Abductive Thinking and Sensemaking: The Drivers of Design Synthesis

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Overview: Making Sense of Chaos

each user about their jobs and record details of their responses. The designer might also take screen shots or photographs of the tools being used, and probe for details about each item. The designer will then return to the design studio. In the privacy of his or her natural work place, the designer will attempt to make sense of what he or she has learned. The goal is to find relationships or themes in the research data, and to uncover hidden meaning in the behavior that is observed and that is applicable to the design task at hand.

The user research sessions will produce pages of verbal transcript, hundreds of pictures, and dozens of artifact examples. Because of the complexity of comprehending so much data at once, "Fieldwork, theory, and evaluation data provide systematic input to and performs only rudimentary sensemaking. The design output and solutions can be unique, novel, and even exciting, but because there is no artifact-based procedural trail, the client isn't aware of the various internal deliberations that have occurred. After encountering several design projects that include implicit design synthesis, a client may proclaim that they don't see the value in a discovery phase for future design activities. They are, of course, right: they didn't see anything of value, and so they assumed the phase to be a waste of resources.

Design consultancies don't plan for, assign resources to, or appropri-
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Sensemaking

Klein, Moon, and Hoffman define sensemaking as "a motivated, continuous effort to understand connections (which can be among people, places, and events) in order to anticipate their trajectories and act effectively."[5] This definition builds on Brenda Dervin's much more abstract description. Dervin explains that "Sense-Making reconceptualizes factizing (the making of facts which tap the assumed-to-be-real) as one of the useful verbings humans use to make sense of their worlds." [6] In plain language, both definitions position sense-making as an action oriented process that people automatically go through in order to integrate experiences into their understanding of the world around them.

Common to all methods of synthesis is a "sense of getting it out" in order to identify and forge connections. This is an attempt to make obvious the sensemaking conditions described above; emphasis is placed on finding relationships and patterns between elements, and forcing an external view of things. In all of the methods, it is less important to be "accurate" and more important to give some abstract and tangible form to the ideas, thoughts and reflections. Once externalized, the ideas become "real"—they become something that can be discussed, defined, embraced, or rejected by any number of people, and the ideas become part of a larger process of synthesis. Essentially, sensemaking is an internal, personal process, while synthesis can be a collaborative, external process.

The data that has been gathered from contextual research will often take many forms; designers gather and create photographs, video clips, transcripts, magazine clippings, and other artifacts related to the problem or opportunity context. In an effort to maintain some sense of coherence, designers frequently attempt to horde the content in their laptop—the digital format allows for ease of organization in the form of files, folders, and databases. This digital structure is, however, arbitrarily imposed by the constraints of the popular software tools and operating systems. The physical limitation of the laptop (the size), combined with the digital limitations of the software (the organizational schema), dramatically limits the designers' ability to see the forest for the trees: they lose the ability to understand the research in totality and are limited in their ability to freely manipulate and associate individual pieces of data.

Synthesis requires a designer to forge connections between seemingly unrelated issues through a process of selective pruning and visual organization. Because of the vastness of data gathered in even a simple design problem, the quantity of data that must be analyzed is often too large to hold in attentive memory at one time, and so a designer will externalize the data through a process of spatialization. The tools that allow for this are presently quite limited—a big wall, a marker, and lots of sticky notes are some of the most common tools used by designers for this process. These tools help the designer gain a strong mental model of the design space; the

5 Gary Klein, Brian Moon, and Robert Hoffman, "Making Sense of Sensemaking 1: Alternative Perspectives." Intelligent Systems

externalization of the research data allows for a progressive escape from the mess of content that has been gathered.

Once the data has been externalized and the literal mess begins to be reduced, the designer begins the more intellectual task of identifying explicit and implicit relationships, physically drawing out these content-affinities through the process of organization. The

faceted, complex, and rooted in culture. Thus, it may be necessary to duplicate content (to allow it to connect to multiple groups), or to abandon or rearrange already established groupings several times during this process.

Once the groupings begin to emerge through the process of organization, the groupings can be made explicit by labeling them. The grouping label captures both the literal and the implied contents of the group—it makes obvious the meaning that has been created through the process of organization.

