Decision Making

Akın Ö., *A Cartesian Approach to Design Rationality*

- Developing a sound basis for constructing theories
- Applying these theories in different domains

- Two paths
  - Normative – rationalist, principles, axioms, formal, mathematical; applied deductively
  - Descriptive – empiricist, decision making is a result of human cognitive process, stochastic

Normative Models

- Selection among possible alternatives based on economic utility
- Von Neuman and Morgenstern (vN-M) stated in axiomatic form (1947)
  - Axiom1 – transitivity : If $p \leq q$, $q \leq r$, then $p \leq r$
  - Axiom2 – value conservation :

    $$p \leq q \Rightarrow ap + (1 - a)r \leq aq + (1 - a)r$$

  - Axiom3 – ordinality:

    $$p \leq q \leq r, \text{ then } 0 \leq ap + (1 - a)r - q \leq 1$$

Rationality

- *Rational economic men* behave as predicted by these models
- Discrepancies between predictions of model and actual behavior
  - Due to non-rational behavior of decision makers
  - Example: buying lottery, explanation: subjective utility

Descriptive Models

- Modified normative models – corrections that take into account non-rational behavior of humans
- Information processing model – a model based on the decision making processes and cognitive mechanisms
- Heuristic models – heuristic rules of decision making and choice

Modified Normative Models

- Shortcomings of normative models (Kahneman and Tversky)
  - Certainty effect – overweight small probabilities
  - Reflection effect – gains vs. losses
  - Isolation – focus on differences
- New model
  - Value
  - Decision weights,
  - Gains vs. losses, simplify choices, changes

Descriptive Models

Problem solving behavior depends on

- Task – task analysis
  - Types of problems:
    - well-defined
    - ill-defined
    - wicked
- Problem Solver – IPS
  - Characteristics and limitations of problem solver

Information Processing Models

- Cognitive capabilities and psychological limitations of decision-makers cause observed behavior
- Humans, computers etc. are information processing systems (IPS)
- The characteristics of IPSs determine human decision making, problem solving etc.

Information ProcessingSystem [IPS]

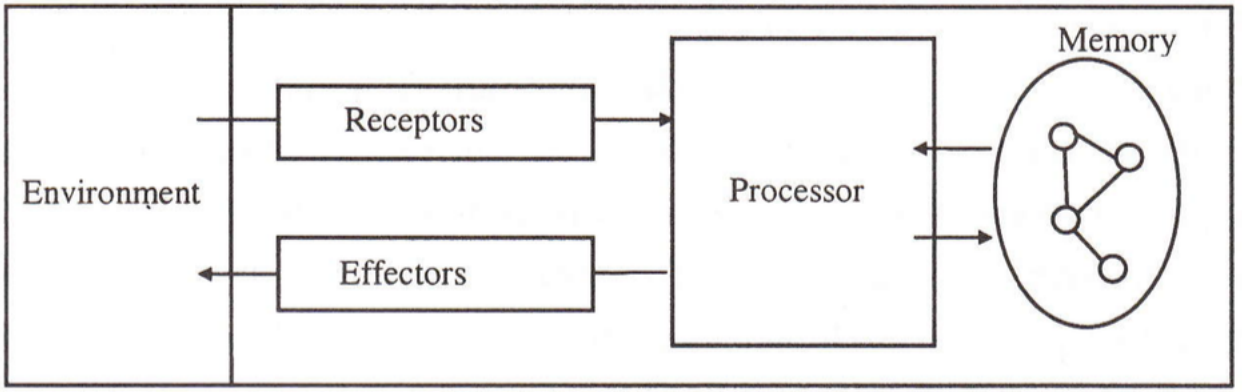


Figure 3.1 Information Processing model of human cognition (From Newell and Simon's, Human Information Processing).

Characteristics of IPSs

- Primitive information processes that operate on symbol structures
- Rules for combining processes into larger functions
- Control mechanism that governs overall goal direction

Human IPS

- Processor
  - primitive information processes
  - serial
- Short-term memory (STM)
  - 7 ± 2 *chunks*,
  - Working memory = STM + external memory under focus of attention

Human IPS

What is a chunk?

