Information Visualization

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Evaluation in Information Visualization

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Motivation

- What are the advantages and limitations of this technique (system)?
- Are there any improvement of this new technique over the existing ones?
- Is this technique (system) just “cool” or actually helps people?

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Measures

- Different possible ways to measure:
  - Impact on community as a whole, influential ideas
  - Assistance to people in the tasks they care about

- Dr. John Stasko, Slides of CS7500 at Gatech

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Strong View

- Unless a new technique or tool helps people in some kind of problem or task, it doesn't have any value

- Dr. John Stasko, Slides of CS7500 at Gatech

Broaden Thinking

- Sometimes the chain of influence can be long and drawn out
  - System X influences System Y influences System Z which is incorporated into a practical tool that is of true value to people
- This is what research is all about (typically)

- Dr. John Stasko, Slides of CS7500 at Gatech

Survey of Evaluation

- InfoVis – top conference in information visualization area. Started from 1995.
- I read through Infovis 95- Infovis 2001 for papers that included some form of evaluation.

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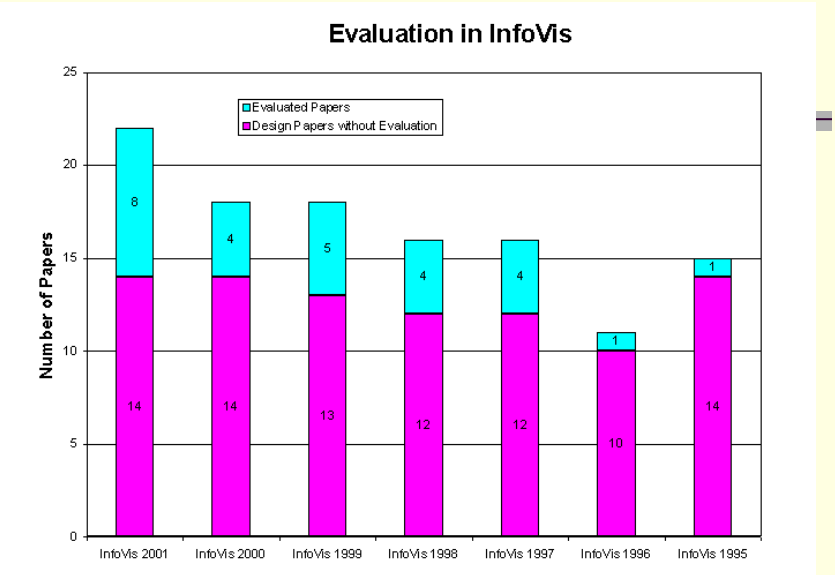

Year 2005: 20 out of 30 papers with evaluation!

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Evaluation In InfoVis

- Evaluation has recently been regarded as important.
- Many evaluations are ad hoc.
  - Ad hoc questionnaires.
  - Ad hoc processes.
  - Insufficient subjects.
- In HCI field, there is a longer history of evaluation and systematic theory and approaches

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Evaluating UI vs. InfoVis

- Difference
  - Usability vs. Utility
    - Usability - quality of a system that makes it easy to learn, easy to use and encourages the user to regard the system as a positive help in getting the job done www.georgetown.edu/uis/ia/dw/GLOSSARY0816.html
    - Utility - A measure of usefulness
    - Imagine a visualization that are very usable but not useful www.mc2consulting.com/riskdef.htm
  - More domain knowledge and situated use are required

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Evaluating InfoVis in General

- Very difficult in InfoVis to compare “apples to apples”
  - Hard to compare System A to System B
  - Different tools were built to address different user tasks
- UI can heavily influence utility and value of visualization technique
- Borrow UI evaluation methods, and adapt it to InfoVis

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Usability Inspection in UI

- Usability inspection - generic name for methods based on having evaluators to inspect or examine usability-related aspects of a user interface [NL94]
- General approaches
  - user testing, heuristic evaluation, feature inspection, heuristic estimation, consistency inspection, standards inspection, pluralistic walkthrough, and cognitive walkthrough [Nie95]

