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A Theory of Modal Thinking in Design

C. H. ,Burnette

University of the Arts,Philadelphia,United States

charlesburnette@COMCAST.NET

Introduction

No theory of design thinking is operationally formulated to represent the dynamic resolution of a design appropriate to the needs of a situation in the many ways in which designing occurs. Efforts to apprehend design thinking have been largely conceptual, Nelson & Solterman (2003) and anecdotal, Rowe (1987) Lawson (1990), Principles of design have been articulated primarily to educate or guide practitioners. Alexander, Silverstein, Angel, Ishikawa & Abrams (1988). Research has focused on behavior during studio teaching of design, Porter & Kilbridge, (1981) , Goldschmidt (2002) and on particular issues such as design strategy, Cross (2001), case based reasoning, Kolodner (1993) or the mediation and flow of information, Archer (1965) Useful techniques have been proposed and demonstrated by practitioners in group dynamics and problem solving, Gordan (1961) Prince (1982), Butan (1989), and DeBono (1999) and very general models such as "analysis, synthesis, and evaluation" have been posited as representing the design process. While informative, these contributions do not offer a sufficiently detailed, dynamically formulated, comprehensive and universally applicable model on which to base design research, computer modeling and education. In this paper a theory of modal thought that appears to have the capacity to address this complex challenge is suggested.

The proposed theory is philosophically grounded in the view that a designer takes different intentional stances, Dennett (1996), to address a design project or task based on the needs they perceive there. In the theory, different intentional stances are presumed to be motivated by different aspects of the focal situation; each stance addresses a particular aspect of the situation and engenders a specialized mode of thought to resolve the anomolies in the information with which it is concerned. People think differently when managing projects, seeking or defining information, conceptualizing possibilities using that information; formulating, expressing or communicating their concerns, or when they take action, evaluate outcomes or build knowledge for later use. Seven modes of thought, each focused on one of these tasks are proposed:

Intentional thought

Thought that directs the flow of thinking is essential to purposefulness and the exercise of will regarding any subject, situation or activity. Intentional thought focusses, prioritizes and directs thought to achieve an

acceptable resolution of a situation. Intentional thought is motivated by the desire to address a need in some situation of interest. People apply intentional thought to pursue their goals - whether to voice a word, design a building, or fly a plane. Everyone applies intentional thought at different levels for different purposes, managers and directors emphasize this mode of thought. Intentions depend on how the thinker understands what their task is "about", and what they can do regarding the conditions they face. The purpose of intentional thought is to establish goals and to manage thought and action so as to acheive them.

One deliberately thinks in an intentional way by adopting an intentional stance toward a subject or situation that has been interpreted through the recall of prior knowledge and then:

1. determining what goals are to be pursued to change the current subject or situation into a preferred one;
2. selecting and prioritizing elements of the subject or situation pertinent to these goals;
3. modeling these elements for organization or analysis to best achieve the goals;
4. formulating how the favored idea or approach should be expressed to best represent, explain or resolve the situation;
5. pursuing the formulated plan of action to change the subject or situation in the manner proposed;
6. evaluating the outcome to determine goal attainment.
7. remembering the episode of intentional thought for future reference and to learn from it.

Referential thought

Referential thought is the means by which elements in a situation are identified and characterized as objects of thought. Thought that enables identification and semantic specification of elements in a situation is necessary to define an intention regarding it and to its description, structuring, communication, processing, evaluation and recall. There would be no design without the capacity to linguistically identify and semantically define what is involved. People normally use referential thinking when they pay attention to individual things or features of things, use words and symbols to identify them, articulate information about them, image their features and properties, identify actions or functions of which the referent is capable, specify criteria by which to evaluate it and remember or recall the acquired meaning, form or use of a particular word, symbol or object.

The goals of referential thought are to identify, label and sprcify the objects of thought.

