

3D User Interface Evaluation II

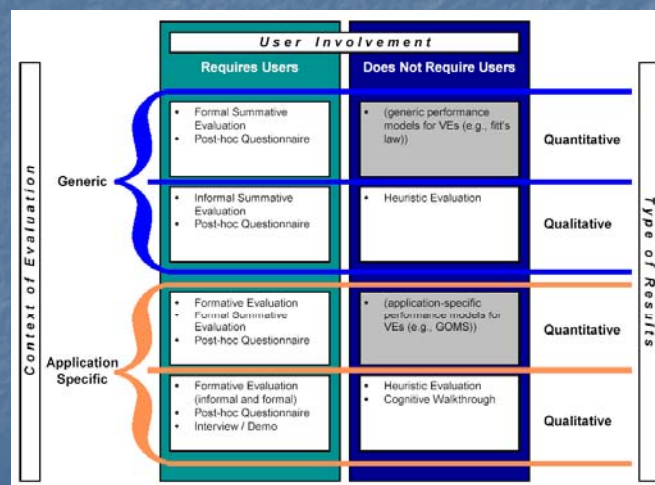
Lecture #17: Evaluating 3DUIs – Part II
Spring 2010
Joseph J. LaViola Jr.

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Usability Evaluation in 3DUIs



Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Classification Shortcoming

- Does not tell you “when” a method should be applied
- Does not tell you “how” to apply more than one method
- 3DUI evaluation models
 - Testbed evaluation
 - Sequential evaluation

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Testbed Evaluation Framework

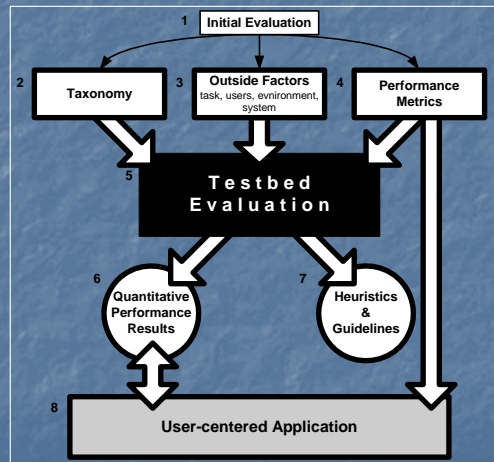
- Developed by Bowman and Hodges (1999)
- Empirically evaluate techniques outside of applications
- Components
 - initial evaluation
 - taxonomy
 - outside factors
 - performance metrics
 - testbed evaluation
 - application and generalization of results

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Testbed Evaluation



Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Testbed Evaluation – Initial Evaluation

- Gain intuitive understanding of generic interaction tasks and current technologies
- Experience and user observation
- Used for
 - building taxonomy
 - identifying outside factors
 - finding performance metrics

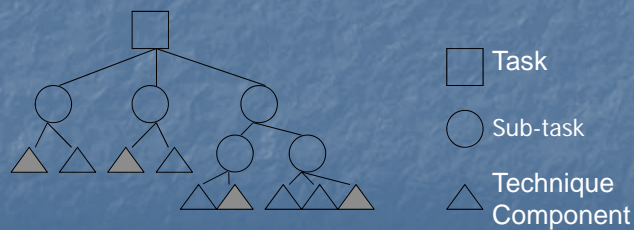
Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Testbed Evaluation – Taxonomy

- Develop taxonomy of interaction techniques for interaction task in question
- Can use task-subtask approach



Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Testbed Evaluation – Outside Factors

- Cannot evaluate in a vacuum
- Need to take other factors into account
- Categories
 - task characteristics
 - environment characteristics
 - user characteristics
 - system characteristics

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Testbed Evaluation – Metrics

- Objective measures
 - speed
 - accuracy
- Subjective measures
 - ease of use
 - ease of learning
 - frustration
 - etc...

Testbed Evaluation – The Testbed

- Allows generic, generalizable , and reusable evaluation
- Testbed
 - examines all aspects of a task
 - evaluates each technique component
 - considers outside influences
 - has good metrics
- Normally use formal, factorial experimental designs

Testbed Evaluation – Results

- Produces set of results or models that characterize an interaction technique for a given task
- Usability in terms of multiple performance metrics
- Results become part of a performance database for task
- Results can be generalized into heuristics or guidelines
- Apply to 3D applications

Testbed Evaluation Experiments

- Travel testbed (Bowman, Davis, et al. 1999)
 - compared seven different travel techniques
 - naïve and primed search
 - 44 subjects tested
- Selection/Manipulation testbed (Bowman and Hodges 1999)
 - compared nine different interaction techniques
 - 48 subjects
- Produced unexpected and interesting results (see papers for details)

