

**DTRS 10: Design Thinking Research Symposium 2014**

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# Polysemy in Design Review Conversations

**Georgi V. Georgiev**

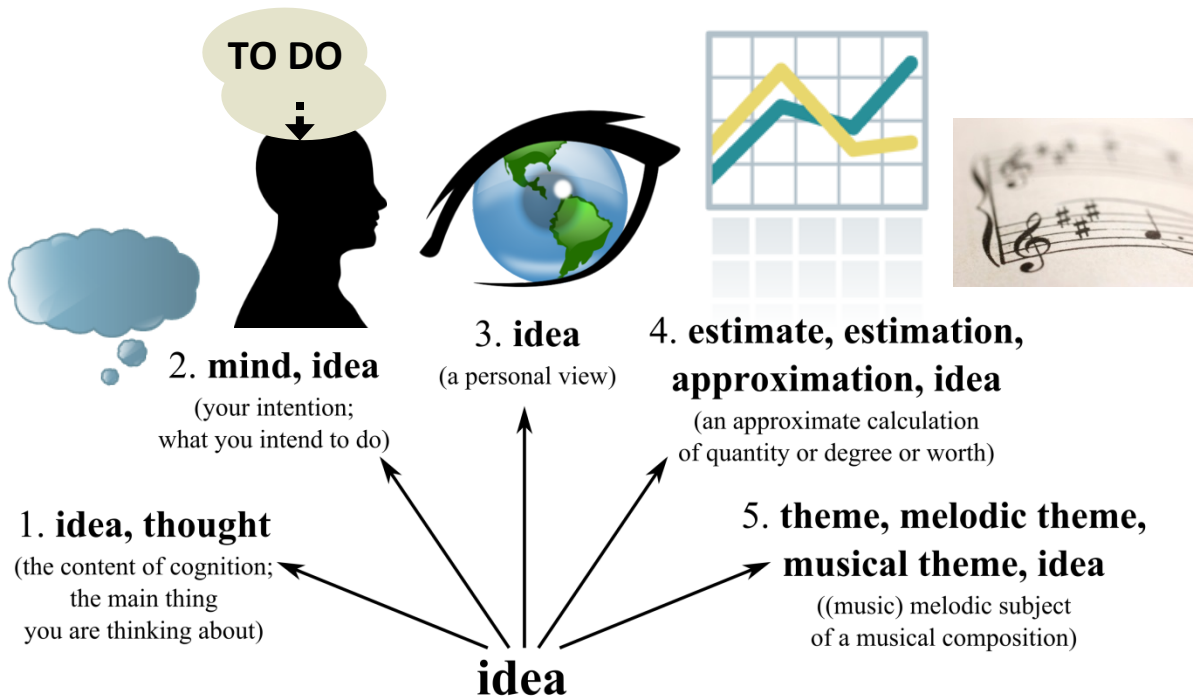
**Toshiharu Taura**

Organization of Advanced Science and Technology,  
Kobe University, Japan

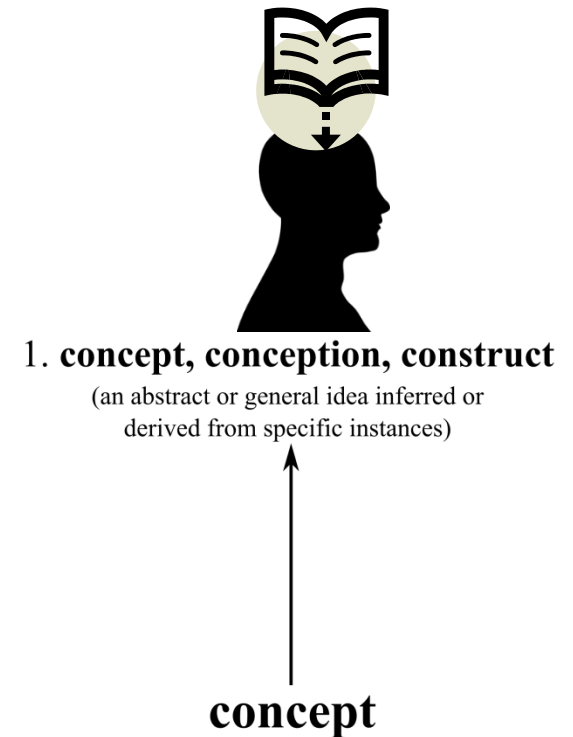
# Polysemy

The quality of having multiple meanings

Higher polysemy



Lower polysemy

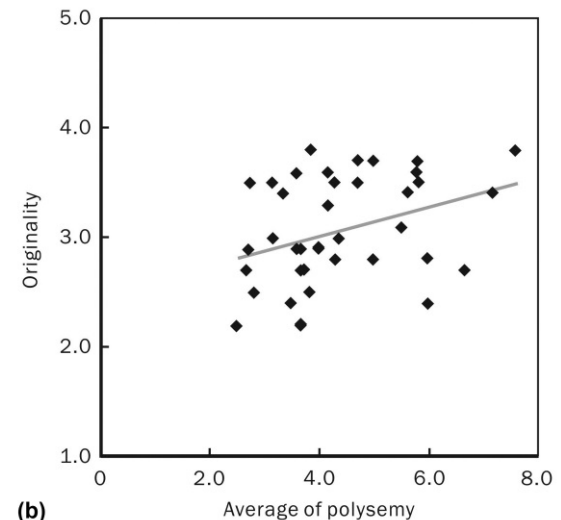


# Polysemy in design thinking

- Seen as problematic for structural accounts of meaning in design:
  - e.g. knowledge-based representations
- Connected with:
  - **Flexibility and ability to think flexibly:** polysemy is “an essential manifestation of the flexibility, adaptability, and richness in meaning potential” (Fauconnier and Turner, 2003).
  - **Association:** certain polysemy meanings are based on association.
  - **Metaphor:** metaphors are often source of polysemy.

# Polysemy and early stage of design

- Operation of polysemous concepts is a major cognitive **resource** for creativity (Fauconnier and Turner, 2003).
- Polysemy represents an opportunity for developing more **original design ideas**; thus, related to creativity:
  - Relationship between the average polysemy of design ideas and originality rating of the ideas in a concept synthesis task (Taura et al., 2012)



# Issue

- Until recently, there has not been much focus on polysemy from the perspective of design thinking.

The relation of polysemy to **teaching design thinking** has not been clarified, and the effect of polysemy on the result of the design review conversations remains an open issue.

