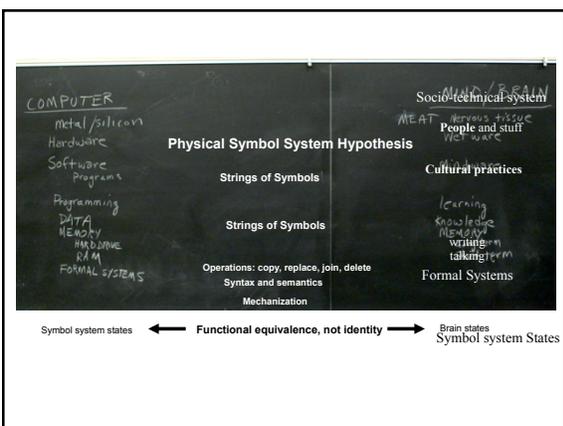


The Social Organization of Distributed Cognition

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

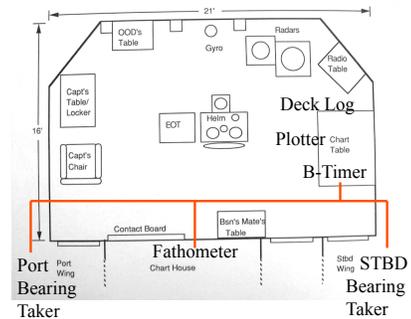
Society as a distributed memory (Roberts)

- 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

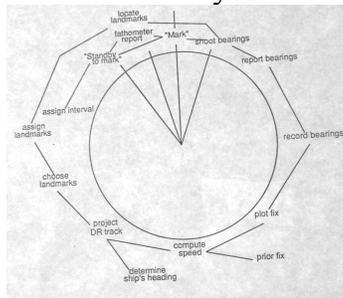
Coordinating the distributed parts

- 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.

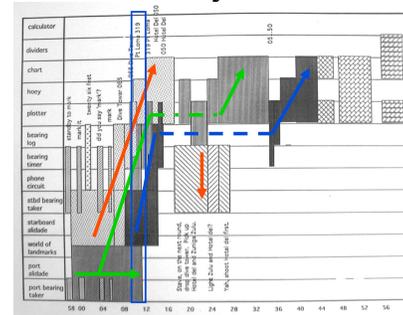
Bridge Layout



The Fix Cycle

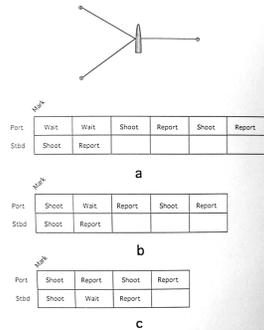


Activity Score



Shoot the beam bearing first

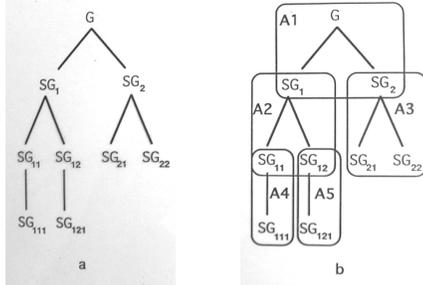
Three ways to sequence the actions of the bearing takers.



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.**

Features of SODC

- Distribution of access to information (sensing, direct and vicarious experience, horizon of observation; notice how this is shaped by the interactions of social and physical space)
- Propagation of representational state across multiple media
- Redundant memory (episodic memory)
- Distribution of knowledge (semantic memory) (specialization and sharing of knowledge)

more features

- Distribution of expectations and anticipation
- Distribution of attention. The management of attention. How attention is organized by the flow of activity. (Who attends to what when and from what perspective?)
- Structure of communication (who talks to whom about what and when they talk?)

More features of SODC

- Coordinating the parts via...
 - stigmergy, aggregation, Daemons and production systems, buffers, command hierarchy, goal hierarchy and relations of goal hierarchy to social hierarchy
- Recipient design in communication and switching modalities to meet the needs of the listener
- Filtering effects in information hierarchies

more features

- Redundant readback for error detection
- Distribution of cognitive task performance (multiple people working simultaneously on related task elements)
- The production and re-production of expertise
- Precomputation (the amortization of complexity)

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!)

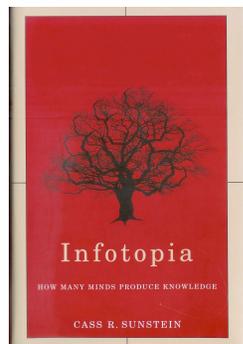
Advantage of distribution: Graceful degradation

- 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)
- The need for coordination
- Design of coordination can be difficult (see beam bearings analysis)

How to get the best cognitive performance out of groups



How should we aggregate knowledge in a group to get the right answer to a question?

- Vote/poll
- Deliberation
- Market
- Blog/wiki

Just ask a lot of people and take the average of their answers

- Galton and the weight of the bull.



How many jelly beans are in this picture?



Majority Rule

- If we have a yes/no question, rather than averaging, we can take the majority opinion.