Frequently, designers will spend a great deal of time creating a war-room style wall of data, organizing and pinning the material up in the manner described above—and then ignore this content for

now be freely moved and manipulated, and the entire set of data can be seen at one time. Implicit and hidden meanings are uncovered by relating otherwise discrete chunks of data to one another, and positioning these chunks in the context of human behavior.

Abduction

Synthesis is an abductive sensemaking process. Abduction can be thought of as the "step of adopting a hypothesis as being suggested by the facts . . . a form of inference."[7] To better understand abduction, it's necessary to understand the duality of the forms of logic that have been more traditionally embraced by western society in argument: deduction and induction.

A valid deductive argument is one that logically guarantees the truth of its conclusion, if the premises that are presented are true. This is the form of logic that is traditionally taught in mathematics courses and manifested in logic proofs:

A is B.
All Bs are Cs.
A is, deductively, C.

This form of logic is one that is self contained, and any argument that uses deduction is one that cannot offer any new findings in the conclusions—the findings are presented in the premises that hold the argument to begin with. That is, A, B, and C all exist in the premises that were presented.

An inductive argument is one that offers sound evidence that something might be true, based on structured experience. This is the form of logic traditionally associated with scientific inquiry:

Each time I do A under the same conditions, B occurs.
Inductively, the next time I do A under these conditions,
B will occur.

Subsequent experiences may prove this wrong, and thus an inductive argument is one where the premises do not guarantee the truth of their conclusions. Like deduction, induction cannot offer any “new findings” contained within the logic of the argument.

Abduction has been described by Roger Martin (Dean of the Rotman School of Management) as the “logic of what might be,” and while this certainly serves to embody this logic in the context of design, it isn’t entirely accurate. Instead, abduction can be thought of as the argument to the best explanation. It is the hypothesis that makes the most sense given observed phenomenon or data and based on prior experience. Abduction is a logical way of considering inference or “best guess” leaps. Consider the example When I do A, B occurs:

I’ve done something like A before, but the circumstances weren’t exactly the same.
I’ve seen something like B before, but the circumstances weren’t exactly the same.
I’m able to abduct that C is the reason B is occurring.

designer's work and life experiences—and their ease and flexibility with logical leaps based on inconclusive or incomplete data—begin to shape the abduction. Abduction acts as inference or intuition, and is directly aided and assisted by personal experience. Yet the personal experience need not be with the specific subject matter of the design problem. The abduction itself can be driven by any design or cultural patterns that act as an argument from best explanation. As described by Peirce, "The abductive suggestion comes to us like a flash. It is an act of insight, although extremely fallible insight. It is true that the different elements of the hypothesis were in our minds before; but it is the idea of putting together what we had never before dreamed of putting together which flashes the new suggestion before our contemplation." [9]

Johnson-Laird has argued contradictorily that, in the context of generative and creative problem solving, the insight is developed not in a "flash" at all. Instead, a four step process leads to an insight, which only seems to appear instantly:

The current problem solving strategy fails to yield a solution, given the existing constraints.

There is a tacit consideration of the new constraints in the strategy.

The constraints are relaxed (or changed) in a new way, thus broadening the problem space and allowing for further consideration.

Many changes in constraints lead nowhere, but, with perseverance, a change may be made that leads at once to a solution of the problem. [10]

Both Peirce and Johnson-Laird agree that abductive reasoning is related to insight and creative problem solving, and it is this creative problem solving that is at the heart of the design synthesis methods that follow.

II. Applied: Methods of Synthesis

A Synthesis Framework

The logical and cognitive background described above points to an

The scale of importance is subjectively derived (but identified in a “reasonable” manner—not arbitrarily), but the use of this scale is then generally objective. (Within the system each element is compared on a consistent basis.) Data prioritization will eventually identify multiple elements that can be seen as complementary, and thus a hierarchical data structure is created.

