

ORGANIZING THOUGHTS AND CONNECTING BRAINS: MATERIAL PRACTICES AND THE TRANSITION FROM INDIVIDUAL TO GROUP-LEVEL PROSPECTIVE SENSEMAKING

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A growing body of research is drawing attention to the material practices that support verbal exchanges and cognitive processes in collective sensemaking. In this study, building on an ethnographic study of a design consulting firm, we develop a process model that accounts for the interplay between conversational and material practices in the transition from individual to group-level sensemaking, and we begin to unpack how the “materialization” of cognitive work supports the collective construction of new shared understandings.

Sensemaking is commonly understood as a process in which individuals or groups attempt to interpret novel and ambiguous situations (Weick, 1995). The process begins when people confront events or tasks they cannot readily interpret using available mental structures (Kiesler & Sproull, 1982). *Collective sensemaking* occurs as individuals exchange provisional understandings and try to agree on consensual interpretations and a course of action (Weick, Sutcliffe, & Obstfeld, 2005).

Scholars generally agree that individual and group-level sensemaking processes are related, in

that individual interpretive efforts feed collective ones (Weick, 1995; Weick et al., 2005). However, although sophisticated theories of individual (e.g., Weick, 1993, 1995) and collective sensemaking (e.g., Balogun & Johnson, 2004; Maitlis, 2005) are available, a comprehensive empirical and theoretical account of the social practices and cognitive work that underpin the transition from one level of analysis to the other is still missing.

Consistently with a prevailing view of sensemaking as “an issue of language, talk, and communication” (Weick et al., 2005: 409), past research on collective sensemaking has placed emphasis on conversational practices such as argumentation (Weick, 1995), metaphorical communication (Cornelissen, 2012), and the exchange of narratives (Sonensheim, 2010) and accounts (Maitlis, 2005) that support convergence around a common interpretation of unexpected or ambiguous events, such as those occurring in times of crises or change (Maitlis & Sonensheim, 2010).

In the last few years, however, a series of studies has highlighted how individuals rely on a variety of material practices and artifacts, such as drawings and prototypes (Bechky, 2003; Carlile, 2002; Sutton & Hargadon, 1996), slide presentations (Kaplan, 2011), visual maps (Doyle & Sims, 2002), and even Lego bricks (Oliver & Roos, 2007; Heracleous & Jacobs, 2008), to support the conversational practices through which they exchange, combine, and construct interpretations as they collectively engage in the less investigated form of *prospective sensemaking* (Gioia, Thomas, Clark, & Chittipeddi, 1994; Gioia & Mehra, 1996) underpinning future-oriented group processes, such as strategy making,

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new product development, and the planning of organizational change.

Research along this line is gaining momentum and, consistently with a broader "material turn" in the social sciences (Hicks & Beaudry, 2010), it suggests how understanding collective sensemaking in purely linguistic terms may provide only a partial account of the process. However, though students of sensemaking acknowledge the possibility that material artifacts may support the construction of new shared knowledge structures (e.g., Rouleau, 2005; Balogun & Johnson, 2005; Rouleau & Balogun, 2011), scholars still know little about how they do it. Past studies have focused on specific material practices and artifacts in isolation, but an integrated theoretical framework accounting for the interplay between conversational and material practices in the transition from individual to collective sensemaking is still missing.

To improve understanding of this aspect of the sensemaking process, we carried out an ethnographic study of concept development in a design consulting firm. We considered this setting appropriate to our research purpose, because product designers often face ambiguity regarding both the solution to the problem they address and the context within which this solution will be implemented (Clark, 1985; Lawson, 2005), and they use various types of artifacts, such as drawings, sketches, and models, to support their interpretive processes (Boland & Collopy, 2004).

Following a rising perspective in management studies, we investigated artifacts as constitutive elements of the broader sociomaterial practices through which organizational processes are accomplished (Orlikowsky & Scott, 2008). Our focus on social practices resonates with renewed interest in the microfoundations of organizational processes in different fields of research, such as strategy (Jarzabkowski, Balogun, & Seidl, 2007), institutional theory (Greenwood, Oliver, Sahlin, & Suddaby, 2008), and organizational capabilities (Salvato, 2009). In this respect, addressing our research question is important to deepen understanding of the sociomaterial underpinnings of a fundamental cognitive process—prospective sensemaking—that underlies all activities associated with planning and initiating change in organizations.

From our observations, we develop a grounded model that advances understanding of this less investigated and undertheorized form of sensemaking by unpacking social practices and cognitive processes that underpin the transition from the individual to the collective level, linking individual generation of early ideas (Hill & Levenhagen, 1995) with collective engagement in the

negotiation of emerging interpretations (Gioia & Chittipeddi, 1991).

Our model describes prospective collective sensemaking as based on three interrelated cycles of retrospective cognitive work occurring as members of groups go back and forth between the tentative organization of selected material cues and the refinement of corresponding categories, embody provisional interpretations in material form, and engage in retrospective reflection to establish the plausibility of emerging accounts. By doing so, our model offers a way to reconcile the future-oriented nature of the collective process with the retrospective nature of individual cognitive work.

Our insights also begin to shed light on how the "materialization of cognitive work," which occurs as individuals and groups engage in material practices, supports the construction of new shared understandings. By doing so, we point to material artifacts as important "sensemaking resources" (Gephart, 1993) that facilitate transitions from individual to collective future-oriented sensemaking.

THEORETICAL BACKGROUND

Sensemaking Theory

Retrospective models of sensemaking. Early empirical applications of sensemaking theory focused on *discrepancies* between a current and an expected state of the world (e.g., Weick, 1988, 1993). Research in this line of inquiry investigated individual and group-level responses to unfamiliar events that occur when people confront circumstances that do not fit available knowledge structures. According to models of sensemaking arising from these studies, individuals respond to cues that disrupt the ordinary, predictable flow of experience and suggest a gap between the reality as it seems to be and how they expected it to be (Barr, 1998). These cues trigger conscious attempts to interpret unexpected occurrences retrospectively and to bring order into ambiguous realities open to multiple interpretations.

Scholars' understandings of transitions from the individual to the collective level vary depending on the focus of their study. On the one hand, research on sensemaking in organizational crises (e.g., Weick, 1988, 1993; Weick & Roberts, 1993; Whiteman & Cooper, 2011) has described fast-paced processes in which a group's early attempts to make sense of unexpected events are followed by rapid action aimed at quickly "testing" provisional interpretations. Under these circumstances, the capacity of a group to collectively make sense of changes and respond to them depends on the ro-

bustness of the role system (Weick, 1993) and the quality of social interaction in the group (Weick & Roberts, 1993).

Research on collective sensemaking during organizational change (e.g., Balogun & Johnson, 2004, 2005; Rouleau & Balogun, 2010; Sonenshein, 2010), on the other hand, emphasizes the conversational practices through which individuals attempt to construct a common understanding of a situation rather than their actions to test their understandings of the environment. Collective construction of meanings is generally described as arising from the spread and sharing of *accounts*—descriptive constructions of reality embodying possible interpretations of events and situations (Maitlis, 2005; Maitlis & Lawrence, 2007).

Prospective models of sensemaking. Another relevant line of inquiry has explored circumstances under which *individuals and groups cope with ambiguous situations that require them to develop novel understandings* and engage in forward-looking thinking to “structure the future by imagining some desirable (albeit ill-defined) state” (Gioia & Mehra, 1996: 1229). This different type of sensemaking has been referred to as “prospective” (Gioia, 1986) or “future-oriented” sensemaking (Gephart, Topal, & Zhang, 2010). Research in this tradition has applied sensemaking theory to strategy making (Gioia et al., 1994; Gioia & Thomas, 1996), entrepreneurship (Cornelissen & Clarke, 2010; Hill & Levenhagen, 1995), and innovation (Rafaeli, Ravid, & Cheshin, 2009; Ravasi & Turati, 2005) to investigate the construction of new understandings of an environment and how to relate to it. Compared to research on crises, these studies show a relatively slow-paced process in which the refinement of emerging interpretations results from cycles of sensemaking and sensegiving, as group members attempt to influence other actors’ interpretations (Gioia & Chittipeddi, 1991; Hill & Levenhagen, 1995).

Despite the fact that prospective sensemaking underpins fundamental organizational processes, such as those mentioned above, this process is underresearched and undertheorized. Available models provide an insightful but incomplete conceptualization, as little is known of the social interaction and cognitive work that underpin the transition between individual development of new interpretations (Hill & Levenhagen, 1995) and collective engagement in giving a sense of emerging interpretations to relevant stakeholders (Gioia & Chittipeddi, 1991).

In summary, a review of past literature indicates that, with the partial exception of studies of organizational crises, collective sensemaking is usually

described as based mainly on conversational practices. Recent research, however, suggests that understanding sensemaking mainly in rhetorical and linguistic terms may lead one to overlook the important ways in which material practices and artifacts affect the process, as discussed in the next paragraph.

Materiality and Conversation in Collective Sensemaking

In management studies, a growing body of research on organizational artifacts (see Bechky, 2008) has highlighted the symbolic properties of material items in shaping how individuals make sense of and give sense to an organization (e.g., Rafaeli & Vilnai-Yavetz, 2004) or their position in its social structure (Pratt & Rafaeli, 2001).

More recent studies, however, suggest that individuals also use various types of artifacts to support the construction of new understandings as they engage in prospective sensemaking. Strategists, for instance, use PowerPoint presentations (Kaplan, 2011) and other visual and textual artifacts (Denis, Langley, & Rouleau, 2006) as they collectively define new courses of action. Drawings, models, and prototypes assist product developers as they evaluate and refine new ideas (Ewenstein & Whyte, 2009; Sutton & Hargadon, 1996) and exchange understandings across professional communities (Bechky, 2003; Carlile, 2002). Finally, the collective production of tridimensional representations of an organization’s strategy (Buergi, Jacobs, & Roos, 2004; Buergi & Roos, 2003; Heracleous & Jacobs, 2008) or identity (Oliver & Roos, 2007) has been shown to facilitate the emergence and the articulation of tacit assumptions and beliefs.

Findings from these studies resonate with research in the sociology of science that shows how scientists use a variety of tools, documents, and instruments to support scientific inquiry and argues that the “openness” (the interpretive ambiguity) of these “epistemic objects” facilitates the collective production of new belief structures (Knorr-Cetina, 1981, 1999; Rheinberger, 1997). Research on the social construction of technology similarly points to the role of visual artifacts, such as white boards (Suchman, 1988), sketches, and drawings as both “interactive communication tools” and “individual thinking tools” (Henderson, 1991: 459).

More generally, research in cognitive psychology suggests that cognition is “distributed”: it does not consist only of individuals’ mental representations and operations but rather interacts with a material environment “rich in organizing resources” (Hutchins, 1995: 2). Therefore, to fully understand

cognitive work, one should look at the interaction between individuals and the various artifacts that they build, use, or surround themselves with. Central to this perspective is the notion of “cognitive artifacts” (Norman, 1991: 17)—such as calendars, to-do lists, or computational devices—that facilitate various mental processes by extending the capacity of the brain to store and process information (Clark, 2008; Clark & Chalmers, 1998),

Taken together, these studies suggest that material artifacts support cognitive work, at both the individual and collective levels, as well as the transition from one level to the other, and that they may do so differently from discursive artifacts. However, although the influence of material artifacts and practices on cognition is acknowledged throughout the social sciences and well documented in management studies, how these artifacts and practices enable individuals and groups to construct new understandings is largely missing from theories of collective sensemaking.

METHODS

Our study combined participant observation with grounded-theory building to investigate practices of collection, production, manipulation, and use of material artifacts in product design.

