From Observations to Insights: The Hilly Road to Value Creation

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ABSTRACT

Insights about complex and ambiguous environments can spot opportunities for new products and services. This paper develops a functional model of design insight by mapping verbalized statements associated with generative sensing onto a semantic scale established by the Legitimation Code Theory (LCT) dimension of Semantics. Analysis of discussions about co-creation workshops reveals that insights develop when observations are gradually represented in terms of abstract, general, and decontextualized features rather than their concrete, contextual, and incidental details or their abstract features alone. This study will show that knowledge-building associated with design insight entails a series of movements 'up and down' a semantic scale ranging from concrete details to decontextualized features. The decontextualization eventually reaches a limit, at which point a hypothesis is offered to explain the observations. The patterns of movements indicate that insight requires simultaneous decontextualization of evidence and observations into highly condensed meanings *and* their recontextualization into a new hypothesis.

1 INTRODUCTION

Design is an act of value creation. At the root of a design-based mode of value creation is the construction of novel insights about ambiguous and complex existing environments (Kolko, 2010) as the basis for hypothesizing new goods that may have value (Dorst, 2011). Value includes profit, human experience (Shedroff, 2001), and ethics (Lloyd, 2009) among many possibilities. Design researchers tend to regard the initiation of value creation at the moment of insight, sometimes called the 'creative leap'. The moment during which an individual instantaneously appears to discover insight into a problem remains steeped in the lore of creativity. In contrast with the myth, research in creativity in design and the cognitive neuroscience of insight shows that the moment of insight occurs gradually rather than instantaneously and purposefully rather than serendipitously. Cross (1997) characterizes the "creative leap not so much as a leap across the chasm … as it is building a bridge across the chasm between problem and solution." Architects report latent preparation through deep understanding of the design situation (Murty, 2007). Neuroimaging studies of moments of insight during problem-solving characterize the 'A-ha! Moment' as the culmination of a series of

neural events rather than an independent, single neural process (Kounios & Beeman, 2009). Rather than singular moments of inspiration, reasoning through abduction toward an explanation to surprising observations or an intended value is generally regarded as the kernel of creativity in design (Dorst, 2011; Roozenburg, 1993).

Despite this recognition, knowledge-building associated with insight lacks a functional model – a structured representation of the necessary processes leading to insight. Where a model exists, this chasm-crossing is depicted simply as an arrow (Cross, 1997, Fig. 14) or as an 'unexpected discovery' contingent upon experience and tacit knowledge (Suwa, Gero, & Purcell, 2000). Moreover, studies in the adjacent area of inspiration in creativity tend to downplay knowledge-building. A review of research on inspiration (Vasconcelos & Crilly, 2016) noted that many studies ignored (or did not report on) dynamic knowledge-building during the task, despite the recognition of design as entailing the dynamic construction of knowledge (Visser, 2006) through the generalization of conceptual ideas (Suwa *et al.*, 2000). Cognitive research in entrepreneurial opportunity recognition has started to identify cognitive strategies such as inductive and deductive reasoning to generate profitable action possibilities (Cornelissen & Clarke, 2010) and heuristics such as counterfactual reasoning (Gaglio, 2004) but is similarly silent about knowledge-building associated with insight.

This paper addresses a gap in the study of the insight: knowledge-building associated with insight and its real effects on the fruitfulness of new design concepts that stem from the insight. First, this paper will propose an operational definition of insight by connecting insight to the hypothesis-setting characteristics of generative sensing (Dong, Garbuio, & Lovallo, 2016a, 2016b). The concept of generative sensing describes design as a process consisting of recursive cycles of logical reasoning during which design practitioners construct and test hypotheses. In this paper, explanatory hypothesis-making is considered as a type of insight. Second, the paper will illustrate knowledge-building associated with generative sensing by mapping statements expressed during generative sensing onto a semantic scale established by the Legitimation Code Theory (LCT) (Maton, 2013a) dimension of Semantics, or LCT(Semantics). Two LCT(Semantics) codes conceptualize the organizing principles underlying semantic structures: semantic gravity and semantic density (Maton & Doran, 2016a, 2016b). The semantic scale measures the complexity of knowledge based upon a continuum of strengths (or weaknesses) in semantic gravity and semantic density. The resulting semantic profile illustrates the way individuals create a knowledge structure from context specific and dependent observations, such as input from stakeholders in a co-creation design workshop, and decontextualized experiences and concepts having highly condensed meanings, such as social theories or design principles embodied in exemplars. Finally, based upon the analysis of discussions intended to generate design insights, the paper will propose a functional model of design insight.