# Research Question

- Aim is to provide insights into the role of polysemy in teaching design thinking.
- Focus on:
  - **successful development** of design ideas
  - **creative** design outcomes
- Research question:
  - Is polysemy involved in design review conversations connected to successful development of design ideas and more creative design outcomes?

# Theoretical framework

Micro-level approach

Definitions:

– *Concept about design:*

- a concept (word) that is used in conversations.

– *Polysemy of concepts (about design):*

- the quality of having multiple meanings for the different concepts. Polysemy of concepts is interpreted as the (average) polysemy of the words used in design review conversations.

# Target: Industrial Design (Grad.) dataset

Analysis focused on transcripts of the conversations and slides with the design ideas.

Student	Steps of the design review conversations				
	D-search Review	Concept Review	Client Review	Concept Reduction Review	Final Review
<b>A (Allison)</b>	x	x	-	-	x
<b>B (Eva)</b>	x	v (transcript)	v (transcript and slides)	-	x
<b>C (Julia)</b>	x	-	v (transcript and slides)	v (transcript)	v (slides of idea from the previous review)
<b>D (Mylic)</b>	x	v (transcript)	v (transcript and slides)	-	x
<b>E (Sydney)</b>	x	v (transcript)	v (transcript and slides)	-	x
<b>F (Walter)</b>	-	v (transcript)	v (transcript and slides)	v (transcript)	x



# Method of analysis on micro-level

Focus on nouns

- **Step 1.** Preparation of the data.
- **Step 2.** Identification of the part-of-speech of all words.
- **Step 3.** Identification of the number of noun meanings.
- **Step 4.** Calculation of the average polysemy of nouns.