One deliberately thinks in a referential way by adopting a referential stance regarding a subject or situation and then:

1. directing attention toward recognizable yet unresolved information in a situation
2. identifying, and defining the selected referents by name, symbols, descriptors, meaning and prior use;
3. conceiving how these linguistic elements might be categorized, ordered, or edited to support an intentional goal regarding the subject of interest;
4. formulating how discrete elements might interpret or express the intention regarding a situation;

5. identifying the functional properties and actions that would govern the use of each referent in the situation;

6. assessing the probable value of each referent for achieving the intended goal;

7. remembering or documenting the identifiable objects in the problematic situation.

Relational thought

Relational thought is the name given to the cognitive processes by which people organize, manipulate, and analyze their ideas. It is concerned with how referential objects of thought are structured, explored and compared. Relational thought is necessary to organize, conceptualize, postulate about, represent, process, analyze and remember the structure of an experience. Complex things must be abstractly modeled in order to be apprehended, described, structured, expressed, manipulated, assessed, and understood. Because it can be applied in creative ways and for constructive and propositional purposes, the analytic capacity of Relational thought is often overlooked.

The goals of relational thought are to associate, organize, and analyze elements of interest to produce a structured representation of an idea, proposition or approach.

One deliberately thinks in a relational way by adopting a relational stance toward a subject or situation that has become the focus of an intention and by:

1. determining the kind of relationships called for by the intention and the organizational or analytic goals to be met regarding the situation.

2. selecting relations appropriate to the referential objects and goals regarding the situation

3. modeling the relationships between selected referential objects to represent or explore the focal situation;

4. formulating how such conceptual models map onto the situation for purposes of interpretation, expression or communication;

5. implementing functional relationships as network models that could transform the situation if executed;

6. analysing the relational model to anticipate how it would change the subject, situation or intention regarding it; and

7. remembering or documenting episodes of relational thought to capture conceptual models, spatial organizations, functional models and analytical structures for future use.

Formative thought

Thought that focuses, interprets, integrates and expresses what is in the mind is essential to communication and interaction with the world. Formative thought compresses, blends, and gives meaningful form at a human scale to information to interpret a situation or express a thought. It is the mode through which the form, meaning and affect of a thought is experienced, comprehended, resolved, represented and communicated.

The goals of Formative thought are to interpret, express and communicate a situation and its resolution through meaningful forms that affectively represent them for communication and interaction.

Formative thought is undertaken after information used in similar situations in the past has been recalled to interpret the current situation but has proved inadequate. It is undertaken by adopting a Formative stance and:

1. formulating an intention to resolve and express the anomalies that remain.

2. attending to the elements or factors that need to be composed, compressed and synthesized in form and meaning;

3. structuring and analysing disparities in the attended information and opportunities for expressing its resolution;

4. formulating how the situation is to be blended, expressed and communicated at a human scale.

5. producing the formulation in the medium, manner and context chosen;

6. affectively and critically evaluating the affects of the interpretations or expressions that are produced against what was intended; and

7. remembering or documenting for future reference the forms and meanings that characterize the formative thought.

Procedural thought

Thought that executes actions is essential to producing an intended change in a situation.

Procedural thought implements and executes processes to achieve an intended goal. Tasks such as project management, gathering information, conceptual modeling and analysis, project or product presentation, document preparation, prototyping or production, critical review and feedback are processes with different goals and constraints by which project objectives are attained.

The goal of procedural thought is to effectuate intentional change.

One deliberately thinks in a procedural way by adopting a procedural stance toward a subject or situation and then by:

1. establishing what the preferred outcome of a process will be;

2. identifying the actors, actions, resources and criteria that could affect the outcome;

3. conceptualizing how these elements might be organized, mediated and managed to achieve the outcome;

4. formulating a program or plan of action using a medium or technology appropriate to the situation and goals:

5. executing the program, plan or process to change the targeted situation in the prescribed manner;

6. evaluating change to determine progress or if the objective has ben attained or produced.