Research Setting

Research site. Continuum is an international design consultancy headquartered in Boston (www.continuuminnovation.com). At the time of our study, the Boston office employed over 130 employees, including product designers, engineers, graphic designers, and model makers. Employees were organized into three overall groups: Strategy, Product, and Brand, responsible for formulating guidelines for product design based on consumer analysis, for executing engineering and product design, and for brand building and communication, respectively. To reduce potential biases associated with the specific professional background of group members or an intended project outcome, we studied one project from each group: Strategy’s Project Transport, Product’s Project Health, and Brand’s Project Window. Table 1 presents an overview of the projects. Only in the case of Health were designers asked to produce technical specifications of a physical object.

Design as sensemaking. The essence of design has been described as “making sense of things” (Krippendorff, 2006: i). Particularly in the initial stage of concept development, design can be considered as open-ended problem solving, character-

ized by a high level of ambiguity with respect to both final solution and context (Clark, 1985). As one of our informants observed, at the beginning of a project “things are not defined at all”: multiple possible directions may be taken, and multiple interpretations about the final solution seem plausible. Accordingly, our informants described the structure of projects as a “funnel”: an iterative process based on the continuous refinement of emerging ideas.

The design process at Continuum. Most literature on how material artifacts affect collective sensemaking in product development has focused on cross-community interactions in the advanced stages of prototyping and testing (e.g., Bechky, 2003; Carlile, 2002). Our study, instead, focused on the “concept development” stage, when designers attempt to produce new understandings of users and their needs, and of products and their design attributes (see Table 1).

Conceptually, the process can be interpreted as *the gradual construction of new shared understandings* in the form of new “mental models” (Johnson-Laird, 1983): shared mental representations of key elements of groups’ tasks and environments (Klimoski & Mohammed, 1994). In an initial phase, designers in each studied group interacted with clients to build a common understanding of the goal of their project and, in particular, of how to interpret the client’s “brand pillars” (a common term at Continuum and among its clients). A research phase followed, in which designers engaged in various activities (collecting objects, interacting with users, etc.) to inform the reconceptualization of elements of their task (goals, users, uses, etc.). In the following phase, designers individually developed new interpretations of design attributes, in light of mental representations of other elements of the task produced earlier. Later, they exchanged, compared, and integrated provisional interpretations in multiple iterations, until they converged on what they referred to as a “big idea”—a new concept based on the integration of emerging understandings of various elements of the task.

It could be argued that the inherently visual nature of design, as a discipline aimed at the creation of tangible deliverables, and designers’ specific training in processing information visually rather than verbally, might have led our informants to make a particularly intense use of material artifacts to support sensemaking. We argue, however, that these features actually made our setting an “extreme case”—an ideal setting in which the phenomenon of interest is “transparently observable” (Pettigrew, 1990: 275). Such a setting facilitates investigation of dynamics that characterize, albeit

TABLE 1
An Overview of the Projects

Characteristic	Transport	Health	Window
Product type	Automobile for new mothers	Hospital chair	Seasonal design of retail window
Brand pillars	"Exciting and enduring," vehicles that are "within reach"	"Design as a way to solve significant problems"	"Network, value, and capability"
Target users ^a	"Stay at home" vs. "working moms"	Patients and caregivers	"Advanced connected" vs. "voice dependent"
Users' needs ^a	Organization of the needs of each group according to Maslow's hierarchy helps categorize the needs of target users as "It works," "I'm safe," "I belong," "I'm successful," "I'm still me"	Patients: Be in the chair rather than in bed as much as possible, elevate legs, etc. Caregivers: transfer patients in and out of the chair, clean under and around the chair, washable and durable materials, etc. Functional: While sitting, patients engage in various different activities (eating, dozing, reading, receiving guests, bathing, etc.) Symbolic: Sitting in a chair marks the transition from sickness to recovery Aesthetic: A sheet ("chuck") on the chair avoids unpleasant skin contact	Needs and features of each segment are compared according to "dependence for both personal and business," "active shopping," and "interest in and usage of advanced features"
Patterns of interactions with the object ^a	Functional: Safety, price, energy consumption, comfort, etc. Symbolic: vehicles help make personal statements and signal social status	Symbolic: Sitting in a chair marks the transition from sickness to recovery Aesthetic: A sheet ("chuck") on the chair avoids unpleasant skin contact	Symbolic: Use of brainstorming to produce 450 visual and verbal interpretations, embodying meanings commonly associated to the selected retail seasons (Valentine's Day, Back to School, and Winter Holiday), and to Sprint's brand pillars (network, value, and capability)
Relevant design attributes ^a	The five needs areas are used to organize eight relevant areas of innovation for the new vehicle, labeled as "managing identity, change, life, interactions, confidence, people, stuff, and expectations"	Search for new aesthetic paradigm (bright colors, simple and elegant shapes) and innovative functional features (moveable armrests, adjustable seatback, reclining mechanism, no footrest) to provide "wellness" and inspire "optimism"	Definition of three potential approaches to connect with season: decorative elements ("seasonal cues"), coherent settings to create product relevance ("season in context"), and brand policies to establish symbolic "ownership" of the season ("Season TM")
"Big idea"	A vehicle that allows to preserve, and affirm users' identity ("It's still me"), while being reliable, safe, comfortable, and within reach	A hospital chair aimed at stimulating wellness and inspiring a sense of optimism in both the patients and the guests who see and use it, by encouraging mobility, offering independence to patients, as well as communicating a sense of "home"	Definition of three meaningful themes ("reinvented traditions," "rescue," and "relationships") inspired by brainstorm, to establish ownership of the season and create a "unique and holistic seasonal experience," coherently with Sprint's brand pillars

^a Emerging from designers' interpretive work.

less visibly, other settings, such as strategy making (e.g., Gioia et al., 1994) or new product development (e.g., Rafaeli et al., 2006), in which groups collectively construct new mental models.

Data Collection

Data collection followed common recommendations for ethnographic work (e.g., Jorgensen, 1989; Spradley, 1980; Van Maanen, 1979) and combined archival search, participant observation, formal semistructured interviews, and informal talks. Table 2 describes our data sources and how we used them.

Over ten months, the first author spent from four to five days per week and from six to eight hours

per day in the field, participating in project meetings and conducting formal interviews, but also attending social events and having informal and impromptu conversations. Initially, she took quick notes at different points during each day to closely document Continuum's structures and work practices as she observed them (Emerson, Fretz, & Shaw, 1995; Fetterman, 1998; Lofland, Snow, Anderson, & Lofland, 2006). After a few weeks in the field, she was granted full access to and participation in the three projects. During project meetings, she would constantly jot field notes in a small pad focusing on the interactions between informants and on the material traces that these interactions left (on boards, walls, etc.) and trying to capture as much conversation as

TABLE 2
Data Sources and Use

Data Source	Type of Data	Use in the Analysis
Archival data	<i>Company-related documents:</i> Guide for newcomers, internal presentations of the three groups, guidelines for project managers, maps of the development process.	Familiarize with the organizational context.
	<i>Project-related documents:</i> Design briefs, meeting minutes, project updates, correspondence with stakeholders, clients' presentations.	Support the reconstruction of the set of concepts produced in each project (Table 1). Support, integrate, and triangulate evidence from observations and interviews.
Observations (617 pages double-spaced)	<i>Field notes from meeting attendance (79 meetings):</i> Detailed record of social interaction, conversations, and use of artifacts observed in the three projects from the early stages until final presentations.	Produce a map of the material practices and the artifacts that were used or produced as members engaged in these practices (Table 3), and link material practices with the outcome of project work. "Triangulate" interpretations emerging from interviews.
	<i>Informal conversations.</i> Informal talk with managers, designers, engineers, and support staff, ranging from brief exchanges to longer talks before and after meetings and during work breaks.	Familiarize with the organizational context, gain trust of informants, discuss insights from observation, clarify uncertainties regarding project-related decisions, and support emerging interpretations.
	<i>Pictures.</i> Visual documentation of material and textual artifacts produced during work meetings (boards, thumbnails, sketches, etc.).	Keep record of the outcome of practices that members engaged in during the projects (e.g., group sketching, material assemblage, bucketing, etc.), and share it with the second author.
Interviews (598 pages double-spaced)	<i>Preliminary interviews (17)</i> with all senior and middle managers, to investigate Continuum's history, culture, and work processes.	Familiarize with the organizational context.
	<i>Debriefing interviews (15)</i> with 12 team members (out of 15), to discuss insights or observations gathered during project meetings; we interviewed key informants for each project twice, at the beginning and at the end of the projects.	Integrate observations with informants' accounts, to improve our understanding of social dynamics and project-related decisions.
	<i>Focused interviews (24)</i> on how the use of material artifacts supports informants' work; the composition of informants (13 for Product, 6 for Strategy, and 5 for Brand) reflected the relative weight of each group within the company.	Investigate cognitive subprocesses supported and/or enabled by different material practices and artifacts (Table 4).

possible verbatim. She would then expand these notes every night recounting "what happened" in detail while memories were still fresh (Emerson et al., 1995: 14), eventually producing 617 double-spaced page of extended field notes.

In the beginning, design teams would frequently peer at her pad and ask questions about her observations. After a few weeks, however, they became acclimated to her presence, stopped paying attention to what she was "discovering" and writing, and increasingly involved her in project work. Lacking a design background, her participation in the projects consisted in the performance of marginal roles (e.g., gathering information, taking minutes, taking pictures). Drawing upon overt involvement and not performing the role of a team member in a strict sense, she managed to balance the roles of participant ("going native") and observer (remaining objective) (Spradley, 1980).

Ethnographic observation was supported by 56 formal interviews: 17 preliminary interviews with senior managers on Continuum's history, culture, and work processes, 15 debriefing interviews with members of the project teams, and 24 interviews focused on the use of objects, carried out with team members. Preliminary and focused interviews followed different protocols, and debriefing interviews had a more open format because they were aimed at discussing specific insights or observations gathered during project meetings. Recording and transcribing all the interviews yielded 598 double-spaced pages. Theoretical considerations led the selection of informants and differed for the three types of interviews. Preliminary interviews included all senior and middle managers at Continuum. Debriefing interviews aimed at capturing members' accounts of project work included 12 out of 15 members of the three project teams. (All members were contacted, but only 12 of them agreed to be interviewed.) Key informants for each project were interviewed twice, at the beginning and at the end of the projects. Finally, for the interviews focused on artifacts, the first author sat with the coordinators of the three main company groups (Strategy, Brand, and Product) and together they identified a list of members to be contacted for each group, using a mix of seniority, background, and other characteristics as criteria. Most informants (30 out of 45 contacted) agreed to be interviewed. The number of people interviewed for each group (13 for Product, 6 for Strategy, and 5 for Brand) reflected the three groups' relative weights—in terms of number of employees—inside the company. Our series of interviews terminated when we felt we had reached "theoretical saturation" (Glaser & Strauss, 1967).

Data Analysis

Step 1. Tracing individual and group-level practices of sensemaking. During the three projects, conversations among members and tentative verbal articulation of emerging interpretations were obviously essential to members' moving from early individual ideas to a collectively agreed upon reconceptualization of users, uses, and product features. As they conversed, however, group members frequently used or produced material artifacts to support forms of engagement in cognitive work and patterns of social interaction that informants described as distinctive practices and labeled accordingly ("bucketing," "thumbnailing," etc.). In an early stage of analysis, consistently with our research question, we combined field notes with interviews to carefully map the material artifacts that members used and the material practices—understood as patterns of behavior involving the collection, production, manipulation, or use of one or more types of material artifacts—that they engaged in during the projects. Table 3 characterizes the material artifacts and presents the labels informants gave them.¹ As we did so, we also kept trace of the conversational practices they were usually associated with. As conversational practices have already been amply discussed in previous research, however, for the sake of simplicity, we acknowledge them as part of the process in both text and figures, but we do not present fine-grained observations about them.