Transcript detail	Nouns (Step 2)	Polysemy of nouns (senses identified with WordNet 3.1) (Step 3)	Parameter (Step 4)
<i>Instructor:</i> ... I see someone sitting in a – in a living room underneath a tree.	someone	1	Average polysemy of all identified nouns: 8.875
	living	4	
<i>Student D:</i> That's the point.	room	4	
<i>Instructor:</i> That's the point. So it's, it's, it's intentionally playing with this idea of being somewhere different, like, like is it the outside living room? ... [Concept Review, Student D]	tree	3	
	point	26	
	point	26	
	idea	5	
	outside	2	
	...		

# Results (polysemy and developed idea)

Student	Idea number	Noun polysemy evaluation of conversations												
		Concept Review step	Client Review step				Concept Reduction step				All identified nouns	Average polysemy of all identified nouns	Weighted average polysemy	Finally developed concept (y/n)
			Identified conversation parts in the step				Identified conversation parts in the step							
			1	2	3	4	1	2	3	4				
B	16	5.20	2.54	5.90	-	-	-	-	-	-	223	4.79	4.74	n
B	17	-	5.44	4.51	-	-	-	-	-	-	78	4.97		n
B	18	-	4.19		-	-	-	-	-	-	42	4.19		n
B	19	-	4.45		-	-	-	-	-	-	22	4.45		n
B	20	-	5.36	4.51	-	-	-	-	-	-	145	5.13	5.13	y
C	11	-	6.20	4.50	-	-	-	-	-	-	29	5.38	4.67	n
C	12	-	5.63	5.40	-	-	-	-	-	-	31	5.52	(includes *)	n
C	13	-	5.53	5.41	-	-	3.57	4.65	4.47	-	136	4.72		n
C	14	-	2.61	1.00	4.91	-	5.17	-	-	-	49	3.86		n
C	14A	-	-	-	-	-	4.85	3.43	4.49	4.38	202	4.47	4.47	y
C	15	-	4.74	3.42	-	-	-	-	-	-	31	4.23	*	n
D	1	-	4.31	4.23	-	-	-	-	-	-	135	4.27	4.75	n
D	2	-	4.62	5.41	-	-	-	-	-	-	72	4.81		n
D	3	-	4.76	-	-	-	-	-	-	-	54	4.76		n
D	4	-	6.09	-	-	-	-	-	-	-	44	6.09		n
D	5	5.29	3.98	4.37	-	-	-	-	-	-	847	5.13	5.13	y
E	41	4.97	3.83	4.65	-	-	-	-	-	-	173	4.79	4.79	y
E	42	-	4.13	-	-	-	-	-	-	-	24	4.13	4.74	n
E	43	-	3.25	-	-	-	-	-	-	-	16	3.25		n
E	44	-	6.45	-	-	-	-	-	-	-	22	6.45		n
E	45	-	3.89	5.02	-	-	-	-	-	-	80	4.75		n
F	6	6.66	5.54	4.52	5.81	-	4.11	4.50	-	-	521	5.26	5.26	y
F	7	3.81	5.12	3.90	-	-	-	-	-	-	169	4.21	4.28	n
F	8	3.81	4.79	5.73	4.57	5.81	3.33	-	-	-	409	4.34		n
F	9	3.76	4.11	-	-	-	-	-	-	-	73	4.03		n
F	10	4.32	4.14	-	-	-	-	-	-	-	319	4.29		n

Student	Idea number	Average Polysemy	Weighted Av. Polysemy	Finally developed idea
B	16	4.79	4.74	n
B	17	4.97		n
B	18	4.19		n
B	19	4.45		n
B	20	5.13	5.13	y
C	11	5.38	4.67	n
C	12	5.52	(includes *)	n
C	13	4.72		n
C	14	3.86		n
C	14A	4.47	4.47	y
C	15	4.23	*	n

Four out of five cases of students: the average polysemy of finally developed concept is greater than the average /weighted average polysemy for not developed concept.