- Unit of memory
- Formed by learning
- Hierarchical
  - chunks are made up of other chunks
  - or primitive symbols

Human IPS

"Chunking" is the process of creating a pattern that can be reactivated when needed. It might be an equation or a phrase in French or a guitar chord. Research shows that having a mental library of well-practiced neural chunks is necessary for developing expertise.

Practice brings procedural fluency, says Dr. Oakley, who compares the process to backing up a car. "When you first are learning to back up, your working memory is overwhelmed with input." In time, "you don't even need to think more than 'Hey, back up,' " and the mind is free to think about other things.

Chunks build on chunks, and, she says, the neural network built upon that knowledge grows bigger. "You remember longer bits of music, for example, or more complex phrases in French." Mastering low-level math concepts allows tackling more complex mental acrobatics. "You can easily bring them to mind even while your active focus is grappling with newer, more difficult information."

Human IPS

- Long-term memory
  - Unlimited capacity
  - Associative
  - Slow 5 – 10 sec.
  - Extended memory – libraries, internet
- These parameters are universal

Bounded rationality

- Satisficing as opposed to optimizing because
  - Finding the best requires looking at all alternatives
  - Finding a good enough solution depends on the distribution of solutions in the problem space
- Bounded rationality takes into account finite cognitive and time resources

Optimization

- Selection of best alternative from possible alternatives based on economic utility – von Neuman Morgenstern [*vN-M*], Economic Theory of Games.
- Mathematical optimization – selection of best element (maximizing expected utility) from some set of available alternatives

Satisficing

- Find a solution satisfying all constraints
  - binary constraints: [0 , 1] defined by a threshold
- If problem is too easy
  - change threshold to make a constraint harder
  - add a new constraint
- If problem is too hard
  - change threshold to make a constraint easier
  - remove a constraint

Cognitive biases

- Anchoring
- Representativeness
- Availability
- Causal quality

Analyzing Intuitive Design

- Building design problems are complex
- Domain knowledge and skill are applied
- Called ill-defined and wicked

Intuitive Design

- Decomposition into subproblems
  - Hierarchical
- Sequence of subproblems to consider and decisions to make

Intuitive Design

- Experienced designers use
  - Breadth-first search to select next issue to consider
  - Consider all issues
  - Dependencies between issues
- Sequence depends on constraints of the problem

Intuitive Design

- Integration of independent decisions into comprehensive ones
- Take multiple passes through the problem to synchronize the independent decisions taken at each stage

Intuitive Design

- Alexander's method decomposes a design problem into sub-parts such that the links or dependencies between the sub-parts are minimized
- Flawed acc. To Akın
  - Dependencies are unpredictable
  - Dependencies may arise due to particulars of a solution
- Decomposition done during, not before problem solving

Problem structuring

- Design acquires structure by by being decomposed into problems of component design
- Evoking requirements to be applied in testing the design of its components
- The inherent dependencies that exist between sub-problems are put into the body of each sub-problem

Methods of Descriptive Modeling

- We can derive general principles from specific examples
- Evidence from the design process be manifested in the external world
- Evidence should be accessible to objective onlookers for study and analysis
- Design decision < – > observed outcome: word, action, design, object

Case Study Method

- Particulars of a given result and associated cases are described in detail
- Inferences about general principles of design are made based on these
- Used in management science, law and architecture

Protocol Analysis

- Hypothesis (*a priori* model) to test against human decisions
- Compare design decisions made against normative models

Protocol Analysis

- Collect protocol
- Transcribe
- Segment
- Analyze

Role of Representation in Problem Solving

- A representation makes certain aspects, attributes etc. of the represented explicit and omits or hides others – abstraction
- A representation makes certain operators possible and easy; others impossible, *ie* Roman numerals vs. Arabic numerals
- A symbolic representation consists of symbol structures + operators

Where do representations come from?