Sequential Evaluation

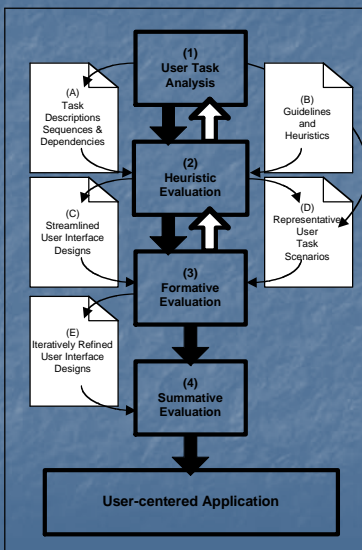
- Developed by Gabbard, Hix, and Swan (1999)
- Usability engineering approach
- Evolved from existing GUI/2D evaluation methods
- Addresses both design and evaluation
- Employs
 - application specific guidelines
 - domain specific representative users
 - application specific user tasks

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Sequential Evaluation



Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Sequential Evaluation – Example

- Applied to Dragon system
- Several evaluations performed in 9-month period
 - one to three users
 - two to three evaluators
 - Four cycles
- Guideline-based evaluation
- Summative evaluation
 - major study
 - four factors (2 x 2 x 3 x 2)
- See
 - Hix et al. (1999)
 - Hix and Gabbard (2002)



Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Comparison of Approaches

- Goals
 - Testbed – finding generic performance characteristics
 - Sequential – better UI for particular application
- Costs
 - Testbed – difficult experimental design, large numbers of trials and subjects
 - Sequential – multiple evaluators, significant time investment

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

3D Usability Evaluation

Things To Consider

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Formality of Evaluation

- Formal: independent & dependent variables, statistical analysis, strict adherence to procedure, hold constant all other variables, usually done to compare multiple techniques or at the end of the design process
- Informal: looser procedure, often more qualitative, subject comments very important, looking for broad usability issues, usually done during the design process to inform redesign

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

What is Being Evaluated?

- Application:
 - Prototype - consider fidelity, scope, form
 - Complete working system
 - Controlled experiments are rare
- Interaction techniques / UI metaphors
 - Can still evaluate a prototype
 - More generic context of use
 - Formal experiments more often used
- Consider "Wizard of Oz" evaluation

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Subjects / Participants

- How many?
- What backgrounds?
 - technical vs. non-technical
 - expert vs. novice VE users
 - domain experts vs. general population
- What age range?
- Recruiting
 - flyers
 - email/listservs/newsgroups
 - psychology dept.
 - CS classes

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Number of Evaluators

- Multiple evaluators often needed for 3DUI evaluations
- Roles
 - cable wrangler
 - software controller
 - note taker
 - timer
 - behavior observer
 - ...

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Procedure

- Welcome
- Informed consent
- Demographic/background questionnaire
- Pre-testing
- Familiarize with equipment
- Exploration time with interface
- Tasks
- Questionnaires / post-testing
- Interviews
- Subject “packets” are often useful for organizing information and data
- Pilot testing should be used in most cases to:
 - “debug” your procedure
 - identify variables that can be dropped from the experiment

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Instructions

- How much to tell the subject about purposes of experiment?
- How much to tell the subject about how to use the interface?
- Always tell the subject what they should try to optimize in their behavior.
- If using think-aloud protocol, you will have to remind them many times.
- If using trackers, you will have to help users “learn” to move their heads, feet, and bodies – it doesn’t come naturally to many people.
- Remind subjects you are NOT testing them, but the interface.

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Formal Experiment Issues

- Choosing independent variables
- Choosing dependent variables
- Controlling (holding constant) other variables
- Within- vs. between-subjects design
- Counterbalancing order of conditions
- Full factorial or partial designs

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Independent Variables

- Main variable of interest (e.g. interaction technique)
- Secondary variables
 - task characteristics
 - environment characteristics
 - system characteristics
 - user characteristics

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Metrics (dependent variables)

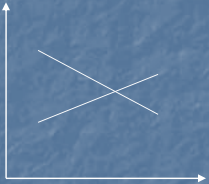
- Task performance time
- Task errors
- User comfort (subjective ratings)
- Observations of behavior (e.g. strategies)
- Spoken subject comments (e.g. preferences)
- Surveys/questionnaires
- Interviews

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Data Analysis

- Averages (means) of quantitative metrics
 - Counts of errors, behaviors
 - Correlate data to demographics
 - Analysis of variance (ANOVA)
 - Post Hoc analysis (t-tests)
 - Visual analysis of trends (esp. learning)
- 
- *Interactions between variables* are often important
 - Expect high variance in 3DUI interaction studies

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Analysis Tools

- SPSS, SAS, etc.
 - full statistical analysis packages
 - parametric and non-parametric tests
 - test correction mechanisms (e.g., Bonferroni)
- Excel
 - basic aggregation of data
 - Correlations
 - confidence intervals
 - graphs
- Matlab, Mathematica

Spring 2010

CAP6121 – 3D User Interfaces for Games and Virtual Reality

©Joseph J. LaViola Jr.

Next Class

- 3DUI evaluation example
- Readings
 - 3DUI Book – Chapter 11, 367-384