Step 2. Tracing cognitive subprocesses of sensemaking. In a second step of analysis, we used interview data to investigate the cognitive subprocesses that, according to informants, material practices and artifacts supported and enabled. Following past research on sensemaking (e.g., Corley & Gioia, 2004; Maitlis, 2005), data analysis relied on common procedures for grounded-theory building (Locke, 2001). We used interview transcripts as primary data for the analysis, and we used field notes to support and refine the interpretation of emerging categories and to guide the integration of categories into an overall framework.

¹ Disentangling conversational practices from material ones could be accomplished in theory, but less so in practice. Few practices were purely conversational or purely material. On the one hand, conversational practices were frequently associated with the use of material artifacts, as team members wrote on boards and/or personal notes, used visual imagery to illustrate their interpretations, etc. On the other, the production, assembly, or elaboration of material artifacts eventually resulted in verbal articulation.

TABLE 3
Material Practices and Artifacts Collected, Used, and Produced during Conceptual Design at Continuum

Aggregate Material Practices	Micro Material Practices ^a	Artifacts Produced
Material classification	<p><u>Material assemblage.</u> In the research phase, designers used <i>pictures</i> to produce understandings of fundamental elements of the task ("visual library meetings"); they collectively created boards gathering pictures expressing desired design attributes either in form of formal features ("image boards") or emotional responses ("mood boards"). At times, they collected artifacts related to a particular user into special <i>user rooms</i> to help members grasp particular systems of users' meanings.</p> <p><u>Bucketing.</u> Designers grouped and regrouped <i>cards</i> and <i>Post-its</i>, searching for patterns that helped them produce a taxonomical understanding of elements of their task (e.g., users, forms of user interaction). Later, they "bucketed" <i>thumbnails</i> embodying early ideas, to move from initial intuitions to provisional understandings of design attributes.</p>	<p><u>Boards and user rooms.</u> Collections of visuals and text resulting from the research phase.</p> <p><u>Boards.</u> Collections of visuals and text from research or preliminary reflections</p>
Visual integration	<p><u>Thumbnailing.</u> During the creative exploration phase, designers individually produced a high number of rough and simple drawings. These "thumbnails" were the very first visual manifestation of ideas about the design attributes.</p> <p><u>Group sketching.</u> During meetings and "creative reviews," designers would often sketch together on white boards or combine individual <i>thumbnails</i> into more refined drawings derivative of the entire group's inputs, but not intended as finished work</p> <p><u>Frameworking.</u> Later in the process, members, individually or collectively, produced visual representations that traced connections (causality, association, sequences, etc.) among understandings of different elements of the task.</p> <p><u>Storybuilding.</u> Designers conceived the presentation of the "big ideas" as a story, illustrated through the display of previously produced material (<i>pictures, boards, sketches, and frameworks</i>) organized into a PowerPoint presentation.</p>	<p><u>Thumbnailing.</u> Small freehand drawings on paper</p> <p><u>Sketches.</u> Relatively detailed freehand drawings.</p> <p><u>Frameworks.</u> Visual representations of linkages between elements of the task.</p> <p><u>Slides.</u> Combination of text and images</p>
Material memory	<p><u>Browsing and collecting.</u> During user research, designers perused books, magazines, collections of images, and personal collections of objects; they leafed through catalogues and looked at store windows for "inspiration" in task-related and unrelated domains. They took pictures, and videotaped interviews and users' interactions with objects, and created "user cards"—pieces of cardboard reporting textual and visual information—to collect insights, pictures, and excerpts from interviews.</p> <p><u>Brain dumping.</u> Team meetings were regularly held within <i>project rooms</i>. During early meetings, designers would pin on the wall pictures and boards illustrating all the cues that they had gathered in the research phase (<i>pictures, objects, cards, boards</i>). Later they regularly added <i>sketches, and frameworks</i> resulting from individual and group work. Often, designers stayed in project rooms even outside meetings, when working on the project.</p>	<p><u>Pictures.</u> Visual imagery, snapshots and films</p> <p><u>Cards & Post-its</u></p> <p><u>Objects.</u> Samples and other task-related objects.</p> <p><u>Project rooms.</u> Physical spaces collecting all project-related artifacts</p>

^a The names of artifacts are in italic.

In a preliminary stage, we both engaged in open coding of interviews, searching for relevant text segments—phrases and passages that referred to how and why artifacts were used in the development process. We initially labeled these segments with "in vivo" terms and phrases used by the informants (Locke, 2001: 65). Following multiple readings of data, we gradually combined in vivo

codes that, although varying in specifics, were similar in essence, into first-order categories (Locke, 2001). At the end of this stage, we compared the separate coding structures, and we resolved discrepancies through discussion and occasional re-coding of data. To ensure the faithfulness of our emerging account to our informants' vocabulary and interpretation, we labeled most first-order

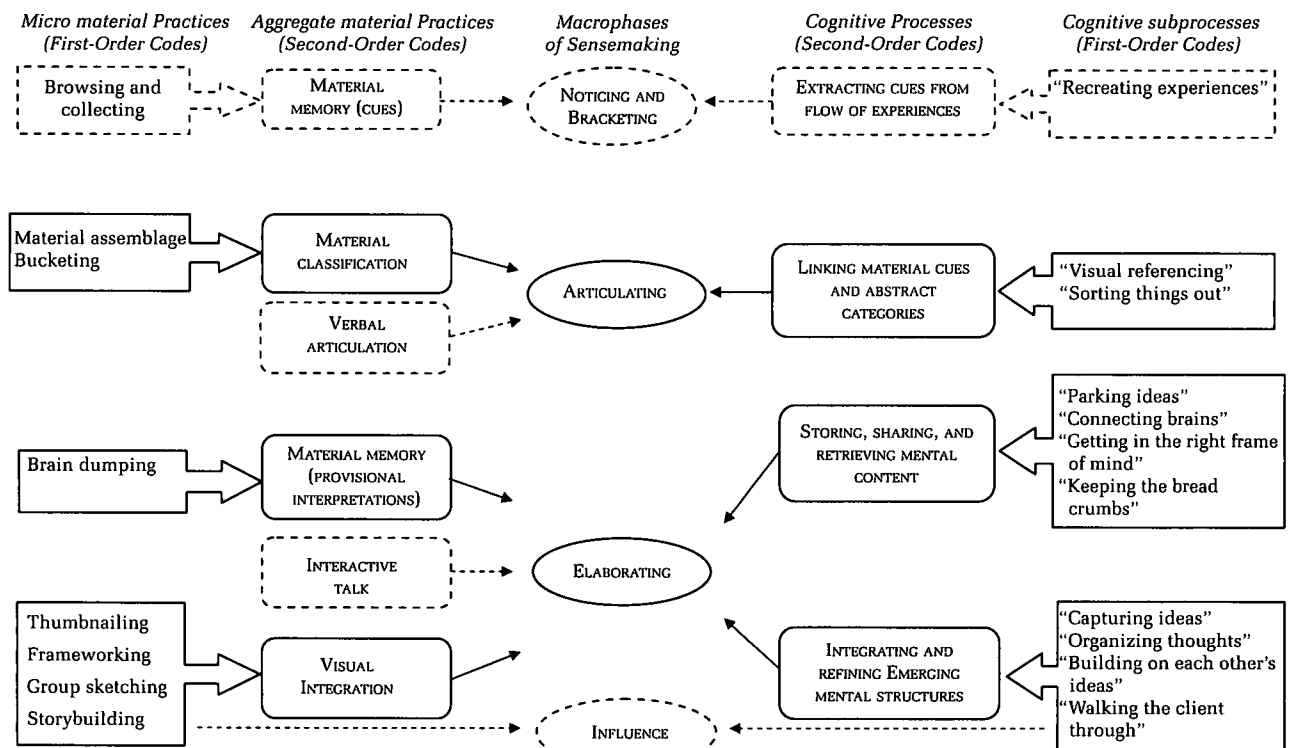
codes with metaphorical expressions alluding to physical engagement with abstract cognitive structures (“capturing ideas,” “connecting brains,” etc.) used by informants to explain how material artifacts and practices supported cognitive work.

In a further round of coding, we tentatively combined first-order categories—describing, in informants’ terms, various ways in which material practices and artifacts supported cognitive work—into fewer, broader, and theoretically relevant second-order categories associated with more general cognitive processes supported by these practices. Finally, drawing on the content of interviews and field notes, we associated material practices with cognitive subprocesses. Using this analysis, we gathered material practices into three groups according to the type of cognitive work that they enabled. Following past research adopting a similar analytical approach (e.g. Corley & Gioia, 2004; Harrison & Corley, 2011), we present the resulting data structure² in Figure 1.

² The dotted boxes and lines indicate parts of the process not discussed in detail in this article. In particular, the dotted lines at the bottom of the figure indicate practices and cognitive processes that marked the transition between intragroup sensemaking and intergroup sensegiving (influence).

Step 3. Building a grounded theoretical framework. As core categories emerged from the analysis of material practices and cognitive processes, we turned to axial coding (Strauss & Corbin, 1990: 123) to uncover relationships among our observations. The observation that different material practices were used at different times and that different practices were associated with individual and/or group-level cognitive work led us to organize our emerging interpretations into a multiphase, multilevel process model accounting for how material practices interact with conversational ones and support cognitive work in collective sensemaking. Combining a map of organizational practices resulting from ethnographic observations with informants’ accounts of how these practices supported cognitive work, we produced a grounded model of how material and conversational practices support collective, future-oriented sensemaking efforts. Following Locke (2001: 76), we tested alternative conceptual frameworks until we assembled our categories into an overarching model fitting our evidence. To increase the reliability of our overall interpretation, we routinely submitted provisional interpretations—at various stages of the analysis—to some informants for feedback. We present the interpretative framework that emerged in the next section.

FIGURE 1
Data Structure



FINDINGS

Collective sensemaking at Continuum rested on the interplay between conversational and material practices. Informants traced connections between the production and use of material artifacts and specific cognitive subprocesses that allowed them to gradually combine cues into tentative understandings of their task and to integrate and refine provisional interpretations into a more complex set of interrelated mental structures.

In Figure 2 we describe the process as it unfolded in the three projects we observed. On the left-hand side, the figure unpacks the material practices that supported collective sensemaking and the cognitive subprocesses that, according to informants, these practices facilitated. On the right-hand side, the figure shows how these material practices, combined with conversational ones, enabled different stages of the sensemaking process. As the dotted feedback lines indicate, the process proceeded through multiple iterations, and there was no exact correspondence between the cognitive macrophases and the levels at which the process unfolded. During the process, members alternated individual work with group meetings, during which

their tentative ideas were shared, debated, discarded, or refined. The individual and the collective levels blended into each other, as people articulated individual ideas partly in conversational practices with the rest of the group and, conversely, group interaction generated cues that stimulated further individual cognitive work.

In the remainder of this section, we intertwine a detailed narrative of our ethnographic observations with theoretical insights generated by interviews (Eisenhardt & Graebner, 2007). To provide a comprehensive overview of the process, we describe all four phases. However, as the initial phase, “noticing and bracketing,” and the final phase, “influence,” are well known in the literature, we focus our analysis on the less explored phases, “articulating” and “elaborating.” Selected quotes supporting our emerging interpretation are displayed in Table 4.