2   THEORETICAL FRAMEWORKS

2.1   Insight

In psychology, insight is defined as the 'sudden' discovery of a solution to a problem despite repeated, prior failures (Bowden, Jung-Beeman, Fleck, & Kounios, 2005). According to current theory in psychology, insight requires a restructuring

of the problem situation (Luo & Knoblich, 2007) including a re-interpretation or re-structuring of the problem (Ohlsson, 1992).

This research studies insight during the period in the design process in which the 'problem' is one of making sense of multiple and ambiguous or conflicting observations and information by inventing a hypothesis (Kolko, 2010). Individuals invent a hypothesis when present observations render current hypotheses as less likely to be true (Gettys & Fisher, 1979). Individuals are less likely to invent a hypothesis when they believe that current hypotheses are satisfactory (Garst, Kerr, Harris, & Sheppard, 2002). Therefore, to invent a new hypothesis requires individuals to relax their attachment to present hypotheses to see the problem in a new way, which is a general feature in functional models of insight. Current models of hypothesis generation in psychology explain the process as one of memory retrieval (Manning, Gettys, Nicewander, Fisher, & Mehle, 1980; Thomas, Dougherty, Sprenger, & Harbison, 2008) with no pathway for the invention of a new hypothesis not previously known to the individual or known in the context of the present observations. Some scholars of logical reasoning describe the former process of retrieving, or better-stated, selection, of a hypothesis from memory as selective abduction (Magnani, 2001). When it comes to the discovery of a scientific theory, wherein the current observations are anomalous per existing theory, the mere selection of a hypothesis from memory is no longer an appropriate description. Scholars of logical reasoning describe this type of reasoning as creative abduction (Magnani, 2001) or hypothetic inference to "discover causes" of observable phenomena (Niiniluoto, 1999; Peirce, 1932, 1998).

It could therefore be concluded that generating a new hypothesis to explain anomalous, ambiguous, or conflicting observations is a form of insight. To create the hypothesis, individuals must relax their present hypotheses, re-structure the elements of their observations, and detach themselves from prior experience to see the problem in a new way, all of which are elements of functional models of insight. In the data that will be presented, one of the participants, Will, describes hypothesis-as-insight succinctly (v11, 97): "I mean, usually when we write a concept or a proposition, right? We set it up with an insight. And the insight is usually a- some pain or tension point." In other words, the "pain or tension point" is a previously unobserved circumstance that requires a novel solution. The problems associated with insight in design are two-fold: first, to explain observations in new ways (Kolko, 2010), and second, to invent a product or service and associated set of solution principles to achieve an intended outcome (value) (Dorst, 2011). The first type of hypothesis is known as explanatory abduction whereas the second form is innovative abduction (Roozenburg, 1993). Both forms of abduction are central to the concept of generative sensing, a design strategy that describes the design process as a recursive process of generating and testing hypotheses, each of which are built upon the conclusions drawn from the previous hypothesis.

2.2   Generative sensing

Generative sensing describes a design approach 'through a design problem' consisting of recursive cycles of logical reasoning during which designers generate and test hypotheses until no further hypothesis could confirm or refute the realized design (Dong *et al.*, 2016a, 2016b). The cycle commences when individuals encounter a surprising observation, which might be an unusual data point or an intended value that

cannot be satisfied by current solutions. The observation is explained by an abductive hypothesis. The hypothesis is tested through deductive or inductive reasoning and should include experimentation with prototypes. Finally, rather than accepting the conclusions of the deductive or inductive reasoning, the individual provides another abductive hypothesis to explain or undermine the conclusion, a hypothesis that can be tested through deductive or inductive reasoning, resulting in a continual testing and reinterpretation of the logic underlying a design problem and solution. The process continues recursively until no new hypothesis could confirm or refute the realized design. The realized design confirms the truth of the hypothesis. Building upon the concept of primary generators (Darke, 1979), generative sensing considers each hypothesis as a partial explanation only, an explanation that cannot address all the constraints and objectives. Designers address parts of the design problem and test propositions in a recursive manner. Crucially, generative sensing is not a trial and error process. New hypotheses explain, resolve, or challenge the evidence in favor of or against a design concept and are always grounded in the evaluation of the present design concept. Stated more loosely, generative sensing is not about discovering that a hypothesis (design solution) is wrong; therefore, a new hypothesis is generated. Rather, if the prior hypothesis were false (e.g., the prototype failed) the new hypothesis should propose a rule that would undermine the false conclusion.

One of the missing elements in the concept of generative sensing is the knowledge-building that occurs concurrently with the invention of the hypothesis. In other words, generative sensing assumes that the hypothesis is 'created' without regard to knowledge-building that underpins a hypothesis that better-explains the present observations. Knowledge-building based upon testing hypotheses and retrieving knowledge sources such as personal experience and external creative stimuli provides the mental preparation for the realization of the hypothesis. To perform this analysis, this research makes use of the Legitimation Code Theory dimension of Semantics.