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What to Measure: Usability Metrics

Three categories:

- Preference metrics
- Performance metrics
- Design metrics

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Preference metrics

- Subjective evaluations and preferences of users
- Questionnaires and rating scales are used.
- Standard forms or questionnaires are more reliable than ad hoc surveys
- Approaches:
  - User testing
  - Heuristic evaluation

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Performance Metrics

- Actual use of working software
  - Example: How fast...? How many...?
- Approach
  - User testing

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Design Metrics

- Quality of designs or prototypes.
- They can be measured without working systems!
- Examples:
  - Essential efficiency (brief interaction)
  - Task concordance (frequent tasks less steps)
  - Task visibility (show what users need)
  - Layout uniformity (moderately uniform and orderly layouts)
  - Visual coherence (related things put together)

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Possible Design Metrics in Information Visualization

- Space usage efficiency
- Overlap extent
- Emphasized regions vs. other regions
- Color usage
- Connection between related views

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Usability Inspection in UI

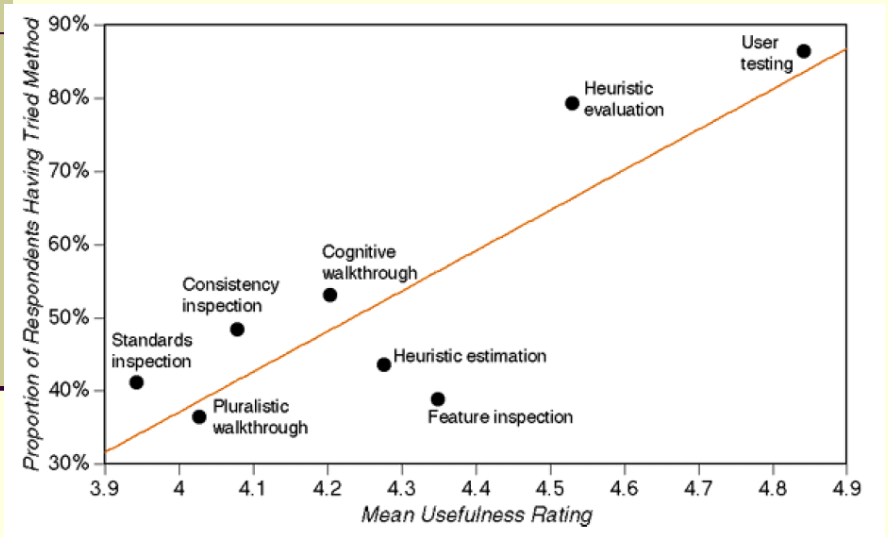

Figure 6.1: Survey with regard to frequencies of methods used and usefulness rating of them [Nie95]

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We will look at

- Approach 1: Heuristic evaluation
- Approach 2: User testing

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Heuristic Evaluation in UI

Definition:

- having a small set of evaluators to examine the interface and judge its compliance with recognized usability principles (the "heuristics").

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Nielsen's 10 Heuristics for UI (1)

- Visibility of system status
- Match between system and the real world
- User control and freedom
- Consistency and standards
- Error prevention

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Nielsen's 10 Heuristics (2)

- Recognition rather than recall
- Flexibility and efficiency of use
- Aesthetic and minimalist design
- Help users recognize, diagnose, and recover from errors
- Help and documentation

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How to Conduct a Heuristic Evaluation

- Heuristics
- Running prototype or simple screen dumps
- Three to five evaluators
- Evaluators work independently
- Output: A list of usability problems.
- Accumulate the results

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Heuristic Evaluation

Advantages:

- Cheap
- Intuitive and easy to motivate people to do it
- Does not require advance planning
- Can be used early in the development process.