The Condorcet Jury Theorem

- Assumptions:
 - Independence of information: people are not affected by the votes of others
 - Each person is more likely than not to be correct.
 - Majority rule.
- The probability of a correct answer by the majority of the group increases toward 100% as the size of the group increases.
 - Groups are more accurate than individuals.
 - Big groups are more accurate than little groups.

A justification for democracy?

- If all of the voters are more likely to be right than wrong, then majority rule will work.
- Even if only most of the voters are more likely to be right than wrong, it will still work.
 - E.g. if 55% of the people are 65% likely to be right and the other 45% of the people are only 40% likely to be right.
 - Who wants to be a millionaire? Ask the audience or your expert?
- And if those who don't know respond randomly, then the outcome will be determined by those who do know.

The dark side

- If each member of a group is more likely to be wrong than right, then the likelihood that the majority's decision will be correct falls to **zero** as the size of the group increases!
- So voters or jurors must be enlightened. They must not be misled.
 - According to Pew Research, 93% of Americans believe that Arab terrorists destroyed the World Trade Center. Only 11% of Kuwaitis believe this.
 - If polled, these two groups will produce different answers. One of these groups is wrong.

What can affect the likelihood that a person will make the right choice?

- Anchors. I am asking 500 people how many jelly beans there are in this picture. How many do you think there are?



Framing

- Of the people who have this procedure, 90% will be alive 5 years from now.
- Of the people who have this procedure, 10% will be dead 5 years from now.

Think of our congress

- “A very numerous assembly cannot be composed of very enlightened men. It is even probable that those comprising this assembly will on many matters combine great ignorance with many prejudices. Thus there will be a great number of questions on which the probability of the truth of each voter will be below $\frac{1}{2}$. It follows that the more numerous the assembly, the more it will be exposed to the risk of making false decisions.”

When should we expect aggregation to work?

- When most people asked are more likely than not to be right.
 - Company president asks advisors about a business decision
 - University dean asks faculty about hiring a certain job candidate
 - Government agency consults a group of scientists about a pollution problem

When will it not work?

- When most people are not more likely than not to be right.
 - Ask the entire nation
 - If the US should sign the ~~Kyoto~~ ~~Copenhagen~~ Cancun Protocol on Climate Change
 - Whether genetic engineering poses serious risks
 - Whether an increase in the minimum wage would increase unemployment.

Deliberation

- Rather than aggregating initial opinions, what if we allow people to talk it over?
- Deliberation can help under some conditions

General effects of deliberation

Views will be more extreme after deliberation than they were before deliberation

Consensus will be higher after deliberation = less diversity of opinion

People will have more confidence in their opinions after deliberation

Are they more likely to be right? If the question has an answer that is difficult to find, but is obviously correct once found, then yes.

BUT in general NO!

Why deliberation sometimes fails to integrate the available information

- Eagerness to conform and be accepted may lead to holding back dissenting opinions
- Fear of punishment may lead to holding back dissent

The internal morality of deliberation

- Rational discourse is supposed to be public and inclusive, to grant equal communication rights for participants, to require sincerity and to diffuse any kind of force other than **the forceless force of the better argument**. This communicative structure is expected to create a deliberative space for the mobilization of the best available contributions for the most relevant topics. (Habermas)
- Explore/exploit and the fundamental tradeoff in cognitive ecology

Different institutions capture different aspects of this ideal

- Religious cults
- Courtroom trials
- Airline cockpits
- Government agencies
- Democratic society
- Science
- This means that **the character of the institutions we have**, determines the effectiveness of our use of “many minds to produce knowledge”

Citizenship in the Digital Age

Bill of Rights and Information flow

- **Amendment I**
 - Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the **freedom of speech**, or of the press; or the right of the people peaceably to assemble, and to petition the government for a redress of grievances.
- **Amendment IV**
 - The right of the people to be **secure in their persons, houses, papers, and effects, against unreasonable searches and seizures**, shall not be violated, and no warrants shall issue, but upon **probable cause**, supported by oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

Officials Push to Bolster Law on Wiretapping

Charlie Savage, NYTimes 10/18/2010

- WASHINGTON — Law enforcement and counterterrorism officials, citing lapses in compliance with surveillance orders, are pushing to overhaul a federal law that requires phone and broadband carriers to ensure that their networks can be wiretapped, federal officials say.

Bill of Rights and Information flow

- **Amendment V**
- No person shall be held to answer for a capital, or otherwise infamous crime, unless on a presentment or indictment of a grand jury, except in cases arising in the land or naval forces, or in the militia, when in actual service in time of war or public danger; nor shall any person be subject for the same offense to be twice put in jeopardy of life or limb; **nor shall be compelled in any criminal case to be a witness against himself**, nor be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use, without just compensation.

Bill of Rights and Information flow

- **Amendment VI**
- In all criminal prosecutions, the accused shall enjoy the right to a speedy and public trial, by an impartial jury of the state and district wherein the crime shall have been committed, which district shall have been previously ascertained by law, and **to be informed of the nature and cause of the accusation; to be confronted with the witnesses against him**; to have compulsory process for obtaining witnesses in his favor, and to have the assistance of counsel for his defense.