Material Anchors for Conceptual Blends

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Handling Conceptual Blends

- Selectively projecting structure from inputs to the blended space
- Completing the projected structure - making inferences
- Elaboration or “running the blend” - cognitive work performed within the blend.
The Need for Stable Conceptual Representations

- All labels manufactured at Pica’s custom label factory have a letter on one side and a number on the other. If a label has a vowel on one side, it must have an even number on the other. Which of the labels would you have to turn over to be sure the rule had not been violated?
Culturally Arbitrary Relations

- If x is true, then y is true (premise)
- y is not true (observation)
- ?? (conclusion)  X is not true.

- If Roger is a Bavarian, then John is tall.
- John is not tall.
- ?? (conclusion)  Roger is not a Bavarian.
Culturally Meaningful Relations

• If this rock is a garnet, then it is a semi-precious stone.
• This is not a semi-precious stone.
• ?? (conclusion)  This is not a garnet.
• Reasoning types:
  – m. ponens (P ⇒ Q, P ∴ Q)
  – m. tollens (P ⇒ Q, ¬Q ∴ ¬P)

• m. tollens is easy with culturally familiar premises, difficult with arbitrary premises.
D’Andrade’s Hypothesis

- m. tollens requires manipulation of the representation of the premises (two shifts in perspective).
- Representations of culturally familiar premises are more stable, less vulnerable to deformation, than arbitrary premises.
- Stability during processing.
Sources of stability for conceptual structure[1]

• Cultural conceptual models
  – shared (constrained by the behavior of, and need to coordinate with, other actors)
  – systematic (constrained by, perhaps over-determined by relations to other models)

• Material Anchors for Conceptual Blends
  – the structure of a physical object or event is one of the input spaces to the blend.
Fictive Motion

• “The aisle runs from the stage to the door.”
• A blend of:
  – a trajector moving between reference points
  – a static scene containing objects
• The blend creates topological correspondences between the path of the trajector and spatial features of the objects.
• It may even structure the temporal organization of the application of attention to the objects.[2]
If we are seeing the room containing stage, door, and aisle, are these sentences processed identically?

- The aisle runs from the stage to the door.
- The aisle runs from the door to the stage.
Method of Loci

• The Method Loci originates with a story: an ancient Greek poet Simonides was at a banquet given by a nobleman, Scopas. A message was brought to him that two people were waiting outside for him. While he was trying to find them, the roof of the banqueting hall fell down killing Scopas and his guests. Afterwards, relatives seeking to bury the bodies could not identify who was who. Simonides saved from the disaster, however, could remember the dining places where they sat and so identify them[24].

Blends in the Method of Loci

Emergent properties -
Sequences of locales
Control of idea sequence

Cognitive ecology -
Remembering a speech

Different Functional systems -
In the space
Remembering a space
Imagining a space
Intelligent use of Space

• “How we manage the space around us is not an afterthought; it is an integral part of the way we think, plan, and behave, a central element in the way we shape the very world that constrains and guides our behavior.”
   David Kirsh
Establishment of categories

- Sorting tasks. E.g., laundry
- Files and Piles
- Recording grades

Regions with category attributes

Category distinctions

Spatial regions
Doing the Laundry
Piles
Ad hoc piles

Unrecorded

Already recorded

Out of sequence
File Index

- Academic Affairs
- Student Affairs
- Fiscal - Budget
- Facilities - Space
- Staff Personnel
- General Administration
Controlling Mundane Action Sequences[4]

- Assembly sequence
- Standing in line

- Trajectory path
- Spatial array
- Sequentially ordered array
Remembering Assembly Sequence

- Disassemble
- Reassemble
Standing in Line

Order of arrival = order of service
300,000 years ago (Wynn, 1989) imagining a trajectory of attention to produce an ordered sequence of blows
Key Properties of Material Anchors

- One input space is a conceptual space in the usual sense.
- Another input is a structured configuration of perceptible material elements.
- Conceptual relations are mapped onto relations among the material elements.
- Stability of conceptual representation is one possible emergent property of the blend.
Giving meaning to spatial structure is an ubiquitous, effortless, and very old process.