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Formal User Testing VS. Heuristic Evaluation

- Expensive
- Discover local problems
- Usually must have running system
- ✓ Formal
- ✓ “Real users” , “Real tasks”
- ✓ Performance metrics

- ✓ Cheap
- ✓ Discover global problems
- ✓ With or without running system
- Informal
- Can’t measure performance metrics

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Formal User Testing (User Study)

- Definition:
  - A “large” set of “real” users performing “real” tasks in a working system

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Essential Components of User Testing

- "Hard" components
  Working systems, environment, subjects, inspectors, datasets, tasks
- Motivation
  "There are ten possible approaches, I can only choose one"
  "Compare system A with system B"
- Hypothesis
  "A is better than B in C aspect"
- The testing methodology
- Information collection
  "average time users use to find D using A/B"
  Questionnaires and rating scales, video, screen capture
- Result analysis
  Statistic methods
  Visualization methods
  Multi-media analysis

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Two Types of User Testing

Task-oriented user testing

- Users are asked to accomplish a number of tasks
  - "time out"
- Tasks: "Find Charlotte", "Count 3s", "Is A larger than B?"
- Results: speed, correctness…

- Features:
  - "Objective"
    - Easy to measure and compare
  - "Rigid"
    - Task design is critical

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Two Types of User Testing

Open-ended think aloud user testing

- Users are asked to find insights from data
- Insight: unit of discovery
  - Facts (actual finding), hypothesis, directed or unexpected…
- Results
  - distinct facts (actual findings), speed, domain value of insights, correctness
- Features:
  - Harder to analyze results
  - Broader

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User Testing Step by Step

Step 1: Decision

- Motivation, hypothesis
- Figure out most important factors
  - A visualization system is complex!
  - Reduce distracting factors
- Create a testing plan

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User Testing Step by Step

Step 2: Preparation (It is time-consuming)

- Running prototype (minimize unrelated factors)
- Subjects (typical users)
- Hardware (room, projectors, camcorders, computers)

- Task sets or open-ended tasks (balanced)
- Subject information survey
- Training materials (presentation, training tasks)
- Questionnaires (rating scales)
- Open-end questions (feedback and clarification)

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User Testing Step by Step

Step 2: Preparation – about result recording

- How to record results such as speed, correctness?
  - Automatically –accurate, less distractive for subjects
  - Manually
  - The more automatic, the better
    - Don't count on your own memory - you can't imagine how busy you will be in the experiment day!
    - Don't count on the users' memories – they are as overwhelmed as you in the experiment!
    - You won't need to input many numbers from paper to computer if they are already there

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User Testing Step by Step

Step 2: Preparation – pilot experiments

- Goal: calibrate the formal testing
  - Formal testing is expensive!
- Subjects: one or two users
- Process: iterative

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User Testing Step by Step

Step 3: Experiment – general processes

- On Site Approach:
  - Presentation (speaker)
  - Training (instructor)
  - Task performing (observer)
  - Questionnaire and open questions (listener)
- Off Site Approach:
  - Conductor sends experiment materials to subjects
  - Subjects learn by themselves
  - Subjects run testing by themselves
  - Subjects sent results to conductor

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User Testing Step by Step

Step 3: Experiment – useful hints

- Alleviate subjects' distressing (subject cried!)
- One-to-one vs. group testing.
- Don't show individual subject's name in report.
- Thank the subjects after the testing. Point out that they leads to improvement to your system.

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User Testing Step by Step

Step 4: Result analysis and report

- Statistic analysis
- Visual exploration and representation
- Multi-media analysis

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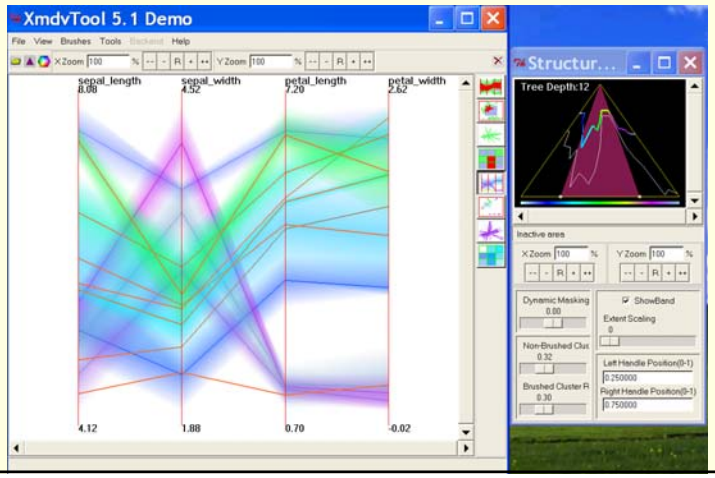
Example User Testing

- Motivation: Is HPC better than traditional PC?