2.3 Knowledge-building

Legitimation Code Theory (LCT) (Maton, 2013a) theorizes that fields of knowledge encode knowledge in semantic structures having underlying organizing principles. These organizing principles are conceptualized as semantic codes having strengths of *semantic gravity* (SG) and *semantic density* (SD). The strength of SG describes the degree to which meaning relates to its context. The meaning of a concept may have relatively stronger (+) or weaker (−) semantic gravity along a continuum. When the meaning is dependent upon its context, the concept has stronger semantic gravity and is denoted as SG+. When meaning is less dependent upon its context, the concept has weaker semantic gravity, denoted as SG−. To take a simple example from design, the 6-3-5 Method has stronger semantic gravity than the process of brainstorming which in turn embodies stronger semantic gravity than ideation. The strength of SD describes the extent to which the meaning of a concept is embodied in knowledge-oriented practices such as words, gestures, models, simulations, etc. When a concept has strong semantic density, denoted as SD+, the meaning is embodied within these practices and would be devoid of semantic strength if those practices were absent. In contrast, weaker semantic density (SD−) implies less condensation. The strength is not intrinsic to a concept *per se*. Again, to take a simple example from design theory,

the semantic density characterizing the concept of 'function' is likely to be much stronger in a research publication in an engineering design journal than in its use in an engineering design class which in turn may be stronger than its use in a general interest technical magazine.

The codes SG and SD when taken together can establish a semantic scale to describe knowledge-building. The semantic scale ranges from weak semantic gravity and high semantic density (decontextualized and highly specific meanings) to strong semantic gravity and weak semantic density (concrete details and common meanings). Cumulative knowledge-building requires progressively reaching further up the semantic scale toward weaker semantic gravity and stronger semantic density (Maton, 2013b).

The next section describes the research methods used to describe knowledge-building during generative sensing that leads to the formation of insight. Based upon the analysis, a functional model of insight is proposed.

3   METHODS

To illustrate the dynamics of design insight, this paper analyses a design team's discussions about co-creation workshops. The dataset for the analyses come from the Design Thinking Research Symposium 2011 (DTRS11) dataset (Christensen & Abildgaard, 2017). A European car company assigned a team to design a product, a service, accessories, a communication package, or an event that can be used to promote the concept of "the good life" in a Chinese context. The design team convened two co-creation workshops with potential customers in China. The workshop conveners intended to develop insights into Chinese consumers and their interpretation of themes relevant to an automotive company as the basis for new product and service concepts. The value the company seeks is the emotional engagement of a Chinese premium consumer who is young and progressive.

The theoretical frameworks described previously provide the basis for the analysis of discussions about the workshop. Analysis of the transcripts commenced by finding statements of surprising observations, which is considered the start of generative sensing (Dong *et al.*, 2016a). In this dataset, surprising observations were evident, even if idiosyncratic in expression. An example of an explicit statement is, (v07, 80) "It was interesting what he said". An example of a reference to a surprising observation is, (v15, 54) "that's definitely something". After identifying the surprising statement, the analysis continued by finding the abductive hypothesis that explains the surprising observation. Statements associated with generative sensing and statements supporting the hypothesis are mapped onto a semantic scale to illustrate the semantic profile of the knowledge-building. Semantic profiles in the same thematic area are connected across sessions to draw a more complete picture of knowledge-building associated with a specific insight. Further details on the tasks associated with each of these steps are described in the following.

3.1   Identifying abductive hypotheses

A key task of the analysis is finding instances of abductive reasoning and, in particular, the abductive hypothesis. Abductive reasoning occurs when individuals encounter

a surprising observation or an intended value that is not currently satisfied by current knowledge. We follow rule-based guidelines for the identification of abductive reasoning in verbalizations (Dong *et al.*, 2016a; Dong *et al.*, 2015). Computational approaches based upon extracting adverbs of manner, referring to process and actions, can also be used to identify instances of abductive reasoning (Bedford *et al.*, 2017). An example of abductive reasoning from the session on clustering insights from the first co-creation workshop is:

> (v09, 239) if *you* actually also *buy these accessories* you have *become* even: *more*, eh: *responsible*
> The rule is: p → q: IF buy these accessories THEN responsible
> Alternatively, the rule could be stated as, "People who *buy these accessories* are *more responsible*."

Once the abductive hypothesis is located, the generative sensing loops, that is, the transitions between deductive or inductive reasoning and abductive reasoning, are identified. These may occur both before and after the abductive reasoning statement. These statements are placed onto a semantic scale to create a semantic profile.

3.2   Mapping statements onto a semantic scale

The analysis of the position of statements on the semantic scale takes place on clauses, the combination of words into a short, coherent passages, and individual words. The following example demonstrates a clause with stronger semantic gravity than the next clause.