- Symbolic representation analogous to language
- Visual and auditory memory stores images and sounds
- We have multiple internal representations
- Maybe some subconscious intuitive reps

How is Problem Space constructed

- Recognize based on previous knowledge
- Heuristics for constructing problem spaces
- Trial and error learning
- Examples:
  - Missionaries & Cannibals – symbolic
  - 9 Dots – iconic
- Problem space exists in a representation that has symbols defining problem states and operators for generating and testing states

Other Approaches

- IPS hypothesis is rationalist
- Constructivism & Situated cognition
- Reflective Practice [Schön]

Reflective Practice [Schön]

Schön D. *The Reflective Practitioner*, 1983.

- Schön challenged practitioners to reconsider the role of technical knowledge versus "artistry" in developing professional excellence.
- The concept most notably affected study of teacher education, health professions and architectural design.

Reflective Practice [Schön]

Schön D. *The Design Studio*, RIBA Publications, 1985.

- Reflective practice is the capacity to reflect on action so as to engage in a process of continuous learning.
- "paying critical attention to the practical values and theories which inform everyday actions, by examining practice reflectively and reflexively. This leads to developmental insight".
- experience alone does not necessarily lead to learning; deliberate reflection on experience is essential.

Understanding Intuitive Design

Design can be viewed as

- Problem solving
  - Problem: when we have a goal that we cannot achieve right away we have a problem
- Decision making

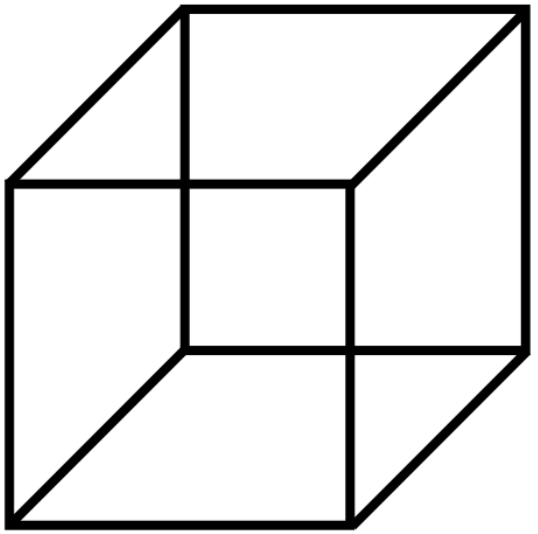
Reflective Practice [Schön]

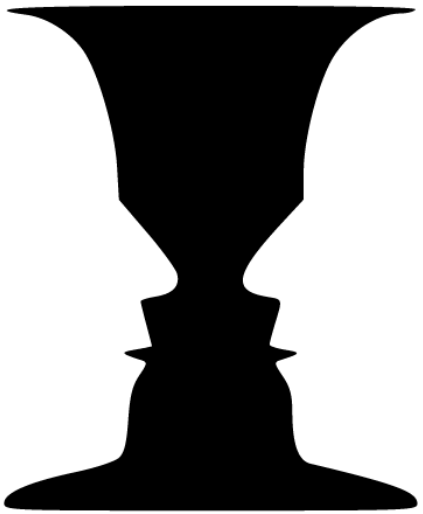
Constructivism & Situated Cognition

- Information in the environment is constructed in the course of perception
- Programs of the mind are created during the process of representing data to be processed
- Memory is a function of the situation which provokes the construction of that memory and subsequent experiences categorize and give meaning to memories
- Memory is the capability to coordinate ways of perceiving and acting

Constructive perception

Necker Cube and Rubin Vase





- Construction of meaning and language

Situatedness

- Having to construct the problem representation(s) and the problem space
- Emergence
- Creativity

Role of Representation in Design

- During the design process
- Design document for communicating the design

Role of Representation in Design

- External memory – working memory
- From Akın
- Ill-defined representations for ill-defined problems
- Sketching – actively reinterpreted every time according to constructivist situated cognition

Creativity

- Intelligence: using knowledge to solve problems
- Creativity: finding new or new and useful solutions to problems
- Constructive memory, constructive perception or constructive problem space formulation may lead to creative insight during problem solving