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Example User Testing

- Methodology: use two groups of users, ask them to find as many insights as possible using HPC and PC respectively

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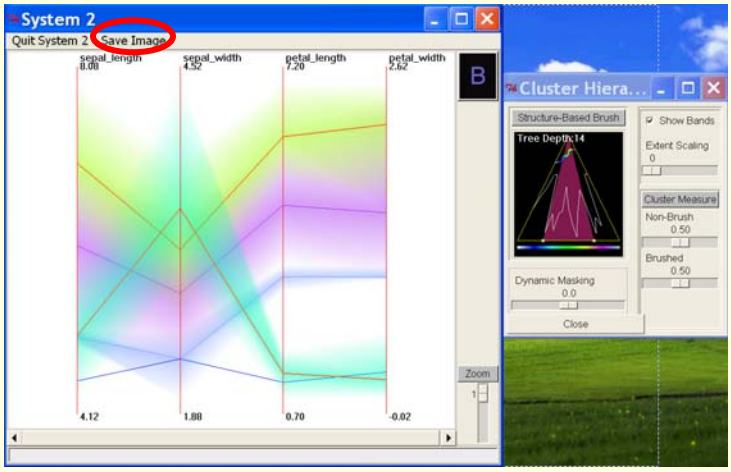
Example User Testing

- Preparing prototypes - HPC



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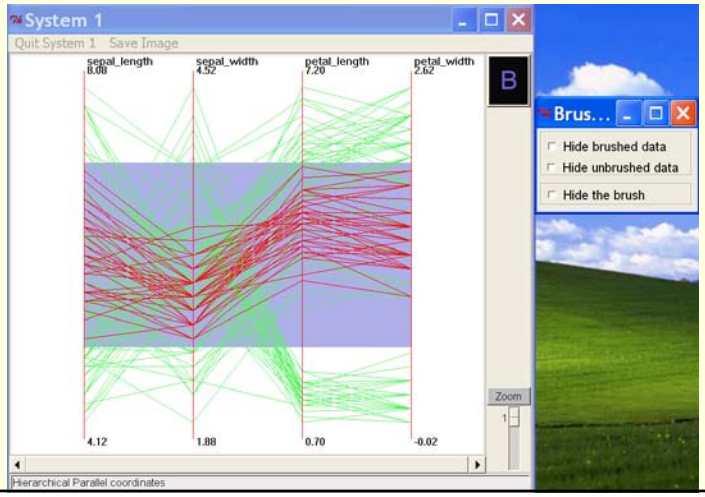
Example User Testing

- Preparing prototypes - PC



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Example User Testing

- Invite users, learn their backgrounds, dividing them into two balanced groups, and make time schedules (one day. Morning: PC. Afternoon: HPC)

Experiment	No. Subjects	CS-Majors	Prior Background
HPC	9	5	2
FPC	11	9	5

- Reserve a large classroom. Reserve pizza!

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Example User Testing

- Pilot experiments
  - They were very important!

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Example User Testing

- Feedback Form Name_____
- OVERALL REACTIONS TO THE SOFTWARE
- terrible wonderful
- 0 1 2 3 4 5 6 7 8 9
- difficult easy
- 0 1 2 3 4 5 6 7 8 9
- frustrating satisfying
- 0 1 2 3 4 5 6 7 8 9
- inadequate power adequate power
- 0 1 2 3 4 5 6 7 8 9
- dull stimulating
- 0 1 2 3 4 5 6 7 8 9
- rigid flexible
- 0 1 2 3 4 5 6 7 8 9
- SCREEN
- Characters on the computer screen
- hard to read easy to read
- 0 1 2 3 4 5 6 7 8 9
- Highlighting on the screen simplifies task
- not at all very much
- 0 1 2 3 4 5 6 7 8 9
- Organization of information on screen
- confusing very clear
- 0 1 2 3 4 5 6 7 8 9
- TERMINOLOGY AND SYSTEM INFORMATION
- Use of terms throughout system
- inconsistent consistent
- 0 1 2 3 4 5 6 7 8 9

