Introduction to GOMS

Psyc2965

Fall’2002
Definition of GOMS

Characterization of a task in terms of

- The user's *Goals*
- The *Operators* available to accomplish those goals
- *Methods* (frequently used sequences of operators and sub-goals) to accomplish those goals, and
- If there is more than one method to accomplish a goal, the *Selection rules* used to choose between methods.
What GOMS Is

GOMS is a task analysis technique

- Very similar to Hierarchical Task Analysis (Indeed, GOMS is a hierarchical task analysis technique)
- Hard part of task analysis is goal-subgoal decomposition
  - Hard part of GOMS is goal-subgoal decomposition
- Different members of the GOMS family provide you with different sets of operators
  - With established parameters
  - But set is not complete (extensionable)
- If you master GOMS at the level required for psyc645, you will be able to transfer your skills to most other task analysis techniques
GOMS & Task Analysis

In formulating GOMS, Card, Moran, and Newell thought hard about building cognitive science into task analysis.

Not the only way to apply cognitive science, but is one way.
Model Human Processor & Task Analysis

Rationality Principle

- P8 – Behavior is determined by goals + task + operators + inputs + knowledge + process limits

Problem Space Principle

- P9 – Goal directed activity can be described in terms of (1) a set of states of knowledge, (2) operators for changing one state into another, (3) constraints on applying operators, and (4) control knowledge for deciding which operator to apply next.
First 7 principles tend to describe ways of estimating duration of operators; e.g.,

- P1 -- Variable perceptual processor rate
- P2 -- Encoding specificity principle
- P3 -- Discrimination principle
- P4 -- Variable cognitive processor rate principle
- P5 -- Fitts’s law
- P6 -- Power law of practice
- P7 -- Uncertainty principle
MHP & Task Analysis

- MHP also includes an extremely generic theory of information processing
  - P0 -- Recognize-Act Cycle of the Cognitive Processor
    - On each cycle of the Cognitive Processor, the contents of working memory initiate actions associatively linked to them in LTM; these actions in turn modify the contents of working memory.
MHP & Task Analysis

Newell & Card

“Psychology delivers to the bounded-rationality band the model that must be used to understand what helps the user and how”

By which they mean that whatever the task, at some level of analysis it must be realized by operators at the level of principles 1-7 of the MHP.
MHP and Task analysis

- Integrated Models of Cognition (N&C p. 229)
- Calculational models of perception
- Partly Linear Models
  - Phenomenon = Volume-part + Difficulty-part
  - A key concept for task analysis (pp. 232-233 of N&C)
Partly Linear Models

Example from Kieras: Which are the volume parts and which are the difficulty parts?

Method for goal: Proofread drawing

- Step 1. Find a red terminal in drawing.
- Step 2. Decide: If no red terminals, return with goal accomplished.
- Step 4. Go to 1.

Method for goal: Draw a wire

- Step 1. Think-of starting and ending points for wire.
- Step 2. Think-of route for wire.
- Step 3. Invoke wire drawing function with starting point, ending point, and route.
- Step 4. Decide: If wire is now green, return with goal accomplished.
- Step 5. Decide: If wire is red, think-of problem with wire.
- Step 6. Go to 1.

Figure 3. Methods incorporating color codes for syntactic drawing errors.
Partly Linear Models

Example from Kieras: Which are the volume parts and which are the difficulty parts?

Method for goal: Proofread drawing

- Step 1. Find a red terminal in drawing.
- Step 2. Decide: If no red terminals, return with goal accomplished.
- Step 3. Accomplish goal: Draw a wire at red terminal.
- Step 4. Go to 1.

Method for goal: Draw a wire

- Step 1. Think of starting and ending points for wire.
- Step 2. Think of route for wire.
- Step 3. Invoke wire drawing function with starting point, ending point, and route.
- Step 4. Decide: If wire is now green, return with goal accomplished.
- Step 5. Decide: If wire is red, think of problem with wire.
- Step 6. Go to 1.