Blocks to Creativity

- Fear of making mistakes
- Fear of being seen as a fool
- Fear of being criticized
- Fear of being misused
- Fear of being *alone*
- Fear of disturbing tradition
- ...
- Fear of being an individual

Keys to developing creativity

- Freedom from pride
- Belief in ones ability to succeed
- Constructive discontent
- Wholeness
- Ability to escape from habit

Creative process

- Work on problem
- Incubation period
- Sudden insight
  - Archimedes
  - Kekule

Creativity

by Selçuk Erdem

The Creative Process

- Accept situation
- Analyze
- Define
- Ideate
- Select
- Implement
- Evaluate

Creativity

by Selçuk Erdem

Prescriptive Methods for Creativity

- Creativity requires both subjectivity and objectivity, feeling and knowing, wholeness
- Creative solutions are those which lead, which inspire, which provoke; which help us to imagine more advanced problems

Synectics

A method for analysis

- Forcing relationships
- How is this thing like that thing?
- What would result if you joined or combined this thing to that thing?
- What would result if a fireplace were joined to a table? *A table on which you could cook; the hearth could be a coffee table, ...*

Brainstorming

A method for generating ideas

- Group of 4 – 12 persons from different disciplines
- Everyone should be familiar with the problem
- Idea generation rules
  - Defer judgement
  - Free wheel – hang loose
  - Tag on
  - Quantity leads to quality
- Generate ideas fast
- Restrict session to 15 minutes

Rittel & Webber

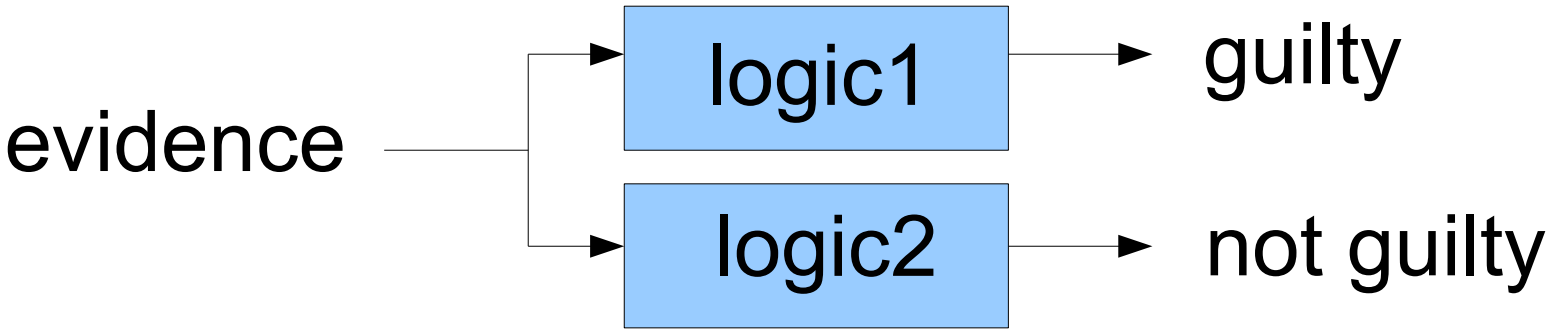
Dilemmas in a general theory of planning

- Wicked problems
  - No definitive formulation
  - No stopping rule
  - Not true-or-false but good-or-bad
  - No test of a solution
  - Every solution one shot
  - No enumerable set of potential solutions
  - Unique
  - Symptom of another problem
  - Can be explained in numerous ways

Logic

Process by which data is transformed into decisions

i.e. in court: maximal logics



Deliberation

Process of coming to a judgement

Deliberation involves listening carefully to other logics (to both sides) and properly weighing the evidence

Processing data thru opposite logics, i.e. [personal logic + maximal pro + maximal con] is better than just personal logic

Deliberation

- deliberation is better than subjective opinion
- shortcomings of personal logic
  - ignoring alternatives
  - pre-weighting alternatives (ignores data)
  - ignoring information (limits inputs)
  - ignoring goals