Judging. Not all of the data identified in a discovery process is relevant. The process of synthesis forces the definition of relevance, as the designer will pass the gathered data “through a large sieve” in order to determine what is most significant in the current problem

> An average person, in their bathroom, using a physical item with small bristles on the end to apply paste to their teeth; that individual will likely then produce friction with the physical item, the paste, and the teeth in order to eliminate food.

Note that this frame describes a person, a setting, and an action-based goal. It describes a very culturally-specific and archetypical example of teeth brushing.

The design method of reframing attempts to recast the above frame in a new perspective. Consider reframing the above example from the perspective of a different individual, rather than the non-descript "average person." The designer can purposefully view the problem from the perspective of a dentist, or a toothpaste manufacturer, or a child; the designer can shift cultural perspectives to think of an "average Indian" or "someone from Thailand"; the designer can reframe from the point of view of a person with no working limbs, or a group of people. The implications for designed artifacts are dramatically shifted each time the problem is reframed.

Thus, reframing is a method of shifting semantic perspective in order to see things in a new way. The new frame "re-embeds" a product, system, or service in a new (and not necessarily logical) context, allowing the designer to explore associations and hidden links to and from the center of focus.

From a methodical point of view, reframing can be achieved by following these steps:

Identify the initial frame. The toothbrush example provided above is purposefully over-simplified and overly analytical; a more realistic example might be in the design context of a complicated piece of enterprise software, intended to allow for pricing and configuration of parts. In this larger context, simply understanding and articulating an initial frame is difficult. For the purposes of this method, a design-specific frame can be described as: An entity, in a context, using or considering a particular design embodiment.

Again, the levels of specificity of the entity, context, and embodiment are dependent on the design problem being considered. It may be easy to very specifically define the frame of a "contained" design problem, while more complicated systems or services problems may require a more robust framing description.

Create blank reframing indices. Three charts will be used to structure the reframing exercises. The design opportunity will be reframed from the point of view of new entities, new contexts, and new embodiments (or new manifestations of the core artifact). Each chart will look like the example on the following page:

Reframe. The designer will begin to develop (through structured or casual brainstorming) new items for the left column of each chart. Depending on the desired level of innovation for the particular design problem, it is often desirable to include “provocations”—as deBono describes, these are ideas that may ultimately prove infeasible, but allow for “movement” across patterns. [14]

Extrapolate likely user goals. As the charts begin to become populated with new frames, the designer will begin to fill in the Primary User Goal for all items in all charts. They will paint a picture of a credible story, judging responses and adding criticism as appropriate.

Extrapolate design implications. The reframed design context will have produced new constraints or implications, or will have highlighted existing constraints and implications that may have been otherwise hidden or overlooked.

(nouns) by describing relationships (verbs). The map provides a visual way to understand relationships through literal connections as well as through proximity, size, shape, and scale. As an artifact, the map is intended to illustrate relationships. As a methodology, the act of creation is generative and critical. The designer must make subjective value judgments in both selecting the items to include on the map and in indicating the relative strength of the relationships between items.

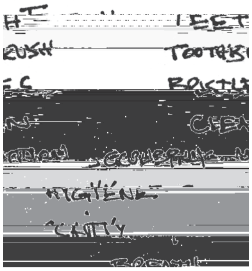


Figure 2 (above)
Raw taxonomy

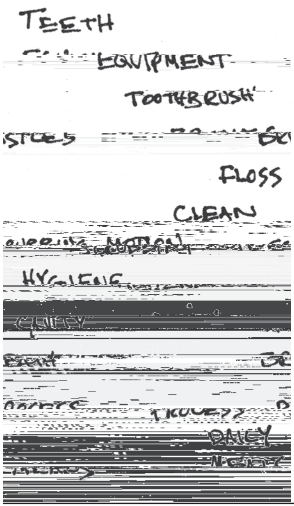


Figure 3 (above)
Prioritized taxonomy

A concept map can be produced through the following steps:

Identification of core taxonomy. Both the noun and verb elements that describe the design problem or opportunity are listed on index cards. These elements include people, places, systems, artifacts, organizations, actions, processes, methods, and other entities and activities. To continue the oversimplified example of teeth brushing, a taxonomy may be identified as shown in Figure 2.