Figure 3. Methods incorporating color codes for syntactic drawing errors.
Partly Linear Models

- **Example from John & Kieras:**
  - Goal-directedness: Task situations that are less goal directed often have subgoals that need effective support

- **Evolution from problem-solving to cognitive skill**
  - Many tasks evolve from problem solving to routine skill after extensive use. Predicting a fully practiced user’s performance is valuable, because such performance cannot be empirically measured for a system that is just being designed and not yet implemented

- **Many tasks have elements of both routine skill and problem solving**
  - Although a user’s task may seem to be primarily a problem-solving task, there will be aspects of that task that involve routine cognitive skill. It is these aspects of the system design for which an analyst can use GOMS to improve the design to allow users to more effectively work on the nonroutine, creative parts of the overall task” p. 296.
Where does GOMS go?

(When do you need to do a CTA versus a TA?)

- Task analysis versus cognitive task analysis?
- What distinguishes GOMS cognitive task analysis from other task analysis techniques?
  - E.g., Cognitive Task Analysis™

Rensselaer Cognitive Science
TASK ANALYSIS
## Time Scale for GOMS

Levels of analysis (based on Newell’s Time Scale of Human Action)

<table>
<thead>
<tr>
<th>Scale (sec)</th>
<th>Time Units</th>
<th>System</th>
<th>Analysis</th>
<th>World (theory)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10000000000</td>
<td>decades</td>
<td>Technology</td>
<td>Culture</td>
<td>Social &amp; Organizational</td>
</tr>
<tr>
<td>100000000</td>
<td>years</td>
<td>System</td>
<td>Development</td>
<td></td>
</tr>
<tr>
<td>100000000</td>
<td>months</td>
<td>Design</td>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>10000000</td>
<td>week</td>
<td>Task</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000000</td>
<td>days</td>
<td>Task</td>
<td>Traditional Task Analysis</td>
<td>Bounded Rationality</td>
</tr>
<tr>
<td>100000</td>
<td>hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10000</td>
<td>min</td>
<td>Subtask</td>
<td>Unit Task Analysis</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>10 min</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>min</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>10 sec</td>
<td>Unit task</td>
<td>Cognitive Task Analysis</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1 sec</td>
<td>Activities</td>
<td>Microstrategy Analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/3 sec</td>
<td>Embodied Activities (Basic units of embodied cognition)</td>
<td>Production Rules</td>
<td></td>
</tr>
<tr>
<td>0.1</td>
<td>100 ms</td>
<td>Production Rule</td>
<td>Elements (DME-MA-VA)</td>
<td></td>
</tr>
<tr>
<td>0.01</td>
<td>10 ms</td>
<td>Elements</td>
<td>Architectural</td>
<td>Biological Band (subsymbolic)</td>
</tr>
<tr>
<td>0.001</td>
<td>1 ms</td>
<td>Parameters</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Level 1: Task Analysis: Task → Subtasks → Subtasks**

**Task**
- Complete Argus Prime Experiment
  - Complete Session #1
  - Complete Session #2
  - Complete Session #3

**Duration**
- 5 hr
- 1-2 hrs
- 12-30 min
- 30 sec to 3 min

**Subtasks**
- Hook Target ID#1
- Hook Target ID#2
- Hook Target ID#3
- • • • • Hook Target ID#n

**Scenarios**
- Scenario #1
- Scenario #2
- Scenario #3
- • • • • Scenario #n
# Levels of analysis (based on Newell’s Time Scale of Human Action)