Phase 1: Noticing and Bracketing

An argument of sensemaking theory is that individuals are constantly immersed in a flow of stimuli, only few of which are attended to (Weick,

FIGURE 2
Micropractices and Macro-phases of Collective Sensemaking at Continuum

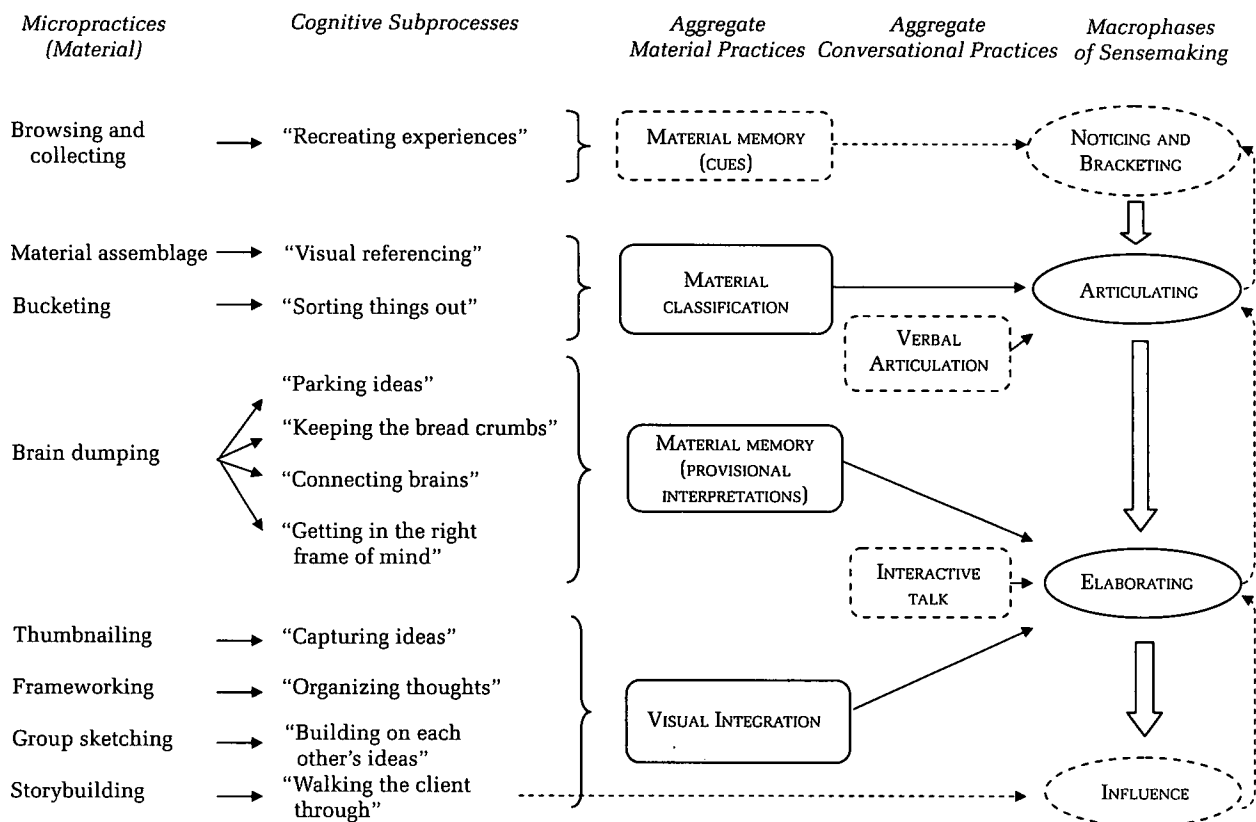


TABLE 4
Material Practices and Cognitive Subprocesses: Additional Evidence

Second-Order Codes	First-Order Codes	Representative Quotes	
Linking material cues and abstract categories	Visual referencing	Often, the words our clients use do not say much, unless you translate them into images. That is why we build mood boards. Images help give meaning to words. . . . They link values to the specific object [of the project]. (EG, Product) The mood board was on the word "inclusive," and it really helped me to see how differently each person interpret a word and how they visually see the word or translate this word into images. It opens up a lot of opportunity for me to visualize the feeling of inclusion. (CY, Brand) If we design, for example, a car for teenagers, we would make the project room into a teenager's room. We would put posters of Avril Lavigne, paint on the walls, or a sofa, just so that you're in the mindset of a teenager. You're no longer a 27 year-old designer: you're an 18 year-old teenager. (BW, Strategy Group)	
	Sorting things out	I lay them out, look at all of them together, and see if there are recurring ideas, groups (GF, Product) Right now we're trying to put everything on little cards or post-its, so you can put them up on the wall. Then we'll move them around, and group them. (JS, Strategy) We have all these drawings and sketches up on a white board, and we look at them, we move them around, we group them. It's really, really helpful to sort things out. (EY, Brand)	
	Integrating and refining emerging mental structures	Capturing ideas	What I try to do first, and this happens in the thumbnails, is, I try to get everything I have right now in my head out of it. (CY, Brand) Sometimes I just sketch on paper just as a reminder to myself of something that I thought of; you know, just to capture ideas. (KH, Strategy) Thumbnails happen all the time, basically to quick capture ideas. . . . They're small little ideas that you see and put down. (MA, Product)
		Organizing thoughts	When I have these ideas down, and I'm really trying to organize my thoughts, especially when I have a presentation coming up, I'll draw a little thumbnail of what I anticipate the content is going to be . . . I make a little rough sketch of what the layout would be." (DV, Product) Frameworks are a way of thinking, a way of looking at part of what we saw and trying to see similarities and connections that we might not have seen during the research phase. (PB, Strategy)
Building on each other's ideas		If you have three or four people on a project, everybody's sketching, everybody's feeding off each other, you're building off . . . you might take one person's idea and then build off those sketches and build other things from that. (JW, Product) So, I get feedback on sketches, my own sketching—sketches for me are generated from a group giving me input, while thumbnails are typically generated by me just thinking through something. (GB, Brand Group) This page is an example of a conversation I had with somebody that where we're trying to figure out how we're going to build something and I drew something, they drew something, I drew something, so we draw on each other. (RC, Product) If I consider this as a ladder, then [artifacts] become. . . . This [thumbnail] is personal. This [sketch] is more social. . . . It's like a pyramid, as you go on more and more and more people have reviewed and been involved. (GB, Brand).	
	Walking the client through	So we often show thumbnail sketches step by step. . . . It helps the clients see the different processes and steps (JS, Product) It facilitates their understanding of what's going on, of how and why we've come to those conclusions and those results. Having pictures and models in front of them helps them to understand the process we went through, what's happened. . . . —It just makes it clearer (CC, Brand) All the frameworks up there are like pieces of the story. And some of them, in the end, end up working to tell the story, and some of them are like pieces of another story that we didn't pick. But by just sort of rearranging them you could support how we developed a whole bunch of ideas. (MAF, Strategy)	

Continued

TABLE 4
(Continued)

Second-Order Codes	First-Order Codes	Representative Quotes
Storing, sharing, and retrieving mental content	Connecting brains	Just putting everything up so you can also see what other people are thinking. (JS, Product) Being surrounded by it, it's almost like your brain a little bit. . . . It's like pieces and sometimes you just haven't . . . it's sort of serendipity but sometimes you just notice some connections that you wouldn't have noticed if they weren't all together. (HR, Strategy) It's very hard to work at your desk by yourself, because it's like designing in a vacuum. Project rooms are the anti—vacuum. It's a sharing of ideas. I could put something up in here that could totally change everybody's attitude towards something. (GB, Brand)
	Parking ideas	Whenever I start a project, I always make a parking lot. While I'm doing research and an idea occurs to me, I put it in the parking lot, because you're not ready to design yet but you don't want to forget about that thing. (JS, Product) It's pinned to the wall right over there, and you can immediately make that connection between that thing and this other thought that you had two weeks later that is on the wall over there. (KH, Strategy) It's nice to just have a kind of war room, as I call it, when you just leave everything out, and when you need some inspiration you just go down there and you have everything that you need for the project right in front of you. (CC, Product) [The project room] might make you recall things that you forgot. It might make you see something in a different way. It might make you catch something you didn't see before. (GB, Brand)
	Keeping the breadcrumbs	The project room ends up being like a little bit of the timeline of . . . there's a little bit of chronologicalness to it. (HR, Strategy) I think it's important to keep like the breadcrumbs so you can find the way back; it represents the end of a phase. This is where we were, this is what we thought, and it captures all our ideas. (GF, Product) Even though when you write stuff down it's not permanent, at least it's like a stake in the ground, it's a marker saying "Remember? We talked about this, and we decided this," and I feel it when we talk about things, and we don't have those little reminders. (KH, Strategy)
	Getting in the right frame of mind	It's important to wrap yourself around what it is you're designing, wrap yourself around images that inspire you, wrap yourself around the current products that are on the market that need improvement . . . and also to be around each other to exchange those ideas. (DV, Product) It's nice to have a project room, because, it puts you into that frame of mind, into that experience (GB, Brand) [Working in a project room] is more like how to almost immerse yourself with everything that that project is about and nothing else. So, it helps you focus more into that. (MA, Product)

1995). Sensemaking starts when these stimuli, or "cues," are extracted from the flux of experience ("bracketed") for further cognitive work (Weick et al., 2005). Consistently with this idea, in the three projects we observed, designers initially immersed themselves in task-related experiences intended to feed reconceptualization of task elements. They interviewed relevant stakeholders and filmed or photographed how they interacted with relevant objects. They collected samples of products and cut both product-related and more general images out from magazines. All these artifacts represented "embodied experiences" that would be made permanently available for the interpretive process that

occurred later, as members—first individually, then in groups—produced new provisional interpretations of elements of the task, in the form of emerging mental models.

Phase 2: Articulating

The early sign of members' attempts to bring order to this flow of experience was the combination of bracketed cues into tentative and ill-defined new understandings of various elements of the task—a phase we refer to as *articulating*. In sense-making theory (e.g. Weick, 1995; Weick et al., 2005), articulation generally refers to verbal expres-

sion of tentative interpretations. In fact, as displayed in Figure 2, at this stage, members relied on various conversational practices that helped them *verbally articulate* tentative understandings. These practices involved the production and use of long lists of features (e.g., the desired aesthetic features of a new hospital chair); metaphors (Gioia et al., 1994) (e.g., the hospital chair as a "blanket," or Sprint as a "hero to the rescue of its customers"); or taxonomical classifications of competitors (see Porac, Thomas, Wilson, Paton, & Kanfer, 1995) or products (see Rosa, Porac, Runser-Spanjol, & Saxon, 1999).

As they attempted to verbalize new understandings of elements of their task, however, group members also systematically engaged in practices that involved the production and/or manipulation of material artifacts to support concept formation in a nonverbal way. These practices supported the infusion of abstract categories with new meanings by linking them to groupings of material cues. We collectively refer to these practices as *material classification*.

When confronting abstract concepts or unfamiliar objects, members would frequently support verbalization by assembling visual imagery and previously collected objects (a practice we refer to as *material assemblage*) or by grouping and regrouping cards reporting cues from the research phase (what they referred to as *bucketing*). Both these practices were characterized by members' physically engaging with cues embodied in visible and tangible form (photographs, cards, other objects) to construct new mental categories and imbue them with meaning.

In the beginning of the project, designers used so-called image boards or mood boards (see Table 3) to build new understandings of elements of the task, such as brand pillars, users' needs or lifestyles, and desired product features. Project members would browse collections of images, pictures from the preliminary phase, or personal files for visual imagery that they associated analogically with the focal concepts and assemble them into large posters. Designers eventually combined *material assemblage* with lists of features to articulate new understandings emerging from the research phase. In an early meeting of Project Health, for instance, designers used an assemblage of images of hospital chairs and pictures from their hospital visits to elicit a list of words like "discouraging," "depressing," "sterile," and "cumbersome" that they associated with the "sense of illness and pain" that, in their view, current products conveyed.

