

Analogies as the Workhorse of Multidisciplinary Creativity and Problem Solving Christian Schunn



The challenges of doing interdisciplinary teamwork



 How will we uncover better ideas? (group think) How will we figure out which one is best?
(confirmation bias)

DIVERGENT CONVERGENT PROCESS PROCESS







My thesis:

Analogies provide support for divergence & convergence

What is analogy?



Analogy = accessing and transferring elements from familiar categories

- 1. Can be within or outside domain of problem
- 2. Factor in success of multidisciplinary teams (Dunbar, 1993)
- 3. Cognitive process (not just the source)
- 4. Creates inferences

Example in the context of engineering:

Analogy raised in designing an unsupported tube to transport liquid:

"the stuff you make Venetian blinds of for example... they can be bent."

The Cognitive Science In Vivo approach to studying team problem solving



Science + Engineering Team video





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Sampled, Transcribed, Coded line-by-line





Part 1: Analogies in Divergent Processes





Analogies in Brainstorming

- Examined analogies & ideas produced during an engineering team's brainstorming sessions (DTRS7)
- Analogies served many purposes:
 - -solution generating
 - -problem identifying
 - -function finding
 - -explanation



Ball, L. J., & Christensen, B. T. (2009). Analogical reasoning and mental simulation in design: Two strategies linked to uncertainty resolution. Design Studies, 30(2), 169–186.

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Analogies produce more ideas



Chan, J., & Schunn, C. D. (2015). The impact of analogies on creative concept generation: Lessons from an in vivo study in engineering design. Cognitive Science, 39(1), 126-155.

Analogies produce more of <u>similar</u> ideas





The powerful effects of fixation

Task: Design a spill-proof coffee mug

PLASTIC TOP





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Even expert designers fixate



- Task: design low cost peanut sheller for Africa that uses no electricity
- Subjects: PhD engineers
- Conditions:
 - -Control (just problem)
 - -Fixation (mediocre gas-powered example)



Linsey, J., Tseng, I., Fu, K., Cagan, J., Wood, K., & Schunn, C. D. (2010). A study of design fixation, its mitigation and perception in engineering design faculty. Journal of Mechanical Design, 132(4), 041003-1-12

This system uses a gas powered press to crush the peanut shell. The shell and peanut then fall into a collection bin. <u>11</u>

Even expert designers fixate





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Even expert designers fixate





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But analogies can de-fixate!

De-fixation condition: Same example + Analogies

Hull, shuck, husk, clean a deer, clean a fish, soak, heat, roast, dissolve, pod, pitt, burr, ream, bark, skin, pare apples, deplume, peel



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Part 2: Analogies in Convergent Processes

CONVERGENT PROCESS

Uncertainty — Analogies — Conflict

Mars Exploration Rovers

- Highly novel and very successful science mission
- 2 solar powered rovers
- Daily commanding on Mars time
 - Mars day = Sol = 24hrs 39min
- Mission lifetime:
 - Nominal mission = 90 sols





The Mars Exploration Rover Case

- Large multidisciplinary science team: > 100 scientists, professors, graduate students
- Five "theme" groups:
 - -Geology
 - -Geochemistry
 - -Soils
 - -Atmospheres
 - -Long Term Planning



Captured ~800 hours of video; sampled and coded ~10 hrs



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Coding Analogy



• Within-domain

- "That looks like everything we've been seeing so far in transition."
- –"Yeah, it's probably not going to look like these little spheroids, it's going to look different."

• Within-discipline

—"You see now how they jump here across the rock, and all these, I don't know if you've ever seen, like in caves or places where you get scalloping by water or something."

Outside discipline

-"[brushing two spots] shouldn't be a problem. Well, it's just a question of it's a chess game. What order do you do your move."

Coding Uncertainty



- –Search for hedge words (e.g., "I guess" "I think" "possibly" "maybe" "I believe")
- -Verify that meant as uncertainty using context
- -exhaustively double-coded (Kappa=.75)
- —"Yea, well I mean, I don't think that we can rule out that this isn't some kind of desert varnish, although I don't understand how desert varnish forms"

Analogies as a tool for resolving uncertainty in teams





Chan, J., Paletz, S., & Schunn, C. D. (2012). Analogy as a strategy for supporting complex problem solving under uncertainty. Memory & Cognition, 40, 1352-1365.

Also in design: Ball, L. J., & Christensen, B. T. (2009). Analogical reasoning and mental simulation in design: Two strategies linked to uncertainty resolution. Design Studies, 30(2), 169–186.

Coding Conflict



–Task

- -Task planning conflict
 - "No, no, no, no. If you want to do the integration on the RAT, you're going to do some additional brushing because you don't want crap in the brushing in the gravel."
- -Task science conflict
 - S2: "That's the deepest granite." S1: "no, this is the granite right there..."

–Process conflict

• S2: "...It's not a big deal to have some overlap." S1: "Well, it is to Science... they want us to cite each others' papers."

-Relationship conflict: non-existent (on tape)

Analogy as a way of producing conflict in teams





Paletz, S. B. F., Schunn, C. D., & Kim, K. (2013). The interplay of conflict and analogy in multidisciplinary teams. Cognition, 126(1), 1-19

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Analogy as a way of producing conflict in teams



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Paletz, S. B. F., Schunn, C. D., & Kim, K. (2013). The interplay of conflict and analogy in multidisciplinary teams. Cognition, 126(1), 1-19

Summary





How we influence analogizing (moderately concrete inputs)



- Studied award-winning product development team in medical plastics
- Videotaped 7 product development meetings (conceptual design)



Christensen, B. T., & Schunn, C. D. (2007). The relationship of analogical distance to analogical function and pre-inventive structure: The case of engineering design. Memory & Cognition, 35(1), 29-38.