

Material artifacts: Practices for doing strategy with ‘stuff’

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ABSTRACT

This paper addresses the dearth of research into material artifacts and how they are engaged in strategizing activities. Building on the strategy-as-practice perspective, and the notion of epistemic objects, we develop a typology of strategy practices that show how managers use material artifacts to strategize by a dual process of knowledge abstraction and substitution. Empirically, we study the practice of underwriting managers in reinsurance companies. Our findings first identify the artifacts – pictures, maps, data packs, spreadsheets and graphs – that these managers use to appraise reinsurance deals. Second, the analysis of each artifact’s situated use led to the identification of five practices for doing strategy with artifacts: physicalizing, locating, enumerating, analyzing, and selecting. Last, we developed a typology that shows how practices vary in terms of their level of *abstraction* from the physical properties of the risk being reinsured and unfold through a process of substituting. Our conceptual framework extends existing work in the strategy-as-practice field that calls for research into the role of material artifacts.

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INTRODUCTION

From a strategy-as-practice perspective, strategy is not a static property of a firm but is continuously created in the doing of strategy work. Embedded in such doing are all kinds of ‘stuff’ to make strategy happen including routines and procedures, discursive resources and material artifacts (Whittington, 2007). There are increasing calls within the strategy-as-practice literature to focus on those material objects, such as whiteboards, spreadsheets, and PowerPoints, through which people do strategy work (Jarzabkowski, Balogun and Seidl, 2007; Jarzabkowski and Whittington, 2008; Kaplan, 2011; Whittington, 2003). However, the study of such objects and, in particular, the implications of the way that they interact with human activity in strategy making remains relatively underexplored (Jarzabkowski and Spee, 2009), with some exceptions (e.g. Kaplan, 2011; Molloy and Whittington, 2005).

The relative neglect of the role of material artifacts – those ‘things’ that are part of the everyday doing of strategy – in strategy research is in part due to inconsistent and overly broad definitions and theoretical conceptualizations of strategy practices, in which actors, objects and intentions are interwoven in a complex bundle of practices (Carter, Clegg, and Kornberger, 2008; Jarzabkowski and Spee, 2009; Reckwitz, 2002). In an attempt to rectify such shortcomings, we place our focus particularly on the material practices – the actual computers, desks, whiteboards, post-its, spreadsheets, telephones and other material objects – that are socially enacted in doing strategy (Jarzabkowski and Whittington, 2008; Whittington, 2007). These are part of the strategy work making up “the stuff of strategy, without which strategy work could hardly happen” (Whittington, 2007: 1579). Specifically, to address the identified gap in the current strategy-as-practice literature, we explore the following research question: *What roles do material artifacts play in accomplishing strategy work?* Consistent

with our strategy-as-practice approach, we define strategy work not only as strategy formulation but also as “the organizing work involved in the implementation of strategies, and all the other activities that lead to the emergence of organizational strategies, conscious or not” (Vaara and Whittington, 2012: 3).

We address our research question in the empirical context of reinsurance – that is the insurance of insurance companies. Specifically, we study underwriting managers’ practice of appraising reinsurance deals in order to better understand the roles of material artifacts in strategy work. A reinsurance firm’s strategy involves the allocation of capital to a portfolio of reinsurance deals. Reinsurance underwriting managers are critical for building the portfolio through their strategy work of appraising a spread of reinsurance deals across different territories with a view to maximizing returns on capital, whilst also ensuring portfolio diversification. While portfolio targets are set as part of the annual planning cycle, these are somewhat flexible, as underwriting managers continuously reevaluate the portfolio according to the returns they can achieve in relation to the market cycle. Consistent with other professional knowledge workers (Knorr-Cetina, 1999; Lowendahl and Revang, 1998), they are thus empowered to make decisions that shape their firms’ strategy. This paper examines the strategy work of underwriting managers in appraising reinsurance deals on properties located in Europe during the 2009/2010 annual reinsurance cycle. At this time, due to a softening cycle (Insurance Services Network), underwriting managers were appraising specific reinsurance deals with a view to adjusting the portfolio to counter potential rate reductions in different territories and on different deals. In doing so, they perform the strategy work that is central to their firm’s strategy of maximizing portfolio gains.