How does it work?
Japanese Hand Calendar

(from Nakahara, 1996)

- Computing the day of the week for any date this year.
- Cognitive ecology: school placement exams
- Observe the construction of a functional system that turns a difficult conceptual task into an easy one.
- Watch for sources of stability.
A handy material anchor
Imagine seven boxes defined by joints on fingers.
Imagine the names of the months in the boxes.
Rhythmic tapping with the thumb establishes the trajectory in motor memory[5]
Now imagine the names of the days of the week in the boxes.

The arrangement of names of days of the week shown works for 2002.
Ready to compute (modulo 7).
The structure of the hand anchoring the complex blend of month and day names
Astrolabe, an early elite dial
Wind Rose
Ancient Tide Charts

Figure 3. Tidal charts of G. Brouscon.
The tide computer is constructed from a deep sequence of nested conceptual blends.
Cognitive Considerations

• Uses:
  – establish current time
  – measure elapsed time

• Why?
  – coordinate with others
  – participate in a world-wide socio-cultural system
Consistency with

- direction of movement of the shadow of a **gnomon** in the northern hemisphere.
- Roman military 12 segment watch-standing protocols
- Babylonian base-60 arithmetic (why 360° circle?)
- practical constraints of accuracy and portability (conditions of use)
- aesthetic standards, marking social status
Watch Features

- Hour Hand
- Minute Hand
- Second Hand
- Hour label
- Minute/second label
- Direction of Rotation “Clockwise”
Watch blend properties

- Conventional structure is mapped onto the physical face of the watch.
- The imagined trajector gives sequential meaning to the apparently stationary watch hands, which “go around”
- We are not able to imagine, with any accuracy, the velocity of the hands.\[6\]
Reading the Watch

Step 1: Hour 2
Step 2: Minute 16
Step 3: Second 50

2:16:50
Slide rule
Slide rule Blend

- logarithms
- Spatial extent
- Logarithmic scale
- Spatial sum of logarithms
- Spatial extent
- Spatial sum
- addition
• You can use a slide rule
• You can imagine using a slide rule
• But you cannot imagine the slide rule accurately enough to usefully imagine the computational outcome. For that, you need to manipulate the material anchor itself.
Is (spoken or written) language a Material Anchor?

Conceptual contrast set

Word as individuated pattern of sound or written shape

Word as conceptually meaningful structure
Are material anchors signs?

• Whether the item is icon, sign, or symbol depends on the nature of the cross-space mapping, thus on the contribution of the internal structure of the material medium.

• Individuation is the minimal material relation, and the symbol is the form of material anchor in which the material medium makes the minimal contribution.

• Signs are a weak form of material anchor.
Material anchors for grammatical relations?

Conceptual structure

- Modifier
- Modified

Material structure

- Position N
- Position N+1

Modifier **precedes** Modified

Material structure anchors conceptual interpretation
Dimensions in the space of MAfCBs

- Complexity of structure in material medium
- Stability or persistence of structure
- Opportunism of appropriation of structure
- Centrality of designed structure
- Extent to which structure is present/imagined/remembered
Coming to a Stop
A Design Principle

User Understanding of the Task

User Interface to the Task

Salient conceptual relations

Salient perceptual properties

Conceptual processes can be enacted in fast, robust perceptual processes. Operators can “see” the solution.
Primary Flight Display

Flight Mode
Annunciator
Why FMA symbols are not good material anchors

- Cross-space relations (between concepts of autoflight and the percepts of the display) do not support effective compressions in the blended space
- Those compressions are what produce the powerful emergent properties of a well-designed interface
- Symbols that lack interesting internal structure make poor material anchors
- Sets of symbols might work, though
Notes

• [1] Are there other sources of stability?
• [2] Does fictive motion guide the construction of mental imagery?
• [3] What cognitive processes underlie the ability to effortlessly assign meaning to regions of space?
• [4] How do we associate trajectors with regions of space? What are the neuro and computational characteristics of these processes?
• The watch has human scale materially, but not temporally.
Dissertation Topics (Free to good home)

- Articulate a theory of design for representations that is grounded in CB and D-COG theories.
- Clarify the dimensions of variation among MAfCBs and relate regions of the space to cognitive effects. (Hint: use ‘functional systems’ and ‘cognitive ecology’ concepts).
More dissertations (also Free)

- Explore the relations of MAfCBs to the theory of embodied cognition.
- Investigate the neural substrate of the fundamental processes underlying conceptual integration using MAs.
- Build a computational model of object recognition that incorporates the blending of conceptual and perceptual structure.