Task Analysis and Distributed Cognition

Robert Bobkoskie
rbobkoskie3@gatech.edu

1 GOMS MODEL

A GOMS (Goals, Operators, Methods, Selection rules) model is a human information processor model that analyzes user behavior as a product of environmental stimuli. GOMS assumes user familiarity with the system.

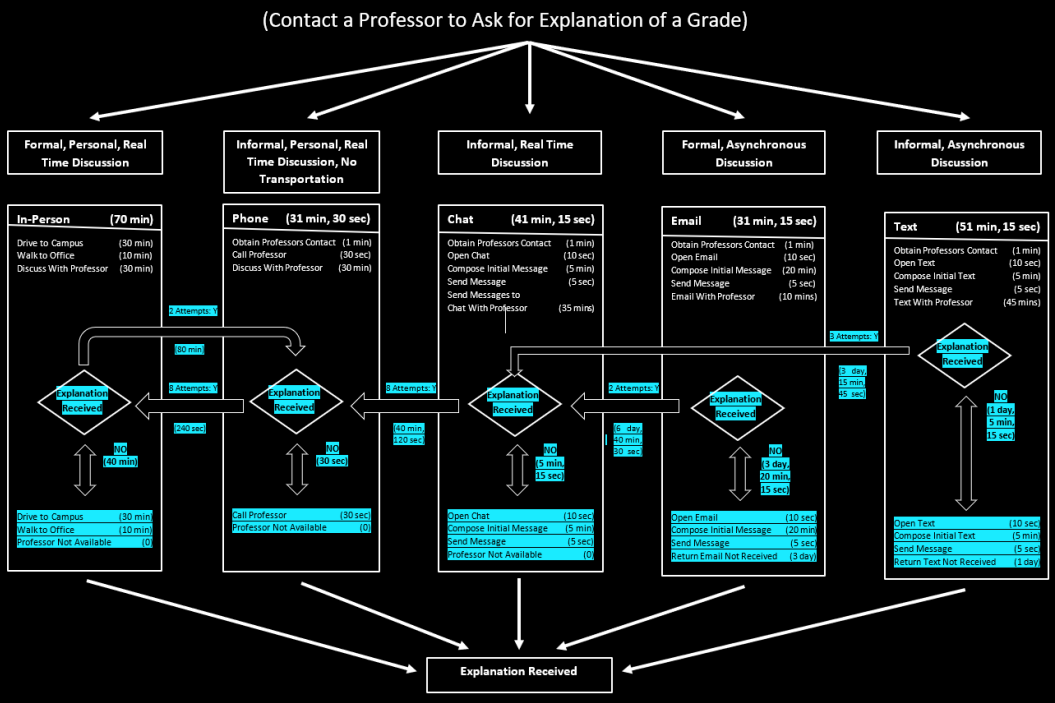

Figure 1: GOMS Model: Contact a Professor to Ask for Explanation of a Grade

2 HIERARCHICAL TASK ANALYSIS

This section will present a Hierarchical Task Analysis (HTA) of the task of submitting an assignment to Canvas and subsequently receiving the grade and feedback for the assignment. Similar to GOMS, HTA assumes the user has experience with the system.

1. **Complete an assignment using Canvas**
2. **Submit a completed assignment**

2a. *Login to Canvas*

2aa. *Open a Web Browser*

2ab. *Enter the Canvas URL in the browsers address bar: https://canvas.gatech.edu/*

2ac. *Click on the Login to Canvas link*

2ad. *From the Georgia Tech Login Service:*

- Enter you Georgia Tech Account ID
- Enter you Georgia Tech Password
- Two factor authentication:
  Verify your Device
  Select Call Me
  Answer call
  Confirm by entering "1"

2b. *Submit Assignment*

2ba. *From the Canvas Dashboard: Choose Class*

2bb. *From the class page: click on Assignments*

2bc. *Click on the assignment to be submitted*

2bd. *Click on the Submit Assignment button*

2be. *Choose option File Upload button*

2bf. *Click on the Choose File button*

2bg. *Select assignment and click on the Open button*
***OPTIONAL**: Add a comment*

2bh. *Click on the Submit Assignment button*

3. **Obtain grade for assignment using Canvas**

3a. *Login to Canvas*

3aa. *Follow operators [2aa ⇒ 2ad]*

3b. *Obtain Grade and Feedback for Assignment*

3ba. *From the Canvas Dashboard: Choose Class*

3bb. *From the class page: click on Grades*

3bc. *From the Grades for ¡Student Name¿ page: click on the button Show All Details*

3bd. *From the Grades for ¡Student Name¿ page: scroll down until the assignment is found*

3be. *Locate the grade for the assignment, which is in the header for that assignment*

3bf. *Locate the comments (feedback) for the assignment, which is below the header for that assignment*

3 DISTRIBUTED COGNITION: SYSTEM ANALYSIS

This section will explore a *navigation system* from the perspective of distributed cognition. The system is comprised of the following artifacts:

- A married couple.
- Other people local to the environment to query for directions.
- A map.
- A marked up map with highlighted directions.
- Dashboard instruments in the car.
- Road signs.

3.1 Analysis of a Navigation System

The navigation system, both human and inanimate artifacts is capable of performing cognitive activities.