7. remembering or documenting the entire episode of procedural thought to inform future processes

Evaluative thought

Thought that enables the critical assessment and feedback of procedural outcomes is essential to the determination of progress and to attaining an intended goal. It is exercised whenever opinions, judgments, tests and measurements are made to assess the consequences of an expression, action or change. It is the mode through which expectations, critical thinking, and values are realized.

Its goals are to measure, judge, and value in order to provide feedback and closure for intentional thought.

One deliberately thinks in an evaluative way by adopting an evaluative stance toward a subject or situation and then:

1. determining what goals regarding the subject or situation are currently operative;

2. selecting criteria by which the goals can be evaluated;

3. conceiving how these criteria can be organized to assess goal attainment;

4. formulating how the evaluation will be made and communicated under the circumstances;

5. comparing the value of the criteria with the results obtained through procedural thought or action;

6. valuing the difference between criteria and outcome to see if the goal has been attained; and. if so, terminating the process of evaluation.

7. remembering or documenting the episode of evaluative thought for future reference.

Reflective thought

Thought that enables the retention, assimilation and adaptive recall of information from prior thought is essential to learning and the effective application of what is learned. Remembering, recognizing, assimilating, generalizing, recalling, adapting, and understanding are all accomplished through reflective thought.

Its goals are to remember, adapt and recall in order to learn, understand, and apply knowledge

One deliberately thinks in a reflective way by adopting the goal of reflecting on a subject, situation or experience and then by:

1. **recalling the goals that were operative regarding the intentional situation;**

2. **selecting features in the just concluded episode to be remembered;**

3. **matching and adapting this information to existing knowledge;**

4. **searching for and recalling information relevant to the situation of concern;**

5. **producing an interpretation of the situation based on recalled or retrieved information;**

6. **evaluating the reflective interpretation to determine if it brought better resolution or understanding to the situation; and**

7. **commiting the conclusions of reflective thought to memory.**

Note that 1-3 constitute "reflection-on-action" and 4-6 constitutes "reflection-in-action", (Schön, 1987) while 7 involves the integration of current and prior thought.

It should be evident from the outlines above that all seven modes of thought have been interpreted as subordinate modes to carry out a modal intention.

All seven modes of thought are used regularly during design. Consider the design of a typeface for a specific use. First the designer would recall what is known about typefaces used in similar situations (Feelings and forms are recognized, interpreted and appreciated by recalling prior examples of their use through Reflective thought) The designer would then clarify their goals regarding the design of the new typeface through Intentional thought. (This typeface should look more authoritative, etc.) Problematic elements in the situation would be identified through Referential thought. (That bold serif is part of the problem, etc.-) and their interrelationships explored through Relational thought (If the shape of the serif changed it would affect these other letters and their spacing, etc) Sensabilities appropriate to the situation are invoked and imagined through Formative thought (This is what a word in this typeface will look like, etc-). A tentative design is produced through Procedural thought (the form of the serif is changed) and then assessed through Evaluative Thought (The spacing is too great there, the affect is not authoritative enough, etc-) until the intent regarding the situation is satisfied and significant features of the experience can be remembered for future use. (The fourth attempt worked! This typeface would also be useful for… etc).

