+ Announcements
  + Upcoming Reading Assignments
    - Thursday - 5/11/00 - Cognitive Walkthrough
    - Tuesday - 5/16/00 - Interface presentations, with Prof. Nancy Cheng from Architecture
    - Thursday - 5/18/00 - Interface presentations
    - Then: User testing.

+ Interface Presentations
  - Prepare a presentation of your user interface design, including overhead transparencies that will allow us to walk through your interface.
  + Presentation must include:
    + Introduction (one transparency)
      - One-sentence problem statement
      - Describe the users
      - Specific sample tasks
    + One transparency per interface screen
    + All groups must be ready to present on 5/16/00.
    + 5% of Project 4 grade

+ Topics for today:
  - Fitts’ law
  + Predictive Engineering Models
    - KLM
    - GOMS

+ Fitts’ Law

\[ T = K \cdot \log_2 \left( \frac{\text{Distance}}{\text{Width}} + 1 \right) \text{ms} \]

- (N&L use Mackenzie's version. There are other versions that differ slightly.)
  - Very accurately predicts relative differences pointing times as the distance and the width change. (K cancels out)
  + Predicts pointing times reasonably well, with K set around 100.
    - A constant coefficient of about 100 should also be included.
    - Assumes target is visible and no visual search is necessary.

+ Predictive Engineering Models
  + Allow the analyst to predict user performance based on
    - A specification of the design
    - Task analysis
    - Device description
    - Fundamental laws of performance
  + All the other engineering disciplines predict system performance in this manner. Usability analysis should be able to predict interface usability in the same manner.

+ Assumptions
  - Well-defined task
  - Practiced user

+ How to Build Usable Systems
Choose Tasks

Specify Design

Build Prototype

Test Usability of Prototype

Find Problems? Yes

No

Build System

+ Problems with this approach:
  - Slow, expensive, and does not necessarily explain why a design is better
  - Solution: Incorporate predictive modeling

+ Predictive Models
  - Predictive Engineering Model:

+ Physical test:


+ Why engineering models are good
  - Faster, cheaper, explain why a design is better
  - Can contribute to a design specification

+ Incorporating Engineering Models into System Design
+ **Predictive Engineering Models in Usability Analysis**
  + **GOMS Models**
    - KLM
    - NGOMSL
    - (others)

  + **By the way, on page 173:**
    - Add "Press or release mouse button: 0.1 sec"
    - Use the 0.28 for your typing predictions.

  + The remaining text is taken directly or adapted from "Cognitive Analysis of Dynamic Performance: Cognitive process analysis and modeling" by Boehm-Davis, Gray, John, and Kieras, materials presented as part of the Free GOMS Tutorial, Pittsburgh, PA, May 17, 1999. Available at http://hfac.gmu.edu/Free_GOMS/FreeGOMS.ppt.

+ **GOMS as Predictive Modeling**
  - GOMS analysis produces a model of behavior
  - Given a task, the model predicts the methods, or sequences of operators, that a person will perform to accomplish that task
  - Can look at the GOMS model in different ways to qualitatively and quantitatively assess different types of performance

  (From Boehm-Davis, Gray, John, and Kieras, 1999)

+ **Scope of GOMS:**
  What it can do
  - Predict the sequence of operators an expert will perform
  - Predict performance time of expert users - even in real-world situations
  - Predict learning time in relatively simple domains
  - Predict savings due to previous learning
  - Help design on-line help and manuals

  (From Boehm-Davis, Gray, John, and Kieras, 1999)
+ Scope of GOMS:
  What it can do (continued)
  + GOMS has been applied to both:
    - User-driven interaction
    - "Situated" or event-driven interaction

(From Boehm-Davis, Gray, John, and Kieras, 1999)

+ Scope of GOMS:
  What it cannot do
  - Predict problem-solving behavior
  - Predict how GOMS structure grows from user experience
  - Predict behavior of casual users, individual differences...
  - Predict the effects of fatigue, user preference, organizational impact...

(From Boehm-Davis, Gray, John, and Kieras, 1999)

- Insert N&L Overhead 8-12 here. Also 6-9, 10, 11.

+ NGOMSL
  - Natural Language GOMS
  - Based on structured natural language notation and a procedure for constructing them
  - Models are in program form
  - Adds a control structure to KLM: Hierarchical goal stack

(From Boehm-Davis, Gray, John, and Kieras, 1999)

+ NGOMSL - why?
  - More powerful than KLM. Much more useful for analyzing large systems
  - More built-in cognitive theory
  - Provides predictions of operator sequence, execution time, and time to learn the methods
  - Represents the user's strategy.

(Adapted from Boehm-Davis, Gray, John, and Kieras, 1999)

+ Example of NGOMSL
  + Carry out a GOMS analysis of the following task involving a digital clock:
    - Set the clock
    - Top level goal: SET CLOCK

(Adapted from Boehm-Davis, Gray, John, and Kieras, 1999)

+ Example of NGOMSL: Goals
  - Goals and subgoals

(Adapted from Boehm-Davis, Gray, John, and Kieras, 1999)
Example of NGOMSL: Operators
- Reach <type> button
- Hold <type> button
- Release <type> button
- ClickOn <type> button
- Decide: if <x> then <y>
- Verify

(Adapted from Boehm-Davis, Gray, John, and Kieras, 1999)

Example of NGOMSL Methods
Top-level user goals
- SET-CLOCK
Method for goal: SET-CLOCK
- Step 1. Hold TIME button
- Step 2. Accomplish goal: SET-HOUR
- Step 3. Accomplish goal: SET-MIN
- Step 4. Release TIME button
- Step 5. Return with goal accomplished
Method for goal: SET-<digit>
- Step 1. ClickOn <digit> button
- Step 2. Decide: If target <digit> = current <digit>, then return with goal accomplished
- Step 3. Goto 1

(Adapted from Boehm-Davis, Gray, John, and Kieras, 1999)

Example of NGOMSL: Selection rules
- Change the SET-<digit> method into a selection rule that calls one of two possible methods:
  Selection rule for goal: SET-HOUR
  - If target HOUR ≤ 4 hours from current HOUR, then Accomplish Goal: ClickOn HOUR
  - If target HOUR > 4 hours from current HOUR, then Accomplish Goal: Click&Hold HOUR

(Adapted from Boehm-Davis, Gray, John, and Kieras, 1999)

NGOMSL - Overall Approach
- Step 1: Perform goal/subgoal decomposition
- Step 2: Develop a method to accomplish each goal
  - List the actions/steps the user has to do goal (at as general and high-level as possible for the current level of analysis)
  - Identify similar methods/collapse where appropriate
- Step 3: Add flow of control (decides)
- Step 4: Add verifies
- Step 5: Add perceptuals, etc.
- Step 6: Add mentals for retrieves, forgets, recalls
- Step 7: Add times for each step
- Step 8: Calculate total time

(Adapted from Boehm-Davis, Gray, John, and Kieras, 1999)