<table>
<thead>
<tr>
<th>Scale (sec)</th>
<th>Time Units</th>
<th>System</th>
<th>Analysis</th>
<th>World (theory)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000000000</td>
<td>min</td>
<td>Task</td>
<td>Production Rules</td>
<td>Cognitive Band (symbolic)</td>
</tr>
<tr>
<td>100000000</td>
<td>min</td>
<td>Unit task</td>
<td>Cognitive Task Analysis</td>
<td></td>
</tr>
<tr>
<td>10000000</td>
<td>10 sec</td>
<td>Activities</td>
<td>Microstrategy Analysis</td>
<td></td>
</tr>
<tr>
<td>1000000</td>
<td>1 sec</td>
<td>Embodied Activities (Basic units of embodied cognition)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.1</td>
<td>100 ms</td>
<td>Production Rule</td>
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<td></td>
</tr>
<tr>
<td>0.01</td>
<td>10 ms</td>
<td>Elements</td>
<td>Architectural</td>
<td></td>
</tr>
<tr>
<td>0.001</td>
<td>1 ms</td>
<td>Parameters</td>
<td>Biological Band (subsymbolic)</td>
<td></td>
</tr>
</tbody>
</table>
Subtask → Unit Tasks

At the next level of analysis, the subtask of “hooking a target” can be analyzed as a series of unit tasks:

- **Target classification**
  - **Classified?**
    - no
      - Target classification
    - yes
      - **Feedback check**

“The unit task is fundamentally a control construct, not a task construct” (Card, Moran, & Newell, 1983)
**Levels of analysis (based on Newell’s Time Scale of Human Action)**

<table>
<thead>
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<th>Scale (sec)</th>
<th>Time Units</th>
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<th>World (theory)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00001</td>
<td>1 ms</td>
<td>Parameters</td>
<td>Architectural</td>
<td>Biological Band (subsymbolic)</td>
</tr>
<tr>
<td>0.0001</td>
<td>10 ms</td>
<td>Elements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.01</td>
<td>100 ms</td>
<td>Production Rule</td>
<td>Elements (DME-MA-VA)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1 sec</td>
<td>Activities</td>
<td>Microstrategy Analysis</td>
<td>Cognitive Band (symbolic)</td>
</tr>
<tr>
<td>10</td>
<td>10 sec</td>
<td>Unit task</td>
<td>Cognitive Task Analysis</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>1000 min</td>
<td>Embodied Activities (Basic units of embodied cognition)</td>
<td>Production Rules</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>1 week</td>
<td>Task</td>
<td>Traditional Task Analysis</td>
<td></td>
</tr>
<tr>
<td>10000</td>
<td>10000 days</td>
<td>Task</td>
<td>System Task Analysis</td>
<td></td>
</tr>
</tbody>
</table>

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**Note:**
- The table outlines different levels of analysis based on Newell’s Time Scale of Human Action.
- The scale ranges from microstrategy analysis to system task analysis, covering various timescales from seconds to years.
- The table categorizes tasks into cognitive and biological bands based on their time scales.
Any Given Unit Task Can be Further Analyzed into a Sequence of Activities

Method for goal: Determine if target is classified

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Select target by mouse click</td>
</tr>
<tr>
<td>2.</td>
<td>Note target ID#</td>
</tr>
<tr>
<td>3.</td>
<td>Determine if radio button in info window is black</td>
</tr>
<tr>
<td>4.</td>
<td>Verify that info window ID# is same as target ID#</td>
</tr>
</tbody>
</table>

First level at which we have described user behavior in terms of cognitive, perceptual, and motor operations.

Not coincidently, it is also the first level at which we have talked about features of the interface.
# Levels of analysis (based on Newell’s Time Scale of Human Action)