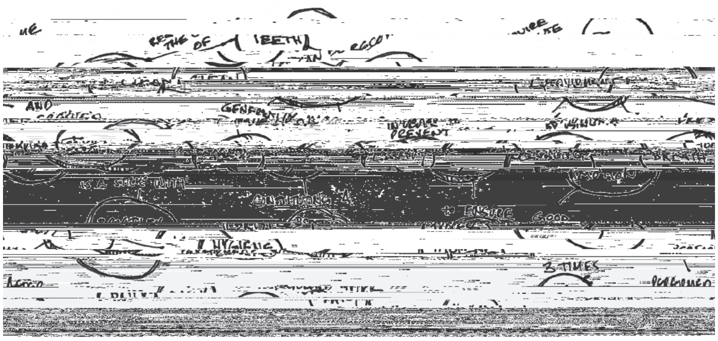
Prioritization of unique taxonomy elements. The index cards are rearranged in a way to indicate the hierarchy implicit in the taxonomy. Elements are deemed to be more or less important than one another, and are physically moved to illustrate this importance. Elements can be identified as being a subset (child) of a larger (parent) element, and are then physically indented to illustrate this relationship. New elements are added at this stage as appropriate.

Again, this prioritization is a subjective exercise that forces the designer to make value judgments about each item based on his or her understanding of the problem space, arguing for or against a particular placement. The taxonomy shown in Figure 2 may be prioritized as shown in Figure 3.

Creation of semantic connections between elements. The index cards now serve as the rough structure for the concept map. On a large sheet of paper, the designer begins to draw circles to illustrate the entities, and lines connecting the circles to one another in order to illustrate relationships between elements.

The map begins to create small sentence fragments of meaning, such as “teeth can become clean by using a scrubbing motion.” This

Figure 4 (right)
Concept Map



illustrates the generative and subtly abductive nature of the map, as the designer may have no deductive or inductive way of knowing that teeth can become clean by using a scrubbing motion.

During synthesis, a designer can utilize the Concept Mapping method (Figure 4, described on previous page) to organize and understand a topic, and to produce a model of that understanding.

Method: Insight Combination

Design patterns are "structural and behavioral features that improve the "habitability" of something."[18] Insight Combination is a method of building on these established design patterns in order to create initial design ideas. Through multiple steps, this method first demands the articulation of individual design insights, and then forces a structured and formal pairing of insights with existing patterns. This pairing creates a new design idea that has a strong connection to both established best practices and to problem-specific research data.

A design insight can be thought of as the additive of problem-specific observation ("I saw this") and personal and professional experience ("I know this"). This grounds an insight in both the subjective and general knowledge of the specific practitioner and in the objective data of the design problem itself. From a sensemaking perspective, this embraces the episodic and experiential uniqueness of the designer's memories, and pairs it with generally accepted ways of doing things.

By combining an insight with a design pattern, the designer is forced to examine and consider each unique insight. Methodically, the designer must think about each facet of the design problem that has been deemed useful or important. The method is then divergent, as it actively produces new ideas. Ideas are "moved forward" in a nonlinear fashion, jumping over the expected in order to arrive at the unexpected.

The method of Insight Combination can be conducted as follows:

Identify insights in the gathered data. The designer will begin to identify insights in the data that has been gathered by combining an observation (I saw this) with knowledge (I know this). They can then write the insights on yellow note cards. As an example, perhaps the designer observed someone brushing their teeth and noticed that the individual avoided using the mouthwash that was sitting next to the sink. The designer might recall his own last visit to the dentist. An insight could then be developed—that mouthwash has an implicit connection of taste and smell with going to the dentist, which taints the product in a negative light. Of course, this insight could be completely wrong, and that's perfectly acceptable.

Identify design patterns relevant to the core domain. The designer

18 Jennifer Tidwell, Designing Interfaces: Patterns for Effective Interaction Design (Sebastopol, CA: O'Reilly Media, Inc, 2005).

will now recall design patterns that are relevant to the discipline being studied. The patterns can be written on

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