-factors-study-myths-1-to-5/.

Thank you! Questions?

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