The process of appraising reinsurance deals is thus a salient context for studying strategy work because it enables underwriting managers to a) spread capital across diverse deals; b) select those deals that they believe will provide the best return on capital for their

firm. In appraising deals, underwriting managers' task is to grow the bottom-line and to seek opportunities to increase the top-line of the firm's reinsurance portfolio in order to achieve targets set in the annual strategic planning cycle. Inability to achieve these targets has a direct impact upon the firm's performance as capital may be underutilized or overstretched. At the same time, consistent with a strategy-as-practice definition, appraising reinsurance deals is mundane, everyday strategy work (Jarzabkowski and Whittington, 2008; Vaara and Whittington, 2012; Whittington, 2007) that constitutes the main activity for underwriting managers, who typically appraise several hundred deals throughout the annual cycle in order to fulfill their strategy portfolio. In doing so, they engage with multiple artifacts, such as photos, maps and spreadsheets, that are an inherent part of the process of appraising deals.

The paper takes the following structure. First, we review the strategy-as-practice literature, highlighting the dearth of empirical research into the role of material artifacts in strategizing. Second, we draw upon literature on epistemic objects and knowledge work in order to provide a conceptual framework for analyzing the situated use of material artifacts. Third, we outline the method of this in-depth qualitative study of appraising reinsurance deals. Fourth, we present findings about the practices of using five artifacts that are part of the everyday strategizing activity of appraising reinsurance deals. Fifth, we discuss these findings by introducing two concepts, abstraction and substitution, that contribute to our understanding of material artifacts in the strategizing process.

LITERATURE REVIEW

Strategy-as-practice: current trends and shortcomings

A practice perspective on strategy builds upon several seminal scholars in social theory, such as Bourdieu (1977; 1990), de Certeau (1984), Foucault (1977) and Giddens (1979). Strategy as a social practice is defined as 'a situated, socially accomplished activity constructed through the interactions of multiple actors' (Jarzabkowski, 2005: 7). The strategy-

as-practice approach thus moves from traditional concepts of strategy as something an organization has to something that people do. Strategy is a type of work, not just a property of organizations, which gives rise to questions about how multiple actors engage in doing strategy work and what practices they draw upon.

Strategy-as-practice scholars have provided a framework for conceptualizing the field, which highlights the praxis, practitioners and practices of strategy (Jarzabkowski et al, 2007; Vaara and Whittington, 2012; Whittington, 2006). Praxis refers to the flow of work, such as meetings, number-crunching, analyzing, form-filling and talking within which strategy is accomplished (Jarzabkowski and Whittington, 2008; Whittington, 2006). Practitioners are defined broadly to include managers at a range of levels, not simply top managers, as well as actors outside the firm, such as consultants, board members and gurus (Whittington et al, 2003). Practices involve the various routines, discourses, concepts and technologies that these actors draw upon in their strategy work, including such practices as strategy workshops (Hodgkinson, Johnson, Whittington and Schwarz, 2006) and business dinners (Sturdy, Spicer and Schwarz, 2006), as well as those practices embedded in various academic and consulting tools and techniques (Seidl, 2007) and in other technologies and artifacts, such as number systems (Denis, Langley and Rouleau, 2006) and visual aids (Molloy and Whittington, 2005).

As part of this growing body of literature into strategy practices, a number of scholars have looked at discursive practices and modes of strategizing (Jarzabkowski and Spee, 2009; Vaara and Whittington, 2012). For example, Rouleau's (2005) work illustrates how middle managers' specific discourses shape a clothing firm's strategic directions by aligning them to different stakeholders' needs. Others, such as Jarzabkowski and Seidl (2008), investigate meetings as episodes of strategizing. In their study, different practices for initiation, conduct and termination of a sequence of strategy meetings shapes either the maintenance of existing strategy by suppressing change, or initiates change by mobilizing support.

While empirical studies in the strategy-as-practice field have tended to emphasize the discursive nature of practice (Vaara and Whittington, 2012), perhaps to the neglect of material artifacts (Jarzabkowski and Spee, 2009), some precursors have begun to examine how these discursive practices are inter-related with material artifacts. For example, Kaplan (2011) shows how the production of PowerPoint slides shapes the outcomes of investment decisions in a telecommunications firm. Others examine texts not solely as discursive resources but also as actual documents, such as Spee and Jarzabkowski (2011) and Vaara, Sorsa and Palli (2010), who illustrate how strategic plans, as textual documents, both shape and are shaped by human interactions within the strategy process – the document is thus invested with meanings from the strategy work within which it has been produced. Other authors (e.g. Whittington, Molloy, Mayer and Smith, 2006) get closer to material objects as artifacts that encode unfolding aspects of the strategy work within an organization. They show how a six-sided ‘cube’ was developed as a material artifact to represent the changes agreed in a strategy workshop. The artifact was then disseminated widely throughout a retail organization to symbolize change, and later further developed as a material artifact with the addition of a seventh ‘side’ protruding from the top to reflect further change agreements.