> SG+: (v07, 148) they are picking up or using ehm emotional indicators as self-expression:, as bragging rights:, as differentiation
> SG−: (v07, 63) Their kind of expression and mentality could also be a form of like status symbol.

The first clause has stronger semantic gravity than the second clause because it directly refers to an observation from the co-creation workshops. The second clause has a relatively weaker semantic gravity because it decontextualizes the workshop participants' "emotional indicators as self-expression … as bragging rights … as differentiation".

The second step analyzes the semantic density of a concept. Two codes characterize the strength of semantic density of words: *technical* and *everyday* (Maton & Doran, 2016b). These codes differentiate the extent to which the meaning of a word locates in specialized fields. Two codes types characterize the strength or semantic density of clauses: *connecting* and *augmenting*. By connecting, individuals relate concepts to established meanings, such as the schemes of classification associated with specialized domains of practice (Maton & Doran, 2016a). By augmenting, individuals add meanings without referring to any established systems of classification. In the previous example, the semantic density of 'self-expression' increases by connecting it to the concept of 'status symbol'. The following examples show examples of strengthening semantic density by connecting complex meanings with 'status' and weakening

$$\text{observations} \quad + \quad \frac{\text{explanatory}}{\text{abduction}} \quad = \quad \text{frame}$$

Figure 25.1 An explanatory abduction establishes the hypothesis for the frame.

semantic density by referring 'status' to everyday common meanings. Examples of connecting and augmenting from the dataset analyzed are:

Connecting (strengthening semantic density)
(v08, 269) consciousness about what kind of *social status symbols* work, what kind of *progressive attitudes* work or don't work
(v11, 232) And it's connected directly into *evolving status symbol*
Augmenting (weakening semantic density)
(v08, 197) It's *an understated way of like showing off*, that you don't have to
(v08, 276) it's kind of "okay, everyone will not know, what this is all about, but the right people will know, that this is actually pretty cool"

A statement is placed higher on the semantic scale, relative to prior statements, when the statement is more abstract, general, and contains decontextualized features. A statement is lower on the semantic scale when it is concrete, contextual, and contains incidental details. The mapping of statements onto the semantic scale proceeds until the participants move onto another topic.

3.3 Frame

The final step of the analysis connects hypotheses to the principle thematic areas that the workshop conveners established based upon their analysis of the workshop discussions and specific frames that emerged during their discussions. The purpose of drawing this connection is to understand whether their insights (hypotheses) turn out to be productive, that is, led to plausible products and services. To connect hypotheses to frames, the research builds upon the model of reasoning patterns established by Dorst (2011). In Dorst's model, value creation is based upon the hypothesis of a 'what' and a 'how' to create an intended value. We extend this model by explicitly linking the hypothesis to a particular frame. The frame is the conclusion of a hypothesis that explains the current observations. The frame is not arbitrary; an explanatory hypothesis leads to a frame as shown in Figure 25.1.

While the truth condition of the frame should ultimately be tested by market validation, the truth condition can be verified by the ability to generate an innovative hypothesis that explains a possible product and its solution principles, which are consistent with the frame. The existence of a solution is *ipso facto* evidence that confirms the validity of the frame. If no solution is possible that is consistent with the frame, then the hypothesis that led to the frame is likely invalid. The frame is the basis for the second abduction, the innovative abduction.

The innovative abduction, Figure 25.2, hypothesizes a product and its solution principles to create the intended value. The product and its solution principles remain consistent with the frame.

$$\text{frame} \quad + \quad \text{innovative abduction} \quad = \quad \text{value}$$

Figure 25.2 An innovative abduction hypothesizes the product and its solution principles to create the intended value, consistent with the frame.

To illustrate this idea, consider the problem of road traffic. One possible frame for this problem is an economic one for which a plausible explanatory hypothesis for traffic avoidance is that drivers are utility maximizers. If the hypothesis is correct, and the corresponding economic frame, then if the intended value is to maximize utility, an innovative abduction could be any type of toll road ('what') in which the toll amount is based upon the time of day and level of congestion ('how'). Drivers can choose to use the toll road if the toll is less than or equal to the utility they derive from their use of the toll-road. Both the explanatory and innovative abduction may be false if in the implementation of the toll road, no driver uses it or even with a toll the congestion level fails to decrease. If so, the economic frame was not valid for traffic congestion. In this research, the ability of the participants to generate useful concepts from the insights will be used as a test of the validity of their insights.