The seven modes of thought, acting to acheive their particular goals, collaborate to achieve the common goal of resolving a motivating situation. This is analogous to the collaborative work of a seven member design team in which each member has a different responsibility in achieving shared project goals. In the proposed theory, once an intention is motivated by a situated need, an identifiable frame of reference called an "intentional frame" is created in which the thought is developed. All the thought and effort to achieve the goals of the intention unfold within this frame of reference or are indexed to it.
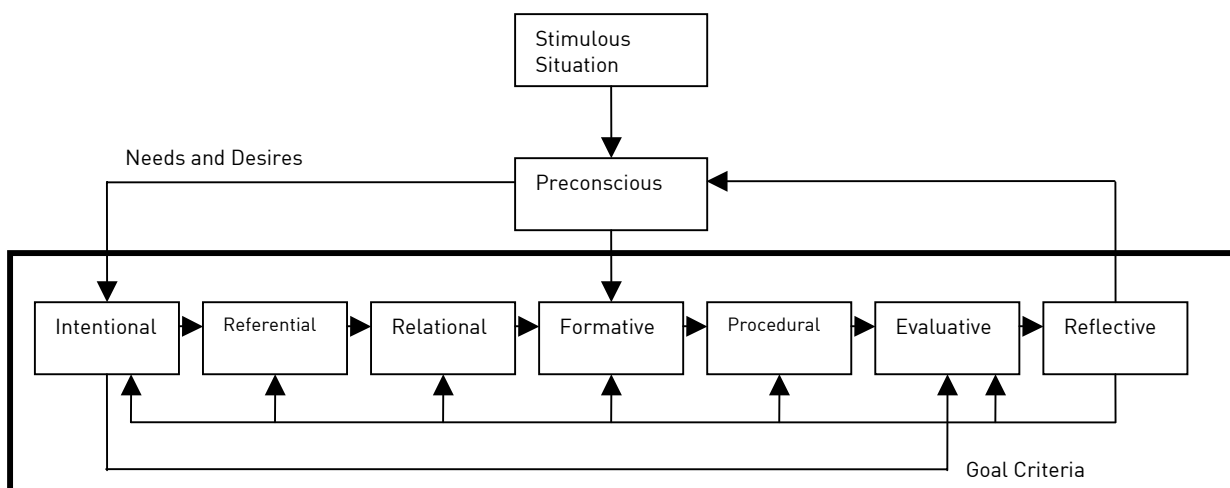
Intentional Frame

(The arrows in the diagram indicate the flow of information not necessarily the sequence of thought.)

Just as the goals of a design team occur within the frame of reference afforded by their shared project, a purposeful thought is "framed" in terms of its motivating intention. This may operate at any level for any subject. For example, if one is "designing" what to say in response to a question, the modes of thought collaborate within that problematic framework to formulate the response. It is the problematic situation, relevant background knowledge, and goals relative to it that determines what the thought is about.

Like design projects, thoughts contain many subordinate thoughts that constitute a cascade subgoals. For example, drawing the facade of a building generates a need to draw the elements that make up the façade; a written paper generates the need for paragraphs that generate the need for sentences, etc. Each subordinate goal has different objectives than the primary goal but helps achieve the goal of the parent intentional frame. Each generates an intentional frame of its own within which subordinated modes of thought collaborate. This heirarchy of intentional frames goes on until anomolies at all levels are resolved. Closure of frames occurs when its goal is achieved or dismissed - a condition recognized by Evaluative thought within the frame. This realization is manifested as a meaningful form that expresses the resolution of the problematic situation that generated the frame. Each subordinate resolution lcontributes to resolution at higher levels until the original situation is resolved (ie the drawing is finished; the paper is completed, the design realized, etc.) Recall of prior solutions to similar needs facilitates and speeds this resolution.

A computational structure for such a model has been previously presented (Burnette, 2002) but is shown again to give some idea of how the theory could be computationally implemented for use in design practice or research. The diagram is in the Universal Markup Language used in software development. Kobryn (2000)
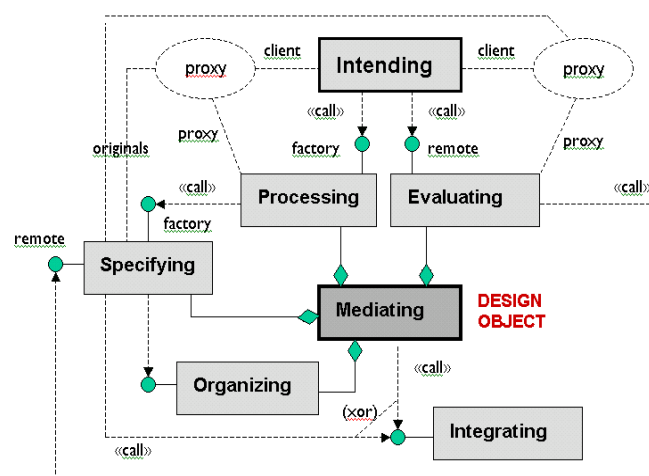
The significance of this theory is that it provides an operationally conceived model of design thinking with the potential to follow the focus of thought during design. The cognitve basis for this theory has been developed and is being prepared for publication as are practical applications in different areas of design. An educationally oriented manifestation of the theory can be found at www.idesignthinking.com.