# Results (polysemy and creativity)

Student	Idea number	Summary of noun polysemy evaluation		Average creativity evaluation			
		Average polysemy of all identified nouns	Weighted average polysemy	Originality	Practicality	Creativity (Originality & Practicality)	
B	16	4.79	4.74	3.25	2.65	2.95	
B	17	4.97		2.75	4.15	3.45	
B	18	4.19		4.25	2.85	3.55	
B	19	4.45		2.75	2.95	2.85	
B	20	5.13	5.13	3.25	3.45	3.35	
C	11	5.38	4.67 (includes *)	3.75	3.95	3.85	
C	12	5.52		4.25	2.65	3.45	
C	13	4.72		3.50	3.70	3.60	
C	14	3.86		3.00	4.00	3.50	
C	14A	4.47	4.47	4.00	3.40	3.70	
C	15	4.23	*	4.00	2.80	3.40	
D	1	4.27	4.75	2.50	3.30	2.90	
D	2	4.81		3.50	3.50	3.50	
D	3	4.76		2.50	3.50	3.00	
D	4	6.09		3.75	2.55	3.15	
D	5	5.13	5.13	3.75	4.15	3.95	
E	41	4.79	4.79	3.00	4.40	3.70	
E	42	4.13		4.74	3.75	3.75	3.75
E	43	3.25		3.25	3.25	3.25	3.25
E	44	6.45		2.50	3.70	3.10	
E	45	4.75		2.50	3.30	2.90	
F	6	5.26		5.26	4.00	3.20	3.60
F	7	4.21		4.28	4.00	2.80	3.40
F	8	4.34		3.00	3.80	3.40	
F	9	4.03		3.75	2.95	3.35	
F	10	4.29		3.25	2.45	2.85	

Creativity was evaluated by four judges using a 5-point scale of originality and practicality (Finke et al., 1992).

Student	Idea number	Average Polysemy	Weighted Av. Polysemy	Creativity (Originality & Practicality)
E	41	4.79	4.79	3.70
E	42	4.13	4.74	3.75
E	43	3.25		3.25
E	44	6.45		3.10
E	45	4.75		2.90
F	6	5.26	5.26	3.60
F	7	4.21	4.28	3.40
F	8	4.34		3.40
F	9	4.03		3.35
F	10	4.29		2.85

Ideas with higher polysemy were with high creativity.