3.4   Data in use

The analyses that follow report on how the design team generated insights within a set of themes (frames) that emerged from the co-creation workshops:

> *progress together* – working to accumulate wealth for family and community
> *conscious commitment* – being dedicated to values that acknowledge individuals as behaving responsibly; the dedication is reciprocated through social recognition that raises an individual's status
> *health as the enabler* – good health being fundamental to all other endeavors
> *in control and self-reliant* – being able to take of oneself and to control the controllable while sublimating those issues beyond individual control
> *endure and enjoy* – work hard now to enjoy the fruits of labor later in life

Most of the discussions associated with these themes occurred when the design team met to report, discuss, cluster, and reflect upon the workshops. Appendix 1 summarizes the product and service concepts generated for each of these themes. The following analyses will focus only on two themes: 'conscious commitment' and 'endure and enjoy. These two themes were chosen because of the richness of the conversation about these themes and a key difference between them: the team could develop design concepts for the 'conscious commitment' theme but struggled with the 'endure and enjoy' theme. The results will show important differences in the semantic profiles of knowledge-building. Based upon these differences, the paper draws some conclusions about knowledge-building for design insight and proposes a functional model of design insight. It should be noted that there were many other insights generated, such as about loyalty, smart living, and sense of achievement, which are not discussed in this paper due to space considerations.

4   FINDING

4.1   Insight into sustainability – from 'status' to 'conscious commitment'

This section illustrates a case from the dataset in which the participants progress between varying degrees of semantic gravity and semantic density as they exhibit generative sensing leading to new insight about 'status'. Their explanatory hypotheses about the origins of status in a Chinese context support the development of several product and service concepts. This theme also ties back to the car company's (v19, 133) "core traditional or primitive value. The sustainability story".

The development of this insight started in the debrief of the first co-design workshop and continued into their second insights meeting. The knowledge-building leading up to the first explanatory abduction expressing this insight began with the team discussing physical and mental health, one of the top-three high-level themes that the co-creation workshop participants voted as being the most important to them. They immediately bring the concept of physical and mental health into the context of the co-creation workshops (descend the semantic scale), mentioning various ways in which the workshop participants described relaxation and expressed concern for the environment, and thought about the effect of the environment on their health. By referring to the co-creation workshop data, the consultants strengthened the semantic gravity of the meaning of physical and mental health by bringing the concept closer to their direct observations from the workshop. This strengthening of semantic gravity is 'interrupted' by a set of *surprising observations*, later referenced to and summarized by Abby as:

> *Abby* (v07, 80): Yeah. It was interesting what he said about that the (.) it's not about all the materialistic things, it's more about knowledge and like for sure that could be: not so rich, but very respected because of his position and eh knowledge eh
> Abby references Amelia's anomalous observation about a participant's (v07, 57) "me making my own decision" sort of thing" as being about status rather than independence. Proceeding up the semantic scale (weaker semantic gravity), Will gives the explanatory abduction for these observations:
> *Will* (v07, 63): And- but, I think *something we can think about* is eh this sort of expression, right? Eh and also for a more cosmopolitan, more progressive city like CHINESE CITY. *Their kind of expression and mentality could also be a form of like status symbol.*

Following Will's statement, Amanda recalls evidence (descends the semantic scale) from the workshop to support Will's hypothesis: (v07, 69) "Exactly. I really felt that also he- he kind of want to state it many times. "*No no, I don't take recommendations from my friends, I don't- no no, I (.) no one should decide, I want to decide this*"." Will generalizes the evidence with the statement that, (v07, 148) "*it's* [participants' statements] quite clearly indicating that *they are picking up or using ehm emotional indicators as self-expression}:, as bragging rights:, as differentiation}:,* you know."

This is the first time that the participants introduce 'status' as a concept into their observations that intangibles such as knowledge and behavior are a type of status.
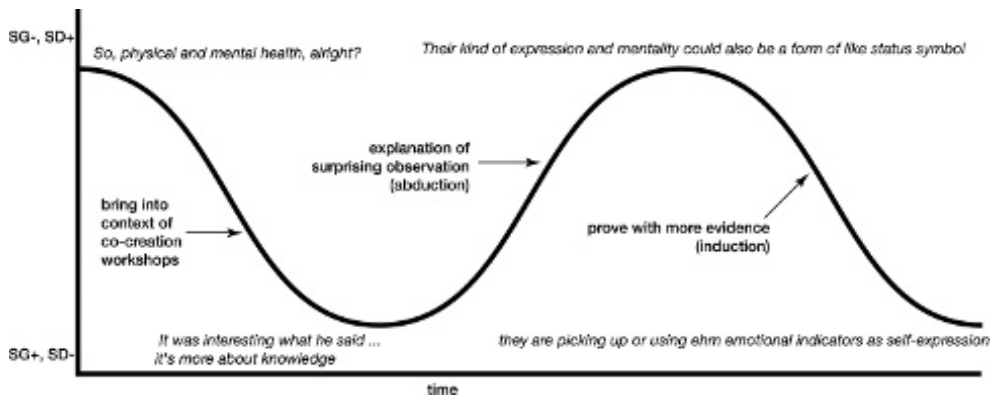
Figure 25.3   Semantic scale corresponding to the development of insight on 'status' leading to the theme of 'conscious commitment'. SG=semantic gravity (degree of dependence of meaning on context) and SD=semantic density (complexity of meaning).