Informants considered the assembled images essential to the construction of new understandings,

as these images allowed them to support the verbal articulation of ambiguous abstract concepts with multiple "visual references"—concrete cues that tapped into preexisting meaning structures, stimulating analogical association. As an informant³ observed:

You can make these comparisons or similarities to things that exist out there already, that people are familiar with. And I think it helps. . . . Like if someone says "rugged," you might not really know what they mean, but if you show a picture of a Jeep, then you know what they mean. . . . You show a picture of Mel Gibson. . . . It's all about coming at the word at every possible angle, so that we get this whole, well-rounded visual description of it. (CC, Brand Group)

Occasionally, in other projects in the firm, although not in the three projects we observed, material assemblages took the form of "user rooms," where members collected various objects that they associated with particular users to acquire an understanding of their general needs and lifestyle, or of more abstract concepts such as "girls' friendships" or "retirement," and to develop ideas accordingly.

During each project, group members would also engage in the tentative grouping and regrouping of simple artifacts (Post-its or cards) representing cues or, in some cases, preliminary ideas, to facilitate the development of broader categories. For instance, during the initial phase of Project Transport, members tried to understand what explained the relative willingness of target users to accept or reject a minivan as a preferred vehicle. To do that, they used cards representing the mothers they had interviewed, including pictures, demographic information (age, number of kids, owned cars), significant quotes, and interviewers' observations. Grouping these cards on the basis of variables such as daily schedules, lifestyles, aspirations, and emotional needs initially led members to identify three main groups—"stay at home," "part-time/new career," and "full-time job"—later reduced to two, as the team realized that cards did not show significant differences in self-image, daily needs, and purchasing behavior between the last two groups (see Tables 1 and 4). The same practice applied also to tentative visual representations of early ideas embodied in the "thumbnails" described in the next subsection (see Table 3), as illustrated by an industrial designer working on Project Health:

³ Initials in parentheses refer to the name of the informant who is quoted.

When you look at all [the thumbnails], you sort of start seeing groups, and that's what Mike did there. He grouped them into these groups driven by the three concepts of pillows, soft slab, and blanket. (GF, Product Group)

According to informants, the physical manipulation of experiences and ideas embodied in tangible form (pictures, cards, Post-its, thumbnails) helped "sort things out"—that is, organized these experiences and ideas on the basis of patterns of difference and similarity. They observed that the possibility to "see" their thoughts and ideas right in front of them and to physically "move them around" facilitated the detection of commonalities, emergence of themes, and their assembly into broader groups or categories that the informants would later label and define verbally. Informants observed that using cards facilitated the intuitive discovery of patterns among features that were not necessarily defined a priori, as comparisons could tap into a richer memory of each encounter. In fact, categorization was often revised, as members recalled different memories of interviews that would make them change the initial categorization.

In summary, material assemblage and bucketing helped members move from a preliminary bracketing of their experience (as reflected in what they filmed, taped, photographed, collected, etc.) to tentative new understandings of users, products, and so forth. It did so by linking groupings of material cues with tentative abstract categories, using the cognitive structures associated with these cues to produce more general categorizations of elements of the task. Physical engagement with material artifacts often preceded the verbalization of emerging ideas and supported the collective refinement of early verbal accounts (or the emergence of new ones). Cognitive theory describes the formation of new mental models as resulting from the sorting of specific experiences (objects, events) into more general classes on the basis of perceived similarities and differences (Porac & Thomas, 1990). In this respect, the embodiment of cues in material form facilitated the organization of the experiences that these artifacts embodied, by allowing members to consciously and collectively combine visual cues to imbue ambiguous categories with meanings ("visual referencing") and construct new categories from the detection of similarities and differences among cues ("sorting things out"). Only later would they articulate the distinctive features in words. We return to the influence of materiality on cognition at the individual and group level in the Discussion section.

Phase 3: Elaborating

As new understandings emerged (*articulating*), cognitive work increasingly shifted to the gradual integration of these understandings into more complex mental structures linking various elements of the task environment (*elaborating*). Research on shared mental models in teams describes the development of collective mental structures as the gradual assembly of simple components through the forging of links among them (Fiske & Dyer, 1984). In this respect, by "articulating" we refer to the cognitive work that underlies the construction of "components" (manifested, for instance, in the reconceptualization of task elements), whereas by "elaborating" we refer to the tracing of connections among them. Although conceptually distinct, articulating and elaborating were in fact intertwined, as the attempt to link emerging understandings of elements of a task occasionally triggered the need for a team to revise their interpretations over the course of multiple iterations between the two phases of the process.

Elaborating occurred mostly during group meetings, as members engaged in interactive talk—verbal exchanges of tentative understandings and discussions of possible linkages between them. Even during this phase, the conversation was assisted by the material practices that members engaged in to support the sharing, integration, refinement, preservation and recovery of emerging structures.

Visual integration. During the elaborating phase, designers would engage in various material practices—which we refer to as *thumbnailing*, *frameworking*, *group sketching*, and *storybuilding*—that relied on the visualization of tentative linkages among emerging mental structures.

As the research phase neared its end, team members began working individually to produce new interpretations of design attributes that were consistent with the emerging reconceptualization of users, use, brand pillars, and so forth. These interpretations first manifested themselves as small visual representations that designers referred to as "thumbnails" (see Table 3). They ranged from formal and functional features to "conceptual and iconic ideas" that represented early attempts to envision new interpretations of product features or communication themes that would address emerging understandings of user needs, brand pillars, etc. In Project Window, for instance, a map of the United States with two dots at the opposite coasts and a phone framed in a heart in the middle was used to express the idea of "phone as the extension of your love relationship."

Our informants considered the production of thumbnails—or *thumbnailing*—an early step in the elaboration of ill-formed ideas, preceding the attempt to give these ideas verbal expression, and used them as “building blocks” to develop more refined interpretations. As an informant insightfully put it, thumbnails allowed them to combine cues, which had been “sitting in the back of their minds,” into tentative ideas⁴ and helped them “capture” these ideas before they were “lost” in the flow of thoughts (see Table 4). By bringing ideas “out of the mind,” thumbnailing provided designers with “physical handles”: something tangible that could support the conscious examination and elaboration of emerging interpretations. As an informant observed: “How can I know what I think, if I don’t see what I think? Or if I don’t express what I think I see?” (GB, Brand Group). By acquiring material form, ill-defined initial insights “became” ideas to be subjected to retrospective assessment.

According to informants, although thumbnails allowed them to “capture ideas,” more complex artifacts helped them “organize thoughts”—that is, draw connections between early ideas and integrate them into more complex mental representations. These artifacts involved a broad range of visual representations (matrixes, graphs, diagrams, etc.) that informants collectively referred to as “frameworks.” During Project Transport, for instance, the group produced a framework integrating a classification of consumers’ needs with insights about possible new product features. During an early bucketing session, members had organized generic needs of new mothers resulting from interviews into five areas (“nurture,” “peace of mind,” “love/bond,” “integration,” and “affirmation”) and arranged these areas over a pyramidal representation, borrowed from Abraham Maslow’s hierarchy of needs. Later, they decided to use the same framework to organize a list of over a hundred needs specifically related to a vehicle, also captured in the research phase, into five main categories (“It works,” “I’m safe,” “I belong,” “I am successful,” “It’s still me”), and to use these categories to organize “areas of innovation” for the new vehicle, visually connected to the needs by using color codes.

⁴ This observation is consistent with research on creative cognition describing creative outcomes as the result of the progressive refinement of “pre-inventive structures,” defined as incomplete and untested early ideas; mental representations holding some promise of producing novel and useful concepts, to be “generated, regenerated, and modified throughout the course of creative exploration” (Finke, Ward, & Smith, 1992).

During a debriefing interview, an informant admitted how important such *frameworking* had been for the project because, at that stage, the group “had a lot of ideas” but “didn’t have a way to organize them in a way that made sense” (HR, Strategy Group). Both individually and during group discussions, members had attempted to build several frameworks combining and recombining early ideas. The process ended when they found a combination that gathered the consensus of the entire group; or, in other words, the process lasted until they achieved a “feeling of order” required for sensemaking to stop (Weick, 1995: 29).

Group sketching was another way to stimulate the integration of early individual ideas into more refined interpretations resulting from collective interaction (see Tables 3 and 5). Sketches resulted from free-hand drawings and/or the physical juxtaposition of early ideas embodied in thumbnails. As an informant remarked:

Sometimes we cut them up and move them around, making a sort of collage. So, it’s really important to have paper print-outs because that is a part of our process, that we combine different ideas into one by cutting them and pasting onto each other. (CY, Brand group)

In Project Window, for instance, sketching sessions ended with the walls of the meeting room covered with individual sketches and other types of free-hand drawings, combined and displayed to present a more elaborated version of the ideas they were initially intended to convey.

Informants considered group sketching crucial in the gradual integration of early individual ideas and in the collective refinement of the result, a process they referred to as “building on each other’s ideas.” They perceived the increasing sophistication of the artifact as reflecting the gradual incorporation of different individual ideas and observed how the physical presence of material artifacts facilitated the exchange of feedback, by providing a common visual referent to lead and structure the discussion (Table 4).

As projects entered a more advanced stage, the conversation gradually shifted toward the arrangement of intuitive insights, often based on “gut feelings” into a “defensible story”—a practice we refer to as *storybuilding*. In essence, storybuilding consisted of collective preparation of a set of slides that would be used to present the big idea to the client. Storybuilding, however, was important to *both* group-level sensemaking and intergroup sensegiving. As sensemaking overlapped with sensegiving, the need to reassure clients about the appropriateness, reasonableness, and coherence of emerging

concepts forced members to retrospectively reassess the cognitive work leading to final solutions. Consistently with the nature of the sensemaking process they were engaged in, team members seemed to consider plausibility as more important than accuracy (Weick, 1995). As an informant observed:

In the end, there are a lot of good ideas, and I think there's a lot of ways that we could have solved this problem. We could have probably picked any of those big ideas and done a different versions of it, but to me the idea isn't as important to the client or to me as the whole story of "Why that idea?" (HR, Strategy Group)

While crafting the "story," team members selectively used artifacts produced throughout the process (boards, thumbnails, sketches, etc.) to reconstruct a plausible line of interpretation, among the several ideas they had pursued, assessed, and discarded (see Table 4)—a process they referred to as "walking the client through."

In summary, in the elaboration phase, the visual integration, connection, juxtaposition, or sequencing of representations of tentative understandings of elements of a task seemed to facilitate cognitive work aimed at forging links between these understandings at both individual (capturing ideas, organizing thoughts) and group (organizing thoughts, building on each other's ideas) levels. The physical rearrangement of visual representations of emerging ideas—as manifested in the revision of the sequence of a set of slides, in the redrawing of a framework, or in the recombination of different sketches—supported the evaluation of emerging interpretations, as members searched for a sense of order among multiple ill-defined understandings and provisional connections that would reassure them of the plausibility of their emerging interpretation (walking the client through).

Material memory. Informants observed how the embodiment of cues and ideas in material form also supported conversational practices and cognitive work by extending the capacity of members to store, retrieve, and share mental content. To some extent, practices of material memory supported cognition in all phases of the process. As mentioned earlier, in the bracketing phase, collecting, taping, and filming fixed the flow of experience and made cues permanently available for later cognitive work. The relevance of these practices increased, however, as the process progressed through the articulation and elaboration phases as members set up a so-called project room—a practice they referred to as "brain dumping"—and they used it as a common workspace throughout the

process, to facilitate the sharing of mental content across members and its retrieval over time.