<table>
<thead>
<tr>
<th>Scale (sec)</th>
<th>Time Units</th>
<th>System</th>
<th>Analysis</th>
<th>Activities/Processes</th>
<th>World (theory)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^5$</td>
<td>day</td>
<td>World</td>
<td>Task</td>
<td>Task analysis</td>
<td>Subgoals</td>
</tr>
<tr>
<td>$10^4$</td>
<td>hours</td>
<td>Task</td>
<td>Task analysis</td>
<td>Subtasks</td>
<td>Bounded</td>
</tr>
<tr>
<td>$10^3$</td>
<td>minutes</td>
<td>Subtask</td>
<td>Unit Task Analysis</td>
<td>Unit Tasks</td>
<td>Rationality</td>
</tr>
<tr>
<td>$10^2$</td>
<td>min</td>
<td>Subtask</td>
<td>Unit Task Analysis</td>
<td>Unit Tasks</td>
<td></td>
</tr>
<tr>
<td>$10^1$</td>
<td>sec</td>
<td>Activity</td>
<td>Cognitive task analysis</td>
<td>Activities</td>
<td></td>
</tr>
<tr>
<td>$10^0$</td>
<td>1 sec</td>
<td>Activity</td>
<td>Embodied cognition</td>
<td>Microstrategies</td>
<td>Cognitive Band</td>
</tr>
<tr>
<td>$10^{-1}$</td>
<td>100 ms</td>
<td>Microstrategy</td>
<td>Computational models of embodied cognition</td>
<td>Elements</td>
<td></td>
</tr>
<tr>
<td>$10^2$</td>
<td>10 ms</td>
<td>Elements</td>
<td>Architectural</td>
<td>Parameters</td>
<td>Biological Band</td>
</tr>
<tr>
<td>$10^3$</td>
<td>1 ms</td>
<td>Parameters</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Activity Level → Embodiment Level

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Select target by mouse click</td>
</tr>
<tr>
<td>Step 2</td>
<td>Note target ID#</td>
</tr>
<tr>
<td>Step 3</td>
<td>Determine if radio button in info window is black</td>
</tr>
<tr>
<td>Step 4</td>
<td>Verify that info window ID# is same as target ID#</td>
</tr>
</tbody>
</table>


Level 4: Embodied Cognition: Activity → Microstrategy

Method for goal: Determine if target is classified

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Select target by mouse click</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 2</td>
<td>Note target ID#</td>
</tr>
<tr>
<td>Step 3</td>
<td>Determine if radio button in info window is black</td>
</tr>
<tr>
<td>Step 4</td>
<td>Verify that info window id# is same as target id#</td>
</tr>
</tbody>
</table>

http://hfac.gmu.edu/~mm
## Levels of analysis (based on Newell’s Time Scale of Human Action)

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<th>Time Units</th>
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<th>World (theory)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 sec</td>
<td>minutes</td>
<td>Technology</td>
<td>Unit task</td>
<td>Social &amp; Organizational</td>
</tr>
<tr>
<td>10 sec</td>
<td>minutes</td>
<td>System</td>
<td>Level task</td>
<td>Technology</td>
</tr>
<tr>
<td>100 sec</td>
<td>minutes</td>
<td>Concept</td>
<td>Task</td>
<td>Education</td>
</tr>
<tr>
<td>1 min</td>
<td>min</td>
<td>Task</td>
<td>Unit task</td>
<td>Education</td>
</tr>
<tr>
<td>10 min</td>
<td>min</td>
<td>Basic unit</td>
<td>Task</td>
<td>Education</td>
</tr>
<tr>
<td>100 min</td>
<td>min</td>
<td>Task</td>
<td>Task</td>
<td>Education</td>
</tr>
<tr>
<td>1 sec</td>
<td>min</td>
<td>Task</td>
<td>Task</td>
<td>Education</td>
</tr>
<tr>
<td>1/3 sec</td>
<td>microsecond</td>
<td>Embodied Activities</td>
<td>Production Rules</td>
<td>Cognitive Band (symbolic)</td>
</tr>
<tr>
<td>0.1</td>
<td>100 ms</td>
<td>Production Rule</td>
<td>Elements (DME-MA-VA)</td>
<td>Biological Band (subsymbolic)</td>
</tr>
<tr>
<td>0.01</td>
<td>10 ms</td>
<td>Elements</td>
<td>Architectural</td>
<td>Biological Band (subsymbolic)</td>
</tr>
<tr>
<td>0.001</td>
<td>1 ms</td>
<td>Parameters</td>
<td></td>
<td>Biological Band (subsymbolic)</td>
</tr>
</tbody>
</table>
Level 5: Microstrategies $\rightarrow$ Elements (Where GOMS doesn’t go!)