As these various authors show, material artifacts such as documents, PowerPoints and the ‘cube’, may represent strategy work and evolve in conjunction with it. However, such studies are only the beginning of a research agenda that needs to go further in exposing the complexity of material artifacts that are part of everyday strategizing. We still know little of how these material artifacts shape strategizing (Vaara and Whittington, 2012), which is at least partially due to the lack of theoretical frameworks with which to conceptualize their uses within the strategy process. That is the focus of this study. Specifically, we build on Schatzki (2006) – who is particularly explicit about the role of material objects and spatial arrangements as a bundle of practices that constitute social phenomenon, such as organization

– and Reckwitz (2002), for whom practices are not simply ‘things’ that are employed by an actor but rather are ways of doing with these things, to conceptualize artifacts not simply as things that have some innate purpose, but rather perceive them as situated artifacts that gain purpose within the context of using (Jarzabkowski, 2005; Suchman, 1987).

Epistemic objects and knowledge work

In order to further develop our conceptual approach to the situated use of material artifacts and the ways that they are enacted in doing strategy work, we turn to the literature on epistemic objects and knowledge work (Ewenstein and Whyte, 2009; Knorr-Cetina, 1997, 1999; Miettinen and Virkkunen, 2005). The concept of epistemic object refutes the assumption that an artifact, such as a cube, flipchart, or post-it note, has stable properties that determines its use. Rather, these artifacts are epistemic objects, which are objects that gain situated meanings within the process of being used in knowledge work (Miettinen and Virkkunen, 2005; Schein, 2004). As Schein (2004) notes in his work on interpreting symbols and artifacts, while such artifacts are accessible, they only comprise strategy artifacts through the interpretations that strategy practitioners give them within their everyday enactment of strategy work. As strategy work is knowledgeable work (Whittington, 2006; et al, 2003), strategy practitioners imbue the artifacts that they use with knowledge properties that are situated within the context of their work. That is, the flipchart, spreadsheet or post-it note is not innately a ‘strategy’ artifact but becomes a meaningful artifact within the context of the strategy work within which it is used. Epistemic objects are thus not stable, but are continuously changing and acquiring new properties during use (Knorr-Cetina, 2001).

Consistent with a practice theoretical approach (e.g Reckwitz, 2002; Schatzki, 2006), these properties of an epistemic object are accomplished within an activity and, at the same time, shape that activity (Gherardi, 2010). Hence, the nature of epistemic objects is

continuously unfolding according to their situated use. That is, the object does not have a single property and use to which it can be put, but rather is a representation of the knowledge work being performed, and so attracts particular types of knowledge in the process of use (Knorr-Cetina, 2001). For example, if we conceptualize Whittington et al's (2006) cube as an epistemic object, we can better understand how it represented not only the strategy workshop in which it originated, but also how its meanings evolved as the strategic change initiative unfolded, which then led to further evolutions of the artifact itself, into a '7-sided' cube.

Moreover, epistemic objects are nested, meaning that objects are not necessarily separate, but rather that multiple objects are layered and entwined in the process of doing knowledgeable work (Knorr Cetina, 1999). For example, Ewenstein and Whyte (2009) show how rough architectural drawings at the outset of a design project to extend the Herbarium in the Royal Botanical Garden in London are increasingly nested within evolving epistemic objects, including formal blueprints and digital technologies, that delineate the specific materials, such as bricks, and design features, such as roofing structures, that are part of the unfolding design process. Their study illustrates how epistemic objects "reflect a knowledge development process that proceeds in an ongoing and dialogical way" (Ewenstein and Whyte, 2009: 27). Actors are able to reorganize and build upon their existing knowledge, imbuing the nested epistemic objects that they use with their evolving knowledge, as part of the unfolding process of knowledgeable work (Hershkowitz, Schwarz and Dreyfuss, 2001). Thus objects become layered, each imbued with different aspects of the knowledge work that has taken place. For example, earlier stages of knowledge work, such as rough sketches, are nested in more formalized representations, such as architectural drawings and digital designs, as the knowledge construction process unfolds (Ewenstein and Whyte, 2009; Irwin, 1977; Weick, 2005; 2011). This theorizing about the situated and nested nature of epistemic objects provides a practice-based framework (Gherardi, 2010) and conceptual lens with which to

examine the situated use of material artifacts in accomplishing strategy work and address our research question: *What roles do material artifacts play in accomplishing strategy work?*