At Continuum, every project was assigned to a "project room," where members would collect all project-related material, gather for project meetings, and frequently linger even when working individually. As projects progressed, group members would gradually pin things on the walls: pictures, thumbnails, boards, frameworks, and other visual or material artifacts that would help members share their experiences and their thoughts with the rest of the team and keep track of the products of collective work. Informants occasionally referred to this practice as "dumping" the content of their brains onto the walls of the project rooms (see Table 4).

Individually, *brain dumping* supported cognitive work by recording early ideas and making them available for later cognitive work. During group discussions, members recorded tentative ideas on boards hanging on the walls as soon as these ideas were verbalized. Informants referred to this function of project rooms as "parking ideas," and they mentioned how being constantly exposed to these artifacts allowed them to "notice connections that you wouldn't have noticed if they weren't all together" (HR) or to identify linkages that they had not previously thought of (see Table 4).

Informants observed how the relative openness of the visual representations pinned on the walls, which were rarely associated with detailed descriptions, allowed their reinterpretation over time in light of evolving cognitive work to produce new tentative elaborations. During Project Transport, for instance, the big idea eventually revolved around the notion of "It's still me." "Still me/no compromises on style" initially emerged from an early bucketing of a mother's car-related needs. The idea was written on a Post-it and hung on a board named "Big Ideas." In the following meetings, many other ideas were produced, discussed, and discarded. Members eventually retrieved the notion of "still me" while talking about the importance of the vehicle's preserving its users' identity. They refined "still me" as "It's still me" and added to stylistic preferences other sides of "me," such as family, social, and professional sides.

"Dumping" everyone's "brain" on the walls also made individual experiences and ideas permanently accessible to the rest of a group. Project rooms acted as a shared cognitive space, facilitating the trace of connections among individual ideas. Informants mentioned how the ability to "look at other people's thoughts and ideas" allowed them to more easily and quickly combine early ideas, taking the first step toward the development of a com-

mon interpretation. An informant aptly described this function as "connecting brains."

According to informants, exposure to artifacts gathered in a project room also influenced the "frame of mind" with which they approached their tasks by stimulating rapid and often unconscious "retrieval from memory" of emerging understandings. As an informant explained:

You might be attracted to specific [artifacts on boards] that are just be kind of sitting there, in your subconscious and in your conscious. And you respond to it as you sketch. . . . You look at it, it's in your memory, and you think about it while you're drawing. (AM, Product Group)

Artifacts included in a project room embodied the result of earlier interpretive processes and had acquired project-specific meanings that members drew upon as they engaged in further cognitive work.

Finally, informants observed how having all their ideas pinned up on the walls helped them "keep the bread crumbs" throughout the process. Designers were often engaged in more than one project, and project rooms also served as "stakes in the ground" supporting the recollection of evolving group interpretations: the cues that triggered reflections, the provisional articulation of new understandings, and the multiple tentative linkages among them (see Table 4). As members engaged in story building, having "dumped their brains" regularly during the project eventually facilitated the retrospective reconstruction of the cognitive path leading to the selected interpretations.

In summary, the embodiment of experiences and ideas in material form supported sensemaking by making the mental content they represented permanently accessible to team members (connecting brains), for reuse in prospective (getting in the right frame of mind, parking ideas) and retrospective (keeping the bread crumbs) cognitive work. By conveying relationships to mental structures already available to team members, embodied cues and ideas facilitated the retrieval and use of these structures in the interpretive process (Gioia, 1986).

Phase 4: Influence

Tentative connections between provisional understandings encouraged further revisions and, occasionally, exposure to new experiences until the groups felt confident enough in their emerging interpretations to present them to their clients. In the phase we refer to as *influence*, group-level sensemaking eventually blended into intergroup sense-

giving, as group members met with clients to gain approval on the emerging ideas.

In this final phase, sensemaking and sensegiving were inextricably linked. On the one hand, the urge to provide a convincing account pushed team members to refine and revise their interpretations several times. On the other hand, consistently with models of future-oriented sensemaking that describe the process as an iterative cycle between sensemaking and sensegiving (Gioia & Chittipeddi, 1991), as members engaged in sensegiving, they occasionally collected feedback that prompted them to reconsider their emerging interpretations, triggering a new phase of elaboration (and possibly articulation and bracketing).

A GROUNDED MODEL OF COLLECTIVE FUTURE-ORIENTED SENSEMAKING

Before discussing the theoretical implications of our observations, let us recapitulate the cognitive work involved in the transition from the individual to the collective level of analysis in the future-oriented, collective sensemaking process we observed. The process began with the purposeful exposure of team members to experiences (interviews, field observations, casual browsing in magazines, etc.) that were expected to feed the constructions of new understandings of elements of a task—still largely undetermined at this stage. Team members deliberately attempted to record relevant "chunks of experience" (*noticing and bracketing*) in material form, such as pictures, images, objects, to share them with the rest of the team and make them permanently available for cognitive work. Team members would occasionally carry out some of these activities (e.g., filming or interviewing) in small groups, but the cognitive process would mainly unfold separately for each individual, as members preselected relevant sets of cues and/or intuitively began to (retrospectively) loosely relate some of them to one another.

In the second phase (*articulating*), team members attempted to more consciously organize these embodied experiences into emerging new understandings. They used material cues to retrospectively tap into individual experiences and bring them to bear on the process. Linking abstract categories with assemblages of material cues helped members fill these categories with meanings resulting from perceived overlaps, similarities, and differences in the concrete experiences embodied in these cues. The articulating phase was partly carried out individually and partly in group. Members used preliminary assemblages to tentatively organize cues into intuitive ill-defined concepts, which were made

available to the rest of their group through the assembled artifacts. The refinement of these artifacts—and the mental structures they embodied—occurred as members jointly engaged in the manipulation and rearrangement of assembled cues through successive iterations. At this stage, *verbal articulation* and *material assemblage* were intertwined. Individuals used combinations of words and images to express their tentative understandings, by producing retrospective verbal descriptions of intuitively assembled cues. The gradual convergence of group members occurred as groups merged, enriched, pruned, and rearranged preliminary assemblages, until they produced a satisfactory order in the organization of material cues (and the meanings that these cues evoked).

In the third phase (*elaborating*), provisional understandings of elements of the task were tentatively integrated to produce a more complex interpretation of a possible, prospective redefinition of the relationship between objects, producers, and users. This interpretation was conceived in narrative form, and in this respect it can be considered an emerging collective account (Maitlis, 2005). The construction of this account largely occurred as groups engaged in *interactive talk*. Even at this stage, however, material and conversational practices were intertwined, as the embodiment of individual tentative connections in material form (rough thumbnails, early versions of frameworks, etc.)—a practice we refer to as *visual integration*—facilitated exchange of provisional understandings and collective engagement in the assessment, merger, and refinement of these understandings. The process continued until the group felt that they had produced a plausible interpretation of their task; that is, they had made retrospective order out of the massive amount of cues that they had gathered at the beginning of the project. Embodiment of cues and emerging ideas in material form (*material memory*) also facilitated their storage, retrieval, exchange, and integration over time and among members.

In the final phase (*influence*), sensemaking was replaced by sensegiving, as the groups attempted to persuade clients about their “preferred interpretation” (Gioia & Chittipeddi, 1991) of the task. Future-oriented accounts were outlined through a retrospective reconstruction of underlying cognitive process and the disclosure of cues and fragments of interpretations produced along the way. At this stage, clients occasionally challenged a group’s interpretation, pushing members to reconsider their emerging interpretations and engage in a new round of elaboration and articulation (as expressed by the dotted feedback lines in Figure 3).

DISCUSSION AND CONCLUSIONS

Our study of designers’ work helped us produce a fine-grained account of the cognitive processes as well as the social and material practices involved in the gradual organization of individual experiences and in the group-level integration of ill-defined early ideas into new and more refined shared mental structures that occurs when people engage in future-oriented collective sensemaking. By unpacking the social practices that the process rests upon, our study improves understanding of the infrastructure that supports social interaction (Jarzabkowski, 2003: 24) and the resources (Jarzabkowski et al., 2007: 9) available to individuals as they engage in prospective sensemaking.

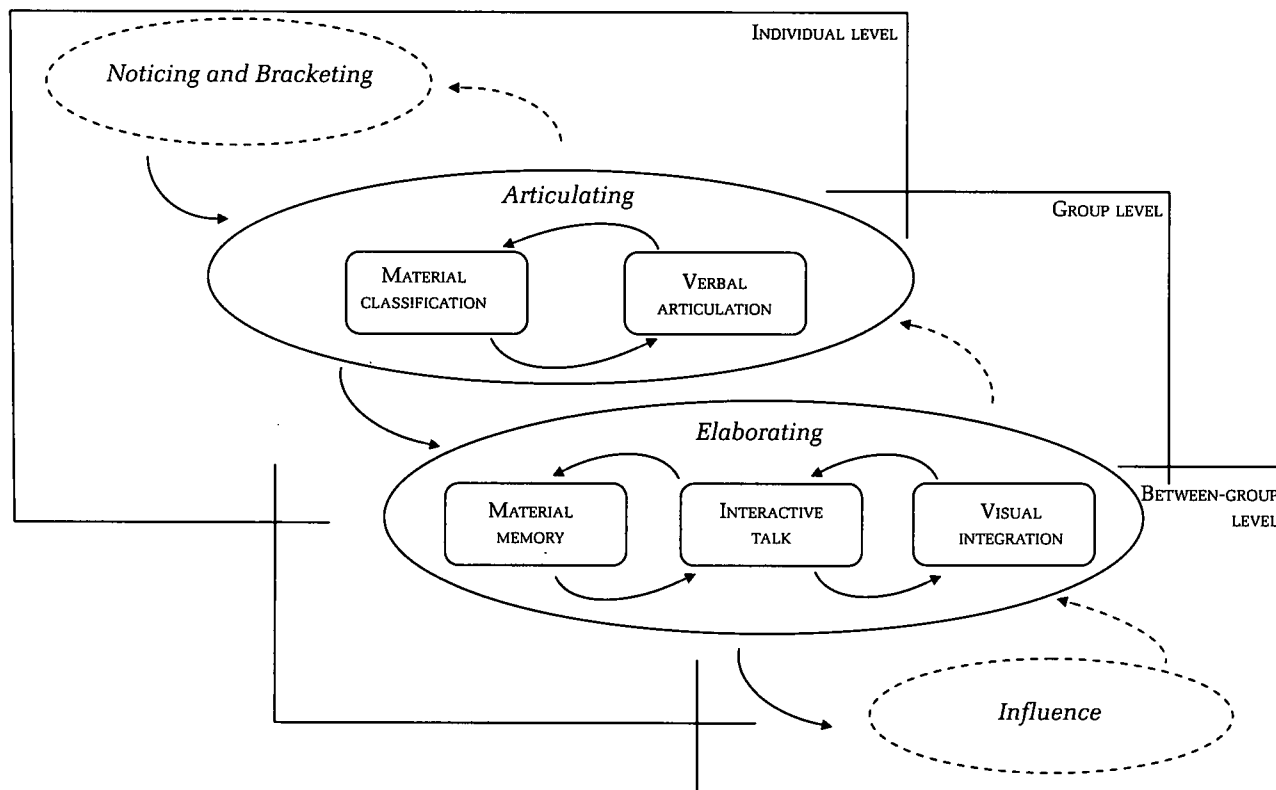
For the sake of simplicity, Figure 3 portrays the sensemaking process we observed as a linear sequence of four macrophases (noticing and bracketing, articulation, elaboration, and influence) unfolding at three different levels (individual, group, and intergroup). However, as illustrated in the previous section, the process is likely to proceed in multiple iterations both across levels (as indicated by the overlap between phases across levels) and across phases (as indicated by feedback dotted lines).