- **Production Rules**

- **If -->** Then rules at the 50-100 msec level
  - **If**
    - This is true of memory &
    - This is true of the environment
  - **Then**
    - Add this fact to memory, &
    - Try to retrieve this other fact from memory, &
    - Send a command to the left-index finger to mouse down
# Levels of analysis (based on Newell’s Time Scale of Human Action)

<table>
<thead>
<tr>
<th>Scale (sec)</th>
<th>Time Units</th>
<th>System</th>
<th>Analysis</th>
<th>World (theory)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 min</td>
<td>days</td>
<td>Cognitive Band</td>
<td>Embodied Activities (Basic units of embodied cognition)</td>
<td>Biological Band (subsymbolic)</td>
</tr>
<tr>
<td>10 min</td>
<td>min</td>
<td>Elements</td>
<td>Architectural</td>
<td>Social &amp; Organizational</td>
</tr>
<tr>
<td>1 min</td>
<td>sec</td>
<td>Parameters</td>
<td></td>
<td>Culture</td>
</tr>
<tr>
<td>10 ms</td>
<td>100 ms</td>
<td>Production Rule</td>
<td>Elements (DME-MA-VA)</td>
<td>Technology</td>
</tr>
<tr>
<td>0.01</td>
<td>10 ms</td>
<td>Elements</td>
<td>Architectural</td>
<td>Environment</td>
</tr>
<tr>
<td>0.001</td>
<td>1 ms</td>
<td>Parameters</td>
<td></td>
<td>Traditional Task Analysis</td>
</tr>
</tbody>
</table>

## Notes
- **Architectural Elements (DME-MA-VA)**
- **Elements (DME-MA-VA)**
- **Embodied Activities (Basic units of embodied cognition)**
- **Microstrategy Analysis**
- **Production Rules**
- **Production Rule**
- **Unit Task**
- **Task**
- **Unit Task Analysis**
- **Task**
- **Task**
- **Unit Task Analysis**
- **Unit Task Analysis**

---

**Levels of analysis** refer to the different scales at which human action can be analyzed, ranging from the biological to the social and organizational. Each level corresponds to a different time scale and a different set of task analysis methods. The time scale of human action, as proposed by Newell, is used to categorize these levels.

**Biological Band (subsymbolic)**
- **100 minutes**
- **10 minutes**
- **1 minute**
- **10 milliseconds**
- **1 millisecond**

**Cognitive Band (symbolic)**
- **10 seconds**
- **10 minutes**
- **100 minutes**

**Embodied Activities (Basic units of embodied cognition)**
- **10 milliseconds**

**Macrostrategy Analysis**
- **1 hour**
- **1 day**
- **1 week**

**Unit Task Analysis**
- **10 seconds**
- **10 minutes**
- **100 minutes**

**Microstrategy Analysis**
- **100 milliseconds**

**Production Rule**
- **1 second**

**Production Rules**
- **10 seconds**

**Traditional Task Analysis**
- **1 day**
- **1 week**

**Unit Task**
- **10 minutes**

**Task**
- **100 minutes**

**Unit Task**
- **1000 hours**

**Task**
- **10000 hours**

**Unit Task**
- **100000 hours**

**Task**
- **1000000 hours**

**Unit Task**
- **10000000 hours**

**Task**
- **100000000 hours**

**Task**
- **1000000000 hours**

**Task**
- **1000000000 hours**
Level 6: Production Rules → Elements
(Where GOMS doesn’t go!)

- Declarative memory elements
  - Internal (created on RHS of production rules)
  - External (created by shifts of attention in the external environment)

- Visual actions

- Motor actions
Level 7: Elements → Parameters

(GOMS doesn’t go here either!)

- w -- amount of attentional capacity
- d -- decay rate
- s -- fluctuations in the strength of declarative memory elements
- rt -- retrieval threshold
**KR not KE**

- GOMS (as with most task analysis methods) focuses on
  - Knowledge representation, not on
  - Knowledge elicitation
- There are many sources of knowledge elicitation techniques, e.g.,
Task Analysis versus Functionality


for a cogent discussion of this issue
Definition of GOMS

Characterization of a task in terms of

- The user's Goals
- The Operators available to accomplish those goals
- Methods (frequently used sequences of operators and sub-goals) to accomplish those goals, and
- If there is more than one method to accomplish a goal, the Selection rules used to choose between methods.
Example of G-O-M-S

To carry out a GOMS analysis of the following task involving a digital clock:

- Set the clock

Top level goal: SET CLOCK
Example of G-O-M-S: Goals

Goals and subgoals

Set Clock

Set Hour  Set Min
Example of G-O-M-S: Operators

Operators are the most elementary steps in which you choose to analyze the task.