As Will explains, (v07, 140) "*Notice that when she say it [good-life behaviors], she expresses it as, "what other people want to do, but they: can't do", as opposed to* "what I want to do, but it's hard for me to do".[1]

'Status' becomes a frame for these observations. Following the framework shown in Figure 25.1, the frame is formed as:

observation	what other people want to do, but they: can't do
+	
explanatory abduction	their kind[s] of expression and mentality are a status symbol
=	
frame	status

To sum up, Figure 25.3 depicts the semantic wave from the data as the participants started from their observations to their hypothesis and subsequent strengthening of the semantic density of 'status' with reference to the workshop participants' statements. Italicized text represents actual quotes from the data.

The increasing semantic density of 'status' is worth noting. The design team recognizes that 'status' has both an everyday meaning (weaker semantic density) and a specialized meaning to them in the context of the co-creation workshops (stronger semantic density). As Lloyd and Oak (2017) point out, 'status' becomes entwined with other ideas including "a very sophisticated way of thinking" and "knowledge, awareness, time, investment". The team increases the semantic density of 'status' by Ewan connecting 'status' to the type of 'status symbol' embodied by a Rolex watch. Ewan's story about a wealthy woman in Scandinavia who travels to Greece to assist refugees while posting photos daily of her with babies supports the team's eventual view about conscious displays of status; his story augments 'status' with a story that has a character, motivation, and plot to lodge the concept into the consciousness of

the team (Lloyd and Oak, 2017). At the peak of semantic density, 'status' redefines the concept of environmental sustainability. Amanda states, (v11, 409) "Yeah. So *it's not just about environment sustainability anymore*." Amanda concludes that 'status' becomes a capability (v11, 415) "to express their (.) to express their commitment". Amanda's statement references a key insight that Ewan made in a previous discussion through an explanatory abduction:

> (v09, 8) you don't prioritize your own needs to cater for others, but other people discover your commitment and sacrifice, and you get elevated to a higher status level.

In this statement is a hypothesis about the cause of 'status': People who have their commitment and sacrifice discovered are elevated to a higher status level. This hypothesis links together two key concepts: 'status' and 'commitment', leading participants to name this frame 'sexy commitment', later renamed to 'conscious commitment'. Daly *et al.* (2017) and Lloyd and Oak (2017) make the interpretation that 'sexy commitment' supplants the company's existing ideas about environmentalism and the 'good life': it is not enough simply to do good, individuals must also be seen and recognized as doing good.

4.2   Insight into the 'good life' – 'endure and enjoy'

This section shows a case from the dataset in which the participants dwell at a level of decontextualized meanings (weak semantic gravity). In this case, the participants will fail to reach productive insight as they will remain at a level of semantic gravity that is too weak because no one refers to the context, the co-creation workshops. As well, they exhibit stronger semantic density that packages up their observations into concepts that have meaning to individual members rather than the team. Therefore, they are unable to construct hypotheses that refer to observations. Their conceptualizations are generic such that they can apply to any situation and decontextualized from the co-creation data. Eventually, the consequence is difficulty in brainstorming concepts related to this theme because there was no knowledge-building.

According to the design team, the theme of 'endure and enjoy' is rooted to the Chinese work morale. In contrast to the Western world in which individuals want to enjoy their work, in China it is not important to enjoy work if there is the payoff later in life. Kenny explains this concept through reference to a prior engagement: (v11, 5) "The Chinese mentality of "endure now, benefit later" has become the recipe of success with aspirations to achieve a good life." In contrast to the teams' ability to reference the co-creation workshop context in relation to 'conscious commitment', with this concept, they continuously weaken semantic gravity while strengthening semantic density. They strengthen semantic density by connecting "endure now, benefit later" to (v11, 7) "concerns and challenges" to (v11, 10) "endure the uncontrollable" to (v11, 19) "break away from society and family constraints" to (v11, 10) "desire to retreat and escape" to (v11, 21) "manifestation of great autonomy". They do not appear to ascend or descend the semantic scale. Individuals added new connections rather than augmenting others' interpretations (weakening semantic density) or relating others' interpretations to the

workshops (strengthening semantic gravity). Aptly, Kenny described the manifestation of new connections as "underlying subthemes" and noted with some optimism:

> (v11, 31) We kept like circling around. We- it was so easy to- to get in to good life. But then going from there into enjoying life, we kept circling around enjoying life with all the underlying sub-themes, just circling around it, but not really getting in to it. Eh: but I think I- I think we're happy about where we came now.