In the remainder of this section, we discuss the implications of our observations for the theory and practice of collective sensemaking.

Extending Theories of Future-Oriented Sensemaking

Our study suggests how extant models provide only a partial account of prospective sensemaking, as they tend to overlook the processes that underlie the mindful collective construction and refinement of new interpretations. By doing so, our study answers a call for “an expansion to the domain of sensemaking to include both prospective and retrospective elements” (Gioia & Mehra, 1996: 1230). Current representations of the cognitive underpinnings of sensemaking (e.g., noticing, bracketing, labeling, and other named subprocesses) largely reflect the traditional retrospective form (e.g. Weick, 1995; Weick et al., 2005). Weickian theories of sensemaking describe interpretation as the tentative “attachment of meaning” to a cue (Weick, 1995). The novelty or ambiguity of the circumstances that trigger sensemaking would suggest that available mental structures are not appropriate to explain the situation those circumstances comprise: new structures need to be constructed or new linkages need to be traced among available structures. Our model begins to unpack this fundamen-

FIGURE 3
A Process Model of Collective Future-Oriented Sensemaking



tal phase in prospective sensemaking, by shifting attention to the articulation and the elaboration of new mental structures (as opposed to the labeling of unfamiliar events based on currently available ones) that occur between the individual bracketing of experience and tentative collective action.

Weickian theories of sensemaking tend to skip articulating and elaborating, compressing them between tentative labeling and action. During crises, time pressure may hamper verbal articulation and the elaboration of provisional interpretations. Precise agreement is not required for action, and people eventually reach consensus by adjusting to evolving events (Weick & Roberts, 1993). During future-oriented sensemaking, instead, more relaxed time pressure provides the opportunity for the prolonged and conscious articulation and elaboration of tentative interpretations. Past research, however, provides only a partial and incomplete account of these phases. Hill and Levenhagen (1995) focused on individual cognitive work, proposing how metaphors support the articulation of future-oriented mental representations. Gioia and Chittipeddi (1991), instead, highlighted the iterative cycle of sensemaking and sensegiving that occurs as actors negotiate new interpretations with other actors, but

these authors remain silent about how these interpretations come to be in the first place. Our model fills the gap between these theories, by outlining cognitive processes and social practices that underpin transition from individual cognitive work to intergroup cycles of sensemaking and sensegiving, providing a more comprehensive representation of collective future-oriented sensemaking.

The lack of fully fledged theoretical accounts of prospective sensemaking can be ascribed to the difficulty of questioning the fundamentally retrospective nature of interpretations. Building on Schutz (1967), Weick (1979, 1995) convincingly argued that people can only assign meanings to events that have already transpired. Accordingly, prospective cognitive work happens as individuals engage in "future perfect thinking" (Weick, 1979: 199)—that is, as they "envision a desired or expected future event and then act as if that event had already transpired" (Gioia, Corley, & Fabbri, 2002: 623). Accounts of prospective sensemaking have documented instances of this approach in the projection of aspirational organizational images, aimed at aligning members' beliefs with the ambitions of organizational leaders (Gioia & Thomas, 1996). Thinking in future perfect tense, however, seems

less appropriate to explain prospective cognitive work when expectations or aspirations about the future are ambiguous or unclear, as often occurs in product development or strategy making. We believe that our model reconciles the forward-looking nature of the collective effort with the retrospective nature of its individual cognitive underpinnings, by describing prospective collective sensemaking as based on three interrelated cycles of retrospective cognitive work.

As outlined in Figure 3, the first cycle of retrospection occurs as group members deliberately immerse themselves in task-related experiences (rather than casually being exposed to them), to produce novel understandings of the environment (*noticing and bracketing*). New retrospective interpretations begin to arise as members go back and forth between the tentative organization of selected cues and the refinement of corresponding labels (*articulation*), eventually producing new understandings of elements of their task environment.

A second cycle is associated to the gradual establishment of linkages among emerging understandings (*elaboration*). Members produce and reflect upon multiple and incomplete new mental structures in parallel, gradually refining them into more complex provisional interpretations of their task. The expression of tentative linkages in verbal or material form allows members to bracket their flow of thought and to make these provisional interpretations available for retrospective assessment.

Finally, the need to give sense of emerging interpretations to external actors (*influence*) induces group members to engage in retrospective reflection to establish the plausibility of prospective accounts by reconstructing the chain of thought leading to them. It is in this phase that the multiple possibilities embodied in the various incomplete and emerging structures are eventually brought to closure and linked in one set of recommendations for a new course of action.

The Materialization of Cognitive Work

Current conceptualizations of sensemaking emphasize the centrality of language, talk, and communication in the development of individual and collective interpretations. According to Weick, "Sense is generated by words that are combined into the sentences of conversation to convey something about our ongoing experience" (1995: 106). Our study extends and enriches the prevailing portrayal of sensemaking as a preeminently linguistic activity by drawing attention to how material practices influence individual and group-level cognitive work.

Our observations resonate with recent work in cognitive psychology maintaining that the manipulation of their physical environment allows individuals to amplify their cognitive capacity (Hutchins, 1995). In line with these ideas, insights from our study suggest that the physicality of material artifacts extends the capacity of individuals and groups to process mental content, as it allows these artifacts to serve as external repositories of mental structures and to support more conscious engagement in cognitive operations (storage and retrieval of mental structures, categorization of experience, integration of mental structures) that are usually carried out below the threshold of consciousness.

Our informants repeatedly alluded to this phenomenon—which we refer to as the *materialization of cognitive work*—as they used several metaphors ("capturing" or "parking" ideas, "organizing thoughts," "dumping" and "connecting" brains, etc.) that pointed to how material artifacts allowed them to physically and consciously engage with the mental structures that they embodied.

Material artifacts and individual sensemaking. Making sense of events requires "stepping outside one's lived experience and analyzing it retrospectively" (Gioia, 1986: 61) (see also Weick, 1995: 26). In this respect, by acquiring material form, experiences and ideas become "separated" from individuals' minds and "available to more conscious processing." As is implicit in Weick's observation about how one cannot really know what one thinks, until one sees what one says (Weick, 1995), verbal utterances perform a similar function. Unlike talk, however, material artifacts are intrinsically durable (Pratt & Rafaeli, 2006). Although subject to natural decay, they constitute a relatively permanent embodiment of experiences and ideas and, as such, they facilitate team members' prolonged retrospective reflection and organization of these experiences and ideas (Buerger et al., 2003). Extracted from the flow of experiences or "captured" from the flow of thoughts and embodied in material form, cues and ideas become "sensemaking resources" (Gephart, 1993) team members can store, retrieve, manipulate, and—as discussed later—share and combine more easily with other team members.

The benefits of the conscious engagement with the production, manipulation or use of material artifacts are partly explained by the fact that the "externalization" of cognitive work partly compensates for inherent limits in the capacity of a human brain to store, retrieve, and process mental content (Clark & Chalmers, 1998; Larkin & Simon, 1987). During meetings, for instance, material artifacts served as repositories of less refined, task-specific

mental content to support relatively short-term mnemonic processes underpinning the construction of new mental structures. Practices of material memory made bracketed cues (and the experiences that they are directly or indirectly associated with) and tentative fragments of interpretations permanently available and salient for cognitive work involved in the categorization of experience (articulating) or in the construction of linkages between emerging mental structures (elaborating). By doing so, they helped compensate for the restriction posed by attentive memory to designers' capacity to process all the information regarding their task (Kolko, 2010). In the long term, as the frequent use of expressions such as "parking ideas" and "keeping the breadcrumbs" suggest, images, boards, sketches, frameworks pinned on the walls constantly exposed members to reminders of earlier cognitive work, facilitating the (often unconscious) retrieval and re-use of the cues and ideas that they embodied. Members could then more easily bring these ideas "back into the conversation" and effectively integrate them in the emerging interpretations, as discussed later.

Obviously, practices of material memory could only reproduce part of the original experience or idea. Similarly, visual imagery alluded to experiences of engagements with objects, places or people (and therefore evoked meanings) that could be in part personal and unique. In this respect, as highlighted in the findings, the collective engagement in practices of material assemblage or grouping of individual experiences facilitated the emergence of possibly different recollections or interpretations. Nevertheless, as discussed later, these differences were reconciled as the "visual order" embodied in emerging boards, sketches, groupings, etc., reflected gradual convergence around a "conceptual order" in collective interpretations (Henderson, 1991; Suchman, 1988).

Prolonged visual and material engagement also supported cognitive work by taking advantage of perceptual inferences associated with the visual processing of information, such as the detection of conceptual linkages between pieces of information that closely located in visual representations (Larkin & Simon, 1987). Similarly to how, as described by Clark and Chalmers (1998), Scrabble tiles are used to facilitate the organization of unrelated letters into a word, the embodiment of experiences and ideas in material artifacts (pictures, cards, slides, etc.) facilitated the classification of these experiences and ideas into emerging mental categories or their arrangement into sequences, by allowing designers to move them around, group them, rearrange them, etc. In the same way dia-

grams support scientific discoveries by spatially grouping pieces of information to be used together (Cheng & Simon, 1995), the physical juxtaposition of visual or material cues facilitated the perception of similarities or causal linkages among the chunks of experiences or ideas that these cues embodied. As outlined in Figure 3, the visualization of provisional mental structures through practices of material assemblage and visual integration supported the ongoing articulation and elaboration of emerging interpretations—as manifested in the revision of assemblages or sequences of slides, in the redrawing of a framework, or in the recombination of different sketches—and facilitated the retrospective assessment of the coherence and plausibility of the tentative groupings, linkages, and sequences underpinning the emerging conceptual order.

These observations are consistent with research in both strategy and design studies. Buergi and Roos (2003), for instance, observed that the use of three-dimensional metaphorical representation of an organization's strategy allows for a "physical experience" of the relatedness of different concepts or different viewpoints. Similarly, research on design traces a link between physical engagement with embodied experiences and ideas and a search for relationships among these experiences and ideas, as the following description of designers' work suggests:

The designer begins to move content around, physically placing items that are related next to each other. . . . This process is less about finding "right" relationships and more about finding "good" relationships. . . . Labeling makes obvious the meaning that has been created through the process of organization. (Kolko, 2010: 19)

Informants pointed to this process by using metaphors such as "capturing ideas" or "organizing thoughts" that alluded to team members' physical engagement with mental content. They referred to these artifacts as their "visual support" or "physical handle," suggesting how their materiality was essential to sustain the construction of provisional interpretations. In fact, some informants reported how at times ideas emerged through relatively free and nonpurposeful manipulation of matter (drawing, molding, assembling images, etc.), which generated cues that were captured and then gave rise to early "fragments of interpretation" to be refined at a later time.

These observations point to a relationship between materiality and cognition qualitatively different from current understandings in sensemaking theory. Sensemaking theory maintains that interpretation occurs as the abstract (a preexisting men-

tal structure) is linked to a material stimulus (a cue) to produce meaning (Weick, 1995: 110). Weick and colleagues (2005) refer to this act as "labeling." As mentioned earlier, however, this conceptualization hardly explains the construction of new mental categories. In the teams we investigated, it was the manipulation of the material that supported the production of new abstract concepts and their infusion with meaning, by enabling the transition between (empty) abstract categories to concrete experiences, and then again from concrete to abstract. In some cases, tentative labels predated interpretive work; in others, new labels arose from the organization of cues and ideas. In both cases, the infusion of labels with meanings occurred as team members gradually outlined conceptual boundaries for these abstract categories—that is, they defined attributes that they perceived to be associated to the category (Mervis & Rosch, 1981)—through the conscious organization and manipulation of concrete cues, based on perceived patterns of difference and similarity.