References

Alexander, C., Siverstein, M, Angel, S., Iswhakawa, S. & Abrams, D. (1988) *The Oregon Experiment*, Oxfrord Uiniversity Press

Archer, L.B. (1965) *Systematic Methods for Designers,* London: Council of Industrial Design, reprinted from Design, No. 172-188, April 1963 to August 1964.

Burnette, C.H. (1982*) A Role-Oriented Approach to Problem Solving*, in Olsen, S. (ed.) Group Planning and Problem Solving Methods in Engineering Management, Chapter 10 pp. 300-316 NY: Wiley

Burnette, C.H. (2002) *Intentionality and Design,* Proceedings, Common Ground Design Research Society International Conference, Durling, D. and Schackleton, J. (eds) Stoke on Trent, UK Stafordshire University Press

Buzan, T. (1989) *Use Both Sides of Your Brain* (3rd ed), New York: Penguin Books

Cross, N. (2001).”Strategic Knowledge Exercised by Outstanding Designers” in J.S. Gero and K. Hori, eds 2001, *Strategic Knowledge and Concept Formation III*, Sydney: Key Centre of Design Computing and Cognition, University of Sydney: 17-30

Cross, N. 2001.”Strategic Knowledge Exercised by Outstanding Designers” in J.S. Gero and K. Hori, eds 2001, *Strategic Knowledge and Concept Formation III*, Sydney: Key Centre of Design Computing and Cognition, University of Sydney: 17-30

deBono, E.(1999) *SixThinking Hats*, New York, Penguin Books

Dennett, D. (1996) *Kinds of Minds*, NY: Basic Books

Goldschmidt, G. (2002) *One on One':A pedagogic base for design instruction in the studio,* Proceedings, Common Ground Design Research Society International Conference, Durling, D. and Schackleton, J. (eds) Stoke on Trent, UK Stafordshire University Press

Gordon, W.J.J. (1961) *Synectics*, New York: Harper and Row Kobryn, C.: 2000, Modeling Components and Frameworks with UML, *Communications of the ACM*, 43(10), 31–38.

Kolodner, J. (1993) *Case Based Reasoning*), San Mateo,CA: Morgan Kaufman

Lawson, B. (1990) *How Designers Think* (2nd Ed.) Oxford: Butterworth Architecture

Nelson, H.G. & Solterman, E. (2003) *The Design Way*. Englewood Cliffs, N.J.: Educational Technology Publications

Norman, D. A. (1969) *Memory and Attention*, New York, John Wiley & Sons

Porter, W.L & Kilbridge, M. (1981) Sponsored by the Consortium of East Coast Schools of Architecture *Architecture Education Study, Volume 1: The Papers, Volume II: The Cases,* Cambridge: Andrew W. Mellon Foundation

Prince G. M. (1982) Synectics, in Olsen,S. (ed) Group Planning and Problem-Solving Methods in Engineering Management, Chapter 11, pp 317- 364, NY:Wiley,

Rowe, P. G. (1987) *Design Thinking*, Cambridge, MA: M.I.T. Press

Schön, D., 1987. *Educating the Reflective Practitioner*, San Francisco: Jossey-Bass Publishers