- **The Driver**: This human artifact performs the following cognitive activities:
  - **Visual and Verbal Processing** when driving car and deliberating with spouse over directions.
  - **Emotional Intelligence** when interacting with spouse.
  - **Long and Short Term Memory** to drive the automobile.
  - **Reaction Time** when driving the automobile.
- **The Passenger**: This human artifact performs the following cognitive

activities:

  - **Visual and Verbal Processing** when reading the map and deliberating with spouse over directions.
  - **Emotional Intelligence** when interacting with spouse.
  - **Long and Short Term Memory** to read a map.
  - **Reasoning** when deciding on a direction.
- **The Map**: This inanimate artifact performs the following cognitive activities:
  - **Long Term Memory** for storing information about the environment, i.e., highway and street names, exit numbers, directionality and distance.
- **The Marked Up Map**: This inanimate artifact performs the following cognitive activities:
  - **Working Memory** for storing more immediate and short-term information about the environment, i.e., an annotated path from origin to destination the current trip.

3.2 Analysis of a Navigation System with GPS

This section will compare the navigation system discussed in Analysis of a Navigation System. This navigational system replaces the passenger and maps with a GPS, i.e., will consist of the driver and a GPS. Although social cognition is removed from this navigation system, both human and inanimate artifacts is capable of performing cognitive activities. The list below highlights differences from Analysis of a Navigation System with strike-through of cognitive activities that do not apply to this system.

- **The Driver**: This human artifact performs the following cognitive activities:
  - **Visual and Verbal Processing** when driving car and ~~deliberating with spouse over~~ processing both visual and verbal directions from GPS.
  - ~~**Emotional Intelligence** when interacting with spouse.~~
  - **Long and Short Term Memory** to drive the automobile.
  - **Reaction Time** when driving the automobile.
- **The GPS**: This human artifact performs the following cognitive activities:
  - **Reasoning** when deciding on a direction.
  - **Long Term Memory** for storing information about the

environment, i.e., highway and street names, exit numbers, directionality and distance.
  - **Working Memory** for storing more immediate and short-term information about the environment, i.e., an annotated path from origin to destination the current trip.

Eliminating the human navigator from the system removed cognitive capacities *Emotional Intelligence and Verbal Reasoning*, thus eliminating social cognition. Although much of the cognitive activities remain the same in this distributed system using GPS, there are some important differences resulting in both loss and benefit:

- **Loss**: Replacing the human navigator with a GPS removes *Emotion and Creativity* from the context of the system. This can eliminate **empathy** that the human navigator may provide the driver, i.e., if the driver makes a wrong turn, **soothing and reassuring the driver**.
- **Gain**: Replacing the human navigator with a GPS removes *Emotion and Creativity* from the context of the system. This can eliminate **anger** that the human navigator may provide the driver, i.e., if the driver makes a wrong turn, **screaming at the driver**.

As seen from the gain and loss of a system without social cognition, the environment plays a role in determining social cognition. That is, the perception and memory of the human participant can affect the distributed system. If the human participant perceives an impending accident, they may influence the driver by yelling or touching. Perhaps the human navigator recalls recent construction on the path to the destination. In this scenario, an alternate route can be taken. In these examples, social cognition can have both positive and negative influences on the success of the system as a whole.

4 DISTRIBUTED COGNITION: TASK ANALYSIS

This section will discuss the cognitive tasks associated with avoiding a collision while driving a car equipped with Artificial Intelligence (AI).

The task of a human driving a car is rapidly being augmented and in some cases, supplanted by Autonomous Systems utilizing AI. This task will explore a car with

level [0, 1] [1] autonomous capabilities, such as lane recognition and collision warning and avoidance, i.e., this is not a *self-driving car*. Thus the interfaces will be comprised of standard automobile controls, as well as the *invisible* interface consisting of the AI system. The system is comprised of the following interfaces and components:

4.1 The System: Artifacts and Cognitive Tasks

The system is composed of both human and inanimate artifacts that perform the following cognitive tasks:

- **The Driver**: Responsible for navigating the automobile.
  - **Perception** when driving the car.
  - **Long and Short Term Memory** to perform the task of driving the car.
  - **Reasoning** when deciding how to drive the car.
  - **Action** when performing tasks such as steering, braking and accelerating to drive the car.
- **The Automobile Controls**: The interface is comprised of artifacts [Steering Wheel, Brake Pedal, Accelerator Pedal] that allows the driver to communicate with the automobile.
  - **Action**. The controls allow the driver to communicate with the car. They enable the user to perform tasks like braking, steering and accelerating.
- **The Automobile Dashboard Instruments**: The interface is comprised of artifacts [Speedometer, Odometer, Tachometer, Fuel Gauge, Oil Pressure Gauge] that provide feedback to enable the driver to communicate with the automobile.
  - **Perception**. The controls allow the driver to receive feedback from their actions. Thus, they allow the user to adjust actions when performing tasks like braking, steering and accelerating.
- **The AI system**: The interface responsible for driver error detection.
  - **Sensors** ***Perception****: An artifact that AI system use to* ***see*** *the environment*.
  - **Computer Vision** ***Reasoning****: An artifact that AI systems use to* ***understands*** *the environment*.

[1] Autonomous

- **Localization** ***Long and Short Term Memory****: An artifact that AI systems use to* ***identify*** *its location in the environment*.
- **Path Planning** ***Reasoning****: An artifact that AI systems use to* ***think about*** *the most optimal route in the environment*.
- **Control** ***Action****: An artifact that AI systems use to* ***actuate*** *the controls of the automobile, i.e., braking, steering, accelerating*.

In this system, knowledge is distributed among the artifacts. The AI system can modulate and correct human slips and mistakes and is an active meta-artifact in this system. Many of the cognitive tasks of the human driver can be ascribed to the AI system. Thus, additional cognitive resource are provided to the system.