Materiality and the transition from individual to collective sensemaking. Current understandings of collective sensemaking place emphasis on the multiple sensegiving acts the process rests upon (e.g., Maitlis, 2005), and the "discursive practices" that underpin them (e.g., Balogun & Johnson, 2004; Sonensheim, 2010). The diffusion of new interpretations tends to be explained in terms of the ability of some actors to produce persuasive accounts (Maitlis & Lawrence, 2007; Rouleau & Balogun, 2011). Consistently with this notion, material artifacts are generally considered to be nonverbal symbolic resources (Balogun & Johnson, 2005; Rouleau, 2005) that individuals use to influence the interpretations of others. Our observations extend this notion by showing how material artifacts support practices of collaborative construction of new interpretations and enable members to "make sense together" (rather than, or in addition to, "giving sense to one another"). By doing so, we extend scholarly understanding of how distributed individual attempts at sensemaking eventually result in the collective construction of new interpretations in future-oriented, collective sensemaking.

Implicit in current understandings of collective sensemaking is the notion that experiences and ideas are shared in the form of accounts (Maitlis, 2005) through which different actors propose tentative interpretations of ambiguous occurrences. In the absence of material records, however, the influence of these accounts on collective cognitive work is tied to perceptual and mnemonic processes that may cause people to filter out or forget parts of verbal exchanges they do not perceive as relevant at

the time they are encountered. Collective sensemaking, then, may really occur as individuals relate limited and imperfect recollections of other individuals' accounts.

As discussed earlier, instead, embodiment of cues and ideas in material form helped compensate for limits to individual memory and the fleeting nature of conversation. As the notions of "parking ideas" and "connecting brains" suggest, informants considered the material embodiment of experiences and ideas important to make these experiences and ideas permanently accessible and reusable, directly and independently from the initial accounts they were associated with. Group members could then more easily pick up others' experiences and ideas and link them to their own—possibly reinterpreting them in light of current cognitive work. Pratt and Rafaeli (2006: 286) observed how materiality facilitates "asynchronous" interaction between the producer and the user of an artifact. In this respect, the "materialization" of experiences and ideas supported temporally distributed, multilevel cognitive work, by enabling members to escape the current flow of the conversation and to freely recover and recombine fragments of earlier individual accounts into the emerging collective narrative.

Research on "boundary objects" shows how material artifacts act as "tangible explanations" facilitating the transfer of understandings across different communities (Bechky, 2003; Carlile, 2002). Insights from our study extend this notion by pointing to the role of material artifacts as "interactive tools" supporting the transition from individual to collective sensemaking by facilitating the emergence and the resolution of "representational gaps" among team members (Cronin & Weingart, 2007) and their collective convergence around new interpretations.

In the three projects we observed, pooling individual mental content and making it physically available to the rest of their team enabled members to collectively engage in the tentative organization, integration, and refinement of this "raw material" (through material assembly, bucketing, group sketching, etc.). The provisional artifacts created by designers—tentative boards, temporary groupings of cards, intermediate versions of sets of slides, etc.—served as evolving material representations of emerging collective interpretations. They represented the group's "negotiated ideas" and, by serving as "receptacles for knowledge created and adjusted through group interaction" (Henderson, 1991: 458), they helped organize socially distributed cognition within the teams.

According to informants, these artifacts provided “common reference” for collective conversations and, by doing so, helped bring out potential inconsistencies among members’ provisional understandings of relevant concepts and of the emerging relationships among them (Heracleous & Jacobs, 2008). Materiality per se did not entirely remove the ambiguity inherent in verbal exchanges (Bechky, 2003), yet the visualization of provisional interpretations anchored the conversation around elements and relationships outlined in the evolving representations. Boards, frameworks, and slides served as “shared interactional spaces” (Suchman, 1988) in which the search for a conceptual order progressed in iterations of verbal exchanges and alterations of visual representations (as outlined in Figure 3).

As the recurrent expression “building on each other’s ideas” suggests, informants considered the possibility of collectively producing or reconfiguring material artifacts important for engaging in cognitive work as a group, rather than individually. The visualization of the tentative structures that evolved as people collectively regrouped cards, rearranged slides, or worked on each other’s sketches made the tentative processing and generation of mental content by each individual more visible to the rest of his/her team, who could then more easily participate in the use, organization, and refinement of this content. Tentative additions from other members could be directly incorporated in emerging representations (boards, sketches, etc.), and these representations often preserved a visible trace of these tentative additions (or deletions) over time. This observation is consistent with past ethnographic accounts of engineers’ work, pointing to the coordinating role of visual representations as “interactive tools”:

In their early draft stages, drawings are used by designers as an interactive tool, in that they may be altered or corrected by someone other than the person who drew them. . . . As an interactive tool, sketches are the most direct way for an engineer to help form a concept in the mind of a colleague by giving form to concepts pictured in her or his own mind. (Henderson, 1991: 459)

By providing a common referent that all members could relate to and engage with at the same time, then, a material embodiment enabled the sharing of cognitive work (categorization of experience, construction of new mental models, etc.) that would otherwise occur individually (and, as discussed earlier, less consciously), facilitating the transition from individual to group-level sensemaking.

Transferability of Insights to Other Settings

Although some of the material practices we described in the previous section (e.g., thumbnailing, sketching, bucketing) are typical of the professional practice of designers, we believe that our insights about the sensemaking process and the materialization of cognitive work can be transferred (Lincoln & Guba, 1985) from our empirical setting to similar contexts in which individuals and groups engage in prospective sensemaking. In essence, design is about making new sense of an object, its potential uses, and contexts of use, and “forging connections” between these elements (Kolko, 2010: 22). Central to design, then, is a process of “meaning making,” manifested in the production of new mental models (Kazmierczak, 2003; Krippendorff, 2006). Consistently with this notion, the outcome of the projects we observed was not expressed in terms of formal and technical specifications for a physical object, but as a set of interrelated mental structures proposing a new conceptualization of products and consumers. The interpretive work underlying these projects, therefore, was not unlike other forms of prospective sensemaking, such as entrepreneurship (Cornelissen & Clarke, 2010; Hill & Levenhagen, 1995) and strategy making (Gioia & Chittipeddi, 1991), in which individuals or groups develop new mental models (of the market, a product, an organization) and attempt to convince relevant stakeholders to accept them.

In this respect, our observations appear corroborated by research on strategy making and organizational change describing similar processes in the accomplishment of less “visually oriented” tasks. The use of Lego bricks in organizational development programs, for instance, can be considered as a form of material assemblage aimed at collectively constructing new understandings of organizational strategy (Buergi & Roos, 2003; Heracleous & Jacobs, 2008) or identity (Oliver & Roos, 2007). Kaplan’s study of PowerPoint presentations shows how slides-in-the-making serve as a form of material memory (in which to “park” individual ideas as the process unfolds) and visual integration (to facilitate the exchange and merger of ideas) in strategy-making teams (Kaplan, 2011). Also, research on cognitive maps suggests how visualizing managers’ understandings of the relationships among elements of their strategy and competitive environment helps them reach convergence around collective cognitive structures (Langfield-Smith, 1992) and evaluate the coherence of the cognitive structures that these maps represent (Fiol & Huff, 1992; Huff, 1990).

In a different setting, Simon and colleagues (Cheng & Simon, 1995; Larkin & Simon, 1997) observed how the production and use of diagrams (a practice of visual representation and integration of different pieces of information) facilitates scientific discovery. Similarly Knorr-Cetina's research on laboratory work in various fields of the natural science suggests how various forms of visual representation produced in the course of experimental research support collective interaction in the production of new scientific knowledge (Knorr-Cetina, 1981, 1999).

Collectively, these studies suggest that our insights may be transferable to other settings, settings in which less visually oriented persons (e.g., strategists, scientists) engage in less visually oriented tasks (e.g., strategic planning, scientific research). Our emerging framework brings together these dispersed observations by providing a unifying theoretical account of how material and conversational practices support cognitive work and facilitate the transition from individual to group-level prospective sensemaking.

Implications for Future Research

We expect comparative replication of our analysis in more traditional (e.g., strategy making) as well as less conventional (e.g., criminal investigators, medical teams) settings to increase understanding of how different contextual conditions may lead to different patterns of interaction and use of artifacts. At Continuum, for instance, it is possible that the apparent absence of diverging interests within a group influenced the relative prominence of practices of intragroup understanding (sense-making) rather than intragroup influence (sensegiving). All members shared the same concern with presenting a story that their client would find credible and plausible. As sensemaking eventually blended into sensegiving, we could see artifacts such as sketches and frameworks, previously employed as epistemic objects to support understanding, being used as discursive resources to support persuasion and influence. Future research may purposefully select settings characterized by intrinsic divergence of interests among group members to investigate in more depth the interplay between material practices and political processes.

Future studies may also build on our insights and investigate more systematically the extent to which engaging in material and conversational practices and/or the types of artifacts used affect the quality of the process. Researchers interested in more microlevel processes may try to isolate the influence of materiality on sensemaking using experimental

research to compare the quality of the process and/or the outcome of tasks carried out by groups using different combinations of material and/or conversational artifacts. Alternatively, researchers more interested in the influence of collective practices on later stages of the process may search for naturally occurring experiments allowing them to compare the organizational outcome of product development or strategy-making initiatives making use of different combinations of material and discursive practices and artifacts.

Regardless of the design that researchers adopt, the fact that sensemaking is more about "plausibility" than "accuracy" (Weick, 1995) requires them to pay particular attention to defining a proper measure of quality. Insights from our study suggest that future research might focus on either the relative "efficiency" or "effectiveness" of the process. In the first case, researchers may focus on measures such as the number of ideas elicited and/or how quickly they are processed, or the rapidity with which consensus (on meanings) is reached in a group. In the second case, researchers may focus on later stages of the process and look at how the accounts produced with or without the use of material artifacts produce a more persuasive story (securing the consensus of stakeholders in the sensegiving phase) or a more actionable one (facilitating implementation and producing consequences that are coherent with the initial goals).

Implications for Management Practice

In conclusion, our findings cast new light on the growing debate on the application of design methods and tools to managerial processes (e.g., business innovation, strategy making) (e.g. Boland & Collopy, 2004; Brown, 2008; Martin, 2009). Advocates of "design thinking" argue that managers should learn to "think like a designer" (Brown, 2008: 85) and emphasize designers' mental processes (Martin, 2009), learning styles (Beckman & Berry, 2007), attitudes and dispositions (Brown, 2008), and intellectual skills (Clark & Smith, 2008). Our findings suggest instead that design thinking cannot be decoupled from "design practicing." Encouraging managers to embrace abductive thinking (Dunne & Martin, 2006) or take a systems view (Brown, 2008), may indeed produce limited results if managers are not trained in the material practices that complement and substantiate these different approaches to problem solving.

Taking design thinking seriously, then, means training managers to complement traditional analytical tools, largely based on the elaboration of quantitative information along predetermined cat-

egories, with practices of material classification and visual integration that stimulate open reconceptualization of products, clients, and competitors, and their integration into new strategies. Our findings encourage managers to consider these activities as important epistemic practices that take advantage of distinctive properties of material artifacts to facilitate the collective reconsiderations of the fundamental assumptions driving strategy making.

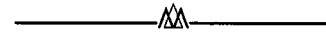
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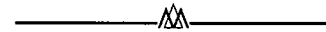
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