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Example User Testing

- Open questions:
  - If you have more time, do you think that you can still find more features?
  - Is it hard or easy for you to find features using this system? Why?
  - Do you think that there is anything we can do to improve this system?
  - Are there any good points of this system?
  - Any words you want to say to us...

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Example User Testing

Result analysis

- images saved with time stamps
  - Classify insights
  - Collect numbers and time stamps of insights
- Answers of open questions
- Answers of questionnaire

An example insight

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Example User Testing

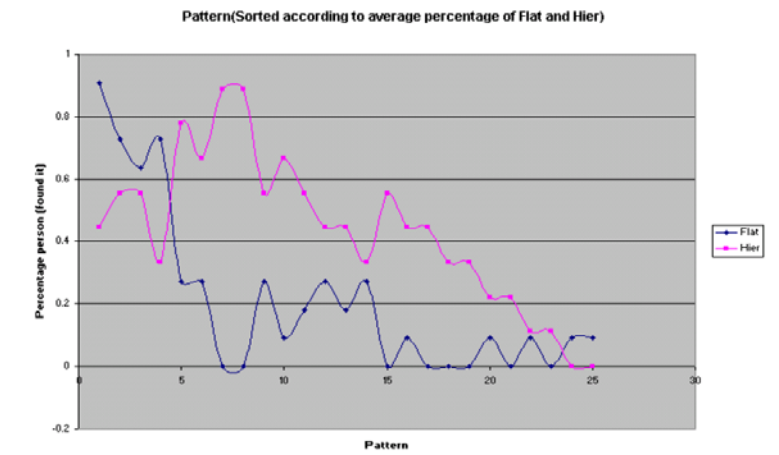

Figure 6.3: Pattern finding results of the HPC and FPC experiments [YWR03b].

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Example User Testing

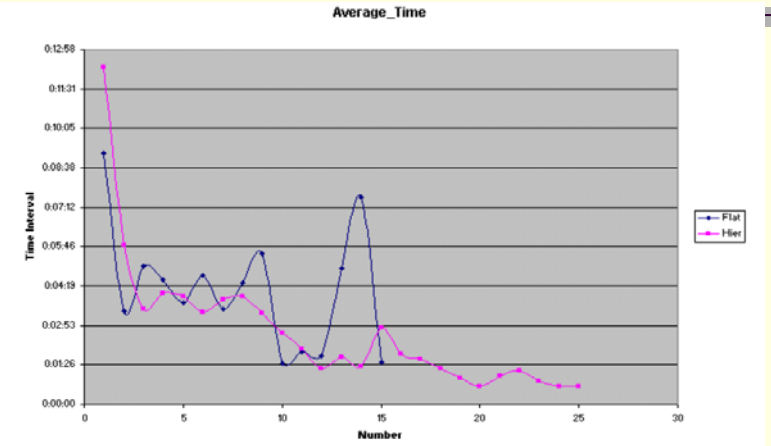

Figure 6.4: Average time interval in pattern finding in the HPC and FPC experiments [YWR03b].

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Preferences

- Nielsen, J., Technology Transfer of Heuristic Evaluation and Usability Inspection. http://www.useit.com/papers/heuristic/learning_inspection.html
- Nielsen, J., and Mack, R. L. (Eds.) (1994). Usability Inspection Methods. John Wiley & Sons, New York.
- Suzie Weisband, MIS 441: User Interface Design, Prototyping, and Evaluation class notes. Arizona University.
- L. L. Constantine and L. A. D. Lockwook, Software for Use: A Practical Guide to the Models and Methods of UsageCentered Design, 1999, ACM press.

- John Stasko's slides

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