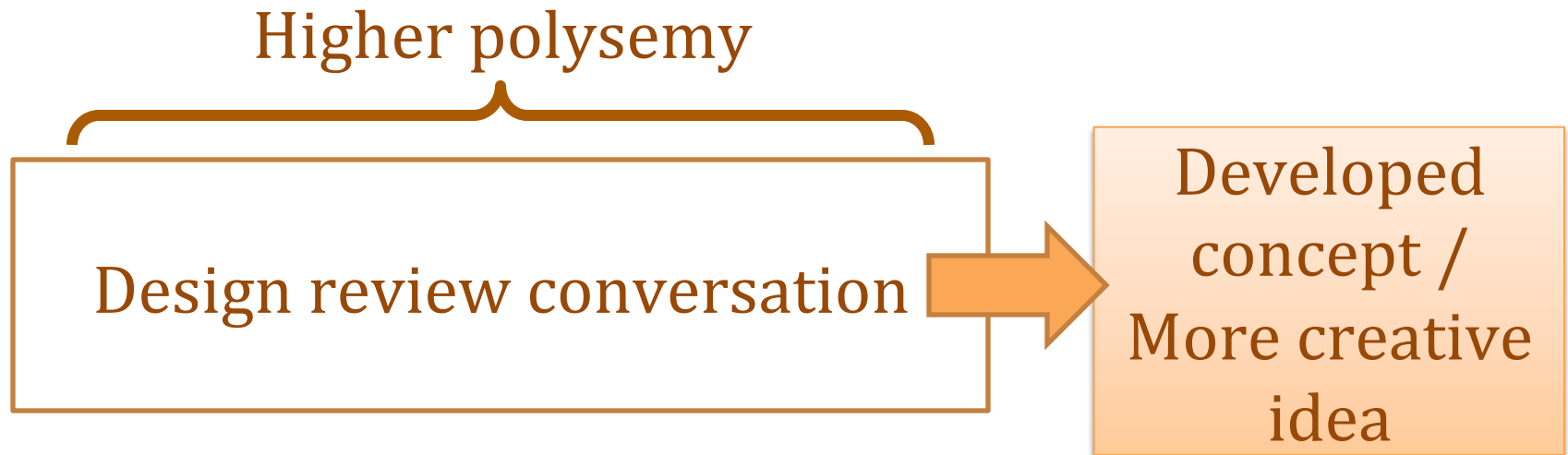
# Discussion

- **Four out of five cases** of students show that the value of the average polysemy of for finally developed concept is **greater** than the average polysemy and weighted average polysemy for concepts that were not developed.
- Furthermore, ideas with **higher polysemy** of conversations were with high creativity:
  - e.g. in one case the most polysemous - the most creative.

Tendency for ideas generated in design review conversations characterized with higher polysemy to be successfully developed and to exhibit high overall creativity.

## Discussion (cont.)

- Polysemy can capture an **unintentional aspect** of the design review conversations.
- On the basis of the results, a **hidden characteristic** of the conversations is expected to be identified.



# Limitations

- English was not the **native language** of some of the participants. (May have influenced their speech and consequently the analysis.)
- The analysis used an **automated method** for the detection of part-of-speech and consequently noun senses. An analysis method in which these steps are manually performed or supervised may yield greater insights.
- Creativity was **evaluated** by four judges only.
- Does not account for the **intersubjectivity of meaning** between the various participants (Dong, 2009).

# Further work

- **Macro-level** investigation of polysemy
- More detailed investigation of the **time-scale** developments of individual design ideas and individual participants.
  - The particular research question here is if the polysemy in the time scale can be connected with particular characteristics of the conversation or features of design ideas (e.g. critical moments (Sonalkar et al., 2014; or approach focusing on noun classes (Akin & Awomolo, 2014))).

# Summary and implications

- Examined the role of polysemy in design review conversations and revealed connection with **developed concepts / more creative ideas**.
- Can be used as a teaching tool for design thinking —specifically, instruction on how to successfully develop design ideas and how generate design ideas with greater creativity with the help of polysemy (e.g., through design briefs, design descriptions, stimuli, background information)



# Thank you very much

georgiev@mech.kobe-u.ac.jp

## References:

Akin & Awomolo (2014) A Discursive Approach to Understanding Dependencies between and Integration of Design Actions, DTRS10.

Dong, A. (2009). The Language of Design. Springer.

Fauconnier G., & Turner M.B. (2003). Polysemy and Conceptual Blending. In Polysemy: Flexible Patterns of Meaning in Mind and Language, Edited by Brigitte Nerlich, Vimala Herman, Zazie Todd, and David Clarke. Berlin & New York: Mouton de Gruyter, 79-94.

Finke, R. A., Ward, T. B., & Smith, S. M. (1992). Creative cognition: Theory, research, and applications.

Sonalkar, Mabogunje & Leifer (2014) Analyzing the display of professional knowledge through interpersonal interactions in design reviews, DTRS10.

Taura, T., Yamamoto, E., Fasiha, M. Y. N., Goka, M., Mukai, F., Nagai, Y., & Nakashima, N., (2012). Constructive simulation of creative concept generation process in design: a research method for difficult-to-observe design-thinking process. Journal of Engineering Design, 23(4-6), 297-321.