- Reach <type> button
- Hold <type> button
- Release <type> button
- ClickOn <type> button
- Decide: if <x> then <y>
- Verify
Example of G-O-M-S: 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
**Example of G-O-M-S: Selection rules**

- No selection rules in this example as this clock has only ONE method for accomplishing each goal, but . . .

  **Selection rule for goal: SET-HOUR**

  If target \( \text{HOUR} \leq 4 \) hours from current \( \text{HOUR} \), then Accomplish
  Goal: ClickOn \( \text{HOUR} \)

  If target \( \text{HOUR} > 4 \) hours from current \( \text{HOUR} \), then Accomplish
  Goal: Click&Hold \( \text{HOUR} \)
Applications of GOMS

Case 1. Design of mouse-driven text editor
Case 2. Directory assistance workstation
Case 3. Space operations database system (for orbital objects)
Case 4. Bank deposit reconciliation system.
Case 5. CAD system for mechanical design.
Case 6. Television control system.
Case 7. Nuclear power plant operator's associate.
Case 8. Intelligent tutoring system.
Case 9. Industrial scheduling system.
Case 10. CAD system for ergonomic design.
Case 11. Telephone operator workstation.

Where does GOMS go?

Usability writ large

- **Organization Issues**
  - [anthropology, social issues]

- **Conceptual Issues, Mental Models**
  - [cognitive science]

- **Procedural Issues (methods)**
  - [GOMS]

- **Perceptual Issues**
  - [traditional HF, cognitive engineering, Tullis, Wickens]
Development process

without analytic modeling
Development process with analytic modeling
GOMS as Analytic 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
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
Scope of GOMS: What it can do, con’t

GOMS has been applied to both:

- User-driven interaction
- “Situated” or event-driven interaction
Scope of GOMS: What it might be able to do

Research has made progress on

- Predicting the number of some types of errors

- Predicting the effects of display layout on performance time
Scope of GOMS: What it can't 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...
General Factors to Consider in GOMS Models

When deciding what type of GOMS model you need, you must consider...

- what control structure
- what level of analysis
- whether to approximate behavior with serial or parallel processes
- ...different uses of GOMS models lead to different values of these factors

These factors will be a recurring theme
GOMS Family of Analysis Methods

Keystroke-Level Model

CMN-GOMS

NGOMSL

CMN-GOMS for Highly Interactive Tasks

CPM-GOMS
Keystroke-Level Model: Intro

- The simplest of all GOMS models: OM only!!!
  - No explicit goals or selection rules
  - Operators and Methods (in a limited sense) only

- “Useful where it is possible to specify the user’s interaction sequence in detail” (CMN83, p. 259).

- Control structure: **Flat**
- Serial or Parallel: **Serial**
- Level of Analysis: **Keystroke-level operators**
NGOMSL

Natural Language GOMS
- based on structured natural language notation and a procedure for constructing them
- models are in program form

Control Structure: Hierarchical goal stack

Serial or parallel: Serial

Level of Analysis: As necessary for your design question
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
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 (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
CPM-GOMS Extension to GOMS

- Critical Path Method (or Cognitive Perceptual Motor) - GOMS
- Control structure: Relaxed hierarchy, can be interrupted and continued based on new information in the world
- Serial or Parallel: Parallel
- Level of Analysis: Primarily elementary perceptual, cognitive and motor operators
**CPM-GOMS - why?**

- Need for analysis suitable for parallel activities
- Human cognition is embodied cognition
  - In some cases we need to understand the interleaving and interdependencies between elementary cognitive, perceptual, and motor operations