METHODOLOGY

Research setting

We selected the reinsurance sector for our study because it is a professional service sector in which professional knowledge workers play a significant role in shaping the strategy of their firms (Knorr-Cetina, 1999; Lowendahl and Revang, 1998; Von Nordenflycht, 2010), so enabling us to focus on managers whose work might clearly display elements of everyday strategy work (e.g. Vaara and Whittington, 2012; Whittington, 2006). Furthermore, financial service sectors, such as reinsurance, have been highlighted as particularly pertinent contexts in which to study materiality (Pinch and Swedburg, 2008). The reinsurance sector is involved in the work of selling capital to insurance companies that want to buy reinsurance deals. These sales are done by reinsurance underwriting managers, who appraise reinsurance deals in order to decide which ones are best to put capital on. The focus of this paper is on this appraisal process for property catastrophe reinsurance deals on properties insured in Europe. Effectively, reinsurance is the insurance of insurance companies. A reinsurance deal comprises the accumulated value of the properties for which an insurance firm has provided insurance policies. For instance, an insurance firm that insures properties in Germany may hold insured values of €600m, which is the value of their whole book of insured properties. The insurance firm then purchases a reinsurance deal, to cover potential losses and enable it to pay its policyholders, in the event of a catastrophic event that would damage or destroy many properties simultaneously. For example, the reinsurance deal will provide cover in case of severe damage caused to multiple properties by catastrophes, such as earthquakes, windstorms or flooding, which are known as ‘perils’.

Our study looks at underwriting managers during their everyday strategy work of appraising reinsurance deals, which is their core activity. Each year in September, reinsurance managers undertake a strategic planning process to establish the reinsurance portfolio that they wish to put together for the year. This portfolio is made up of different reinsurance deals that need to be sufficiently diversified to ensure that the firm will have a broad capital base of stable, profitable business that contributes to the bottom line as well as exploring new opportunities that may contribute to the top line. As underwriting managers appraise a range of possible reinsurance deals throughout the next 12-months, they enact the reinsurance firm's strategic objectives to achieve or adjust the portfolio targets established during the strategic planning cycle. Underwriting managers are responsible for their reinsurance portfolio, which means that they have a certain amount of capital and need to place it selectively by appraising reinsurance deals in order to reap the highest return on investment according to the objectives of their portfolio for top and bottom-line growth. This appraisal process is part of the everyday strategy work (Jarzabkowski and Whittington, 2008; Vaara and Whittington, 2012) that underwriters perform in selecting specific deals on which to place capital.

In the appraisal process, an underwriting manager is evaluating whether to place capital on a deal that would reinsure an insurance firm against a particular peril. This activity is strategic in that each approved deal shapes the underwriting manager's overall portfolio targets and enacts the strategic objectives. The appraisal process is not straightforward in terms of evaluating the potential to earn more from placing capital on one deal versus another. First, due to the uncertain nature of the damage triggered by a peril, including whether a windstorm or earthquake will occur and, if it does, how much damage it will do, the actual loss remains unknown until after the event. Second, deals only involve payout for a loss if the damages to property exceed an agreed threshold. For instance, a European windstorm like Kyrill in 2007, may damage a firm's insured values to the extent of €20m. A reinsurance deal

that has a threshold of €5m comes into effect with damages to insured policies accumulating above €5m. Hence, with claims related to a storm like Kyrill, the reinsurer will have to pay. However, if there is a smaller storm, or if the insured properties are not in the path of the storm, so that there is no loss up to the threshold of €5m in any given year, the reinsurer will not have claims and will keep the premium that has been paid. Appraisal is thus not just about the amount of premium to be earned from a deal, but also the potential for and extent of a possible loss from that deal. The strategy work that underwriting managers perform is thus knowledgeable, because they must bring together different aspects of knowledge about the likelihood for losses as they select deals to fulfill their portfolio. While this work is strategically critical, because large losses seriously impair profitability and can lead to a firm's collapse, at the same time, it is a mundane, everyday strategizing practice that comprises the core activity for underwriting managers. For example, underwriting managers typically appraise several hundred reinsurