Applying Usability Engineering to the NEES Tsunami/Wave Basin

Oregon State University collaboration:
Dept. of Civil, Construction, and Environmental Engineering
Hinsdale Wave Research Lab
Northwest Alliance for Computational Science & Engineering (NACSE)

Re-Engineering the Wave Research Lab

• Extend the capacity of the physical facility
• Create an Information Architecture that
  - Enables remote access in real-time
  - Captures and preserves all relevant information
  - Facilitates re-use of knowledge gained from experiments
• Enhance effectiveness of WRL researchers through usability engineering
Adding an Information Architecture

Wave Research Lab
Data acquisition
Audio/video capture
Temporary caching

Campus Router

Internet2 Cloud

NACSE
Data filtering and conversions
Archive: Tsunami Experiment Database
Web-based access to audio/video
Web-based access to Experiment Database
Remote access toolkits

At the WRL

Wave generator control node

Network switch

Local (cache) fileserver

Sensors

Remote-operable cameras

Microphones/Hydrophones

Video workstations

NACSE – Oregon State University
Special Need for Reliability

- Experiments must be captured as they happen
  - Very expensive
  - Typically destructive in nature
- Lead researcher must have “instant feedback”
- Reliability is key part of architecture
  - Combination of redundancy, over-design, and alternative paths
  - Builds on previous experience with fully interactive, network-based video
Applying Usability Engineering

- **Human factors**
  - Characteristics, capabilities and limitations of human beings
  - How these affect our use of technology
- **Usability engineering**
  - Addresses human factors explicitly during design process
    - To improve system effectiveness and safety
    - To improve user productivity

Why Is Usability Engineering Important?

A system that doesn’t
- Respond to user needs
- Align with user processes
- Accommodate user expertise

... may be worse than no system at all!

Mozart writing the digital version of his symphony No. 38 in D major
Usability Engineering and NEES

• UE can make it possible for researchers to
  - Control and observe experiments from remote sites
    • Reduce requirement for on-site presence
  - Gain more from experimental processes
    • Exploit technology to enhance human observation
  - Share experiments with colleagues and students
    • Broaden participation in experiments
    • Extend useful lifetime of experimental processes
  - Exploit corpus of experimental results
    • Facilitate re-use of previous experimentation
    • Support integration of computational and experimental modeling

Telepresence: The Raw Ingredients

• Sensor data: raw, filtered, graphical summaries
  - 10s to 100s of devices operating concurrently
• Data streams from remotely operable cameras and microphones
  - 10s of devices at eye level, suspended from roof, and underwater
• Robotic controls
• Use of computation to merge/analyze real-time data streams
Without attention to usability

Usability essentials:
- Seamless synchronization of data streams
- “Intelligent” choice of what to display
- No requirement for user to download software
- Experience at one NEES site “pays off” at others

Engineering the User Experience

• Role 1: Steering and observing the remote experiment
  • Researcher(s) sets up and directs experiment in near-real-time
  • Colleagues from same/other institutions participate
  • Observe/assimilate/discuss varying sets of data streams

• Role 2: After-the-fact experiment replay
  • Researcher(s) observe experiment in simulated time
  • Identify subsets of data streams for targeted uses
**Issues in Remote Steering/Observation**

**Goal:** Make remote experimentation efficient and useful

- Helping PIs select optimal control settings
- Acquiring metadata only the PI can furnish
- Placing audio/video effectively
- Integrating sensor data into meaningful summaries
- “Intelligent” management of displays
- “Instant Replay” to improve on traditional viewing
- Electronic Lab Notebook: saving/annotating records for personal use

**NACSE - Oregon State University**

---

**Issues in Experiment Replay**

**Goal:** Make it possible to derive real benefit from others’ experiments

- Generating markers for “interesting events” in sensor and audio/video streams
- Zooming forward through simulated time to next event, then slow-stepping through critical data sequences
- Synchronized access to raw/filtered/summarized data
- Ability to download arbitrary sequences of data

**NACSE - Oregon State University**
Usability engineering means working with users to identify their needs and preferences.

Data Exploration: The Raw Ingredients

- Extremely large quantities of data must be archived and made publicly available
- Synchronization markers must be added
- Diverse data formats need to be integrated
- Metadata need to be standardized
- Must be possible to compare experimental data with data from simulations
Engineering the User Experience

- Tsunami Experiment Databank archives all aspects of NEES experiments
- Role 3: Single or collaborative researchers use search-and-exploration interfaces
  - So duplication can be eliminated
  - So models can be calibrated
  - So model results can be validated

Issues in Databank Exploration

Goal: Make searching flexible enough to quickly locate appropriate experiments

- Generating most metadata automatically during data acquisition/processing
- Multi-tiered interfaces that support typical user scenarios:
  - “Experiments involving certain wave configurations”
  - “Experiments involving certain types of models”
  - “Experiments yielding particular types of results”
  - “Find experiments similar to this one”
Key Issues for Tsunami Community

- Metadata will be essential
  - Who defines it?
    - Must be community-based
    - Recommend that task force(s) be convened
  - Most should be generated automatically during experiments
    - Some must be defined by PI - need to make this easy
  - "Incentive" approach to obtaining metadata from NEES researchers
    - Require it before experiment can start
    - Carrot: “automatic experiment report” generation
Key Issues for Tsunami Community

• Data formats
  - Known formats needed for raw and first-order processed (filtered) data
  - Format standards?

• “Publishing” experimental data
  - Site will retain raw and first-order data
  - Quick-look (low resolution) data
    - Can’t lead to publication - made available immediately
  - High-resolution data needed for publications
    - Made available after PIs have a chance to publish
  - PIs encouraged to deposit other processed data

NACSE - Oregon State University