Some concepts never progress from an everyday meaning. The semantic density of 'endure and enjoy' remains at the level of an everyday meaning. The clause (v11, 19) "desire to retreat and escape from daily chores to accommodate me-time" is the only example in which the participants augment the meaning of 'enjoy' by relating it to an observation, the "cleaning robot quote", but this only confirms its everyday meaning. Given the lack of semantic complexity of these concepts, the participants do not create any new hypothesis to explain their observations. Their summary of this theme is, (v11, 21) "freedom of having pockets of enjoyment reflects a sense of achieve' – achievement towards a good life" – is simply a paraphrase of a statement made by Rose in their first debrief: (v8, 314) "the main goal actually I think it's still the enjoying life bit, that was what they really wanted, to have time, spending time with family, and so the choice is how to optimize time." The lack of deep insight is reflected in Will's statement, (v11, 23) "So that's (.) the result of eh: one and a half hour work, and I'm sorry it looks like so few words-".

4.3 Proposal for functional model of design insight

In the dataset analyzed, the design team developed insight into the theme of 'conscious commitment' but struggled to develop insights into 'endure and enjoy'. The difference in the semantic profiles of knowledge-building between these two themes is that for 'conscious commitment' the team traversed the semantic scale toward a novel hypothesis whereas for 'endure and enjoy' the team remained at weaker semantic gravity and weaker semantic density. The difference in patterns between the two cases suggests that insight occurs when individuals represent observations (or information) in terms of abstract, general, and decontextualized features (weak semantic gravity) that convey a novel central coherence (strong semantic density). As these abstractions become increasingly detached from the information, individuals establish the connection between the abstraction and the source information through hypotheses. In other words, the abstraction, which might be thought of as a new way of seeing the information, triggers the generation of a hypothesis, which if true, explains the cause(s) of the observations. The hypothesis becomes tested and further ones established through generative sensing until no new hypotheses can be generated that validate or invalidate the observations. Semantic structures characterized by varying degrees of strengths in terms of semantic gravity and semantic density operates as a structure upon which possible hypotheses can be grounded.

Based upon this observed difference, we propose a functional model of insight. Knowledge-building associated with the generation of the insight entails a series of movements 'up and down' a semantic scale ranging from concrete details to decontextualized features. Insights develop when observations are gradually represented in

terms of abstract, general, and decontextualized features rather than their concrete, contextual, and incidental details or their abstract features alone. The decontextualization eventually reaches a limit, at which point an abductive hypothesis is offered to explain the observations. The patterns of movements across the semantic scale indicate that insight requires simultaneous decontextualization of evidence and observations into highly condensed meanings and their recontextualization into a new hypothesis.

In a follow-up interview, Ewan is proud of the team's insight into 'conscious commitment' and acknowledges the team (v22, 114) "getting stuck" in "the whole collectiveness versus- versus individual … kind of network". 'Conscious commitment' is a re-contextualization of the car company's concept of sustainability in a Chinese context. "Conscious commitment" is about the dual effect of being dedicated to collectivism values including care for your family and other people. Value is about giving back to society, which is reciprocated through value recognition. As stated by David, (v21, 11:57) "Your investment there, the values that you emit will come back to you in the form of social recognition and social elevation." The person doing the recognition must have the same level of sophistication to recognize that the other individual is climbing up the social ladder. The theme of 'endure and enjoy' in contrast lacks a similar level of elaboration.

It should be noted that the analysis of the dataset occurred before the follow-up interview. The agreement between Ewan's statement on the themes with which the team succeeded and struggled and the team's trek across the hills and valleys of the semantic scale or along a high ridge line illustrates the importance of selecting and recontextualizing observations into hypotheses, which serve as the foundation of insights.

5   IMPLICATIONS FOR SUSTAINABLE DESIGN

We conclude the analysis by drawing some broader implications on the insights into sustainability derived from the co-creation workshops. Different cultures have different concepts of "sustainability" and value sustainability differently. The insights generated by the participants in the co-creation workshops suggest that China values sustainability as a status symbol and has only a vague interest in the details of how this sustainability is achieved. One study alone cannot support this broad generalization; however, if one assumes it applies more broadly, China has a potential advantage in adopting sustainable design over the United States (U.S.) and other Western countries. The following discussion is based on a broad application of this finding. Sustainable design, specifically eco-friendly or green design, faces a boundary in the U.S.: people are not willing to pay more for it, on the whole. In an extensive literature review, MacDonald and She (2015) find that it would be better if sustainability, as a feature, could compete with other features for which people are willing to pay more, such as luxury. In the absence of this willingness-to-pay, sustainable products must offer feature benefits that can compete with other non-sustainable products. These "triumph", or possibly "hero" as mentioned in the data set, products are not only better for the environment; they also have other feature advantages over competitors. Triumph products are more challenging to design, especially without added cost. Designing sustainable products for the Chinese market may not face this challenge, as the Chinese may not need triumphs, but rather as-good-as-competitor-products with the addition

of superficial indications of sustainability. She and MacDonald (2013) created a design method for identifying "trigger" features that can be added to make products communicate thoughts of the sustainability through how they are perceived. This method could be used to add sustainable-communication features to aid in the communication of sustainability as a status symbol. The Western view of sustainable purchase as an altruistic action (MacDonald & She, 2015) is in conflict with the idea of sustainability being a status symbol. Also, when people view a purchase as altruistic, they expect to sacrifice on other features (quality, price) as part of their charitable action. This leads to the perception of sustainable products as less-good than non-sustainable competitors. Again, the Chinese have an advantage here, because without perceived altruism, the consumer can enjoy their status-purchase without guilt or perception of inferiority. Lastly, the study indicated that the Chinese consumer does not care much about the way sustainability was achieved. This allows designers and manufacturers to pursue sustainability in whichever way is most beneficial to them. However, as the number of products that claim sustainability increase, this flexibility on the part of the Chinese consumer will wane. The consumer will become more skeptical of claims and/or the prevalence of claims will significantly decrease their worth. If policy-makers in China get ahead of this trend, they can guide sustainability claims in a meaningful manner.

6   CONCLUSIONS

This paper described knowledge-building associated with the formation of design insight. The oft-valorized creative 'leap' is more a trek over semantic hills and across valleys, reaching toward higher levels of semantic complexity. At the nadir, the 'leap' is a hypothesis that explains a surprising observation. By mapping the semantic structures of generative sensing onto a semantic scale, and finding differences in semantic profiles between two representative cases, the paper proposed a functional model of insight. The model proposes that design insight entails the gradual representational detachment of observations away from their concrete features toward generalized principles until such time that a new hypothesis is necessary to explain the observations.

The analysis of co-inquiry by Adams *et al.* (2017) demonstrates an alternative approach to study knowledge-building toward insight. Using a collaborative inquiry framework (Heron & Reason, 1997), Adams *et al.* (2017) investigated the way that the participants created coherence about the problem space based upon knowledge brought into the co-creation process. In their analysis, co-inquiry is a knowledge-building process that entails finding a new relation between four ways of knowing (practical, propositional, presentational, and experiential) while attending to experiential knowledge in relation to critical frameworks. They identified insight as practical knowing, which is signaled by a tangible action that converts other forms of knowing into an externalized act. They found several instances of propositional[2] and practical knowing co-occurring, which is the same as our identification of insight as emerging from a hypothesis.

The approach taken by the design team to generate potential product or service concepts by developing insights rather than by searching for specifically-articulated user needs speaks to the value of *explaining* observations of individuals' behavior, experiences, and beliefs rather than simply reporting upon them. Specifically, the functional model of design insight proposes that design teams explain surprising observed

behaviors through hypotheses that are not necessarily known to be empirically, scientifically, or logically true. That is, their hypotheses should be abductive rather than deductive or inductive. If the hypothesis could already be proven through established rules, then the hypothesis is not likely to be an insight. Actions should then be taken to test the hypothesis, which should include the introduction of a prototype. Under certain conditions of knowledge-building, those insights can lead to fruitful design concepts. For design strategists, this finding is important because it sheds light on the way that leaders should facilitate design insight workshops. Specifically, the model of design insight advises strategists to support the formation of design insight through several actions:

1 lead the team toward more detached representations of their observations of users by:

   a) connecting their observations to other known concepts (e.g., psychological theories, social theories, design principles) and explanatory hypotheses
   b) augmenting their observations with other concrete cases from their personal experiences

2 push the team toward the invention of a new way to explain their observations rather than accepting established explanations
3 discourage the proliferation of abstract representations of observations that are segmented from each other, that is, representations that fail to create explicit connections to prior representations.

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NOTES

1 The original observation is, (v8, 22) "Susan [a co-creation workshop participant] is eh: a little bit more about looking good projecting eh certain kind of image, in front of other people. Not necessarily from the material stance, but she talked about things like- the comment that we really liked and we focused on is like she said something about "I want to do something that other people want to do, that they can't do". So it's what other people want, and want to achieve, not necessarily what- what I want to achieve, but I wanna show them that I can do what they can't do:"
2 Propositional knowledge in the form of "Proposing or making assertions that depict an aspect of the world" (Adams *et al.*, 2017) is an instance of abductive reasoning.

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APPENDIX 1 BRAINSTORM

During the brainstorm session, the team generated a number of ideas based upon the themes. The following data shows the ideas they generated based upon a photograph of Post-it notes containing descriptions of the ideas and the video of the brainstorm session.