The Social Organization of Distributed Cognition

How social arrangements affect the cognitive properties of groups (which can be different from the cognitive properties of the individuals in the group).

Computational Architecture

- Computational architecture describes how the pieces of a computational system are connected.
- What information goes where, when, in what form?
- What are the pieces?
  - Central processor
  - Memory stores
  - Input, output, buffers, etc.
- How can information move?
  - Processor retrieves an operation from program memory, data from another memory, and writes a result back into the data memory.

Social organization as computational architecture

- Social organizations take the form they do for many reasons
- No matter what form a social organization takes, it will have cognitive consequences.
- Because social organization determines what jobs get done, where, by whom.
- It shapes what information goes where, when, and in what form.

Distribution of cognitive labor

- Distribution of knowledge
  - Specialization of knowledge.
- Coordinating the distributed parts, interactions among specialists
- Producing and reproducing expertise

Society as a distributed memory (Roberts)

- Native American groups have different kinds of social organization, and these give rise to different memory properties.
- Factors that affect memory retrieval
  - Group size
  - Distribution of knowledge among individuals
  - Patterns of interaction among individuals
  - Changes in patterns of interaction through time
Coordinating the distributed parts

- There are many ways to do this, social organization of distributed cognition
- Stigmergy: reacting to structure left by others, (e.g., ants)
- Aggregation: voting schemes, juries, markets, Wisdom of crowds.
- Society of agent specialists, distribution of knowledge and distribution of responsibility.
- Hierarchies, and chain of command
- Distributed AI, Chandrasekeran, natural and social system metaphors.

How a Cockpit Remembers its Speeds

Some issues to keep in mind

- The cultural practices that orchestrate pilots’ interactions with the artifacts.
- The extent to which we can consider the Airspeed Indicator or speed book to be an example of a culturally domesticated space.
- The functional system that is created in interaction with the speed book and ASI.
- The contributions of internal and external resources. For example consider the perceptual and motor processes.
- The computations that are accomplished in this interaction.
- The way that the ASI permits you to do conceptual inferences using perceptual processes.

More Issues to keep in mind

- The representation of the abstract concept of speed as perceptible objects.
- The propagation of representational states from the fuel panel to the states of the airplane.
- The comparison of the round-dial ASI to other formats for representing the same speed relations and the ways that each representational format implies or requires a different functional system.

Fuel Quantity Panel
Approach Reference Page on MCDU

Speed Card

Airspeed Indicator

Labeled Airspeed Indicator

Flap Control Handle

Propagation of representational state across media
Embodied Cockpit?

- Fuel panel = sensory system
- Speed card book = long term memory
- Bugs on ASI = short term memory
- Flap handle = motor system

Setting the Bugs

“Flaps 15”

Instrument Cross-check

500 Feet Above the Field

767 Airspeed Indicator
Lessons

- Knowing all about ‘human memory’ would not allow you to understand this system
- Structure in the world participates in memory and in processing
- Distribution of cognitive effort through time - amortization of complexity
- Robustness through redundant representation and processing

Lessons (continued)

- Transformation of information to auditory medium to prevent overload of visual senses.
- It’s curious how well the traditional cognitive science story works here
Sequential control of action/production systems

- Condition/action pairs
- Agents waiting for conditions that trigger actions.
- With the right distribution of productions, a complex procedure can be accomplished without any agent knowing the plan.

Coordinating Goal Structure and Social Structure
Cognitive properties of the navigation team are twice removed from the cognitive properties of the members of the team.

- Cognitive properties of individuals are transformed by the functional systems they form when they interact with technology.
- Social organization of distributed cognition produces effects at the group level that are simply not those of the individual level.

Advantages of distributed architectures

- Decomposition to control complexity (modularity), limiting complexity of input encountered by any individual.
- Also enables parallel activity for efficiency.
- Filtering reduces processing costs.
- Organizing activity on the basis of social relations rather than domain content. (Take care of syntax and semantics will take care of itself. Take care of social relations, and syntax will take care of itself.)

Advantage of distribution: Graceful degradation

- Robust adaptation or gradual reduction in capacity rather than catastrophic failure.
- Redundant knowledge and skills.
- Intersubjectively shared understanding of the task and filling in for other agents.

Costs of distributing cognition

- Filtering effects (hard to diagnose causes of failures, premature commitment IranAir).
- The need for coordination.
- Design of coordination can be difficult (see beam bearings analysis).

Properties of these systems

- Computation via propagation of representational state.
- Parallel activity.
- Bottom-up and top-down processes.
- Readbacks and redundant representation.
- Buffers and demons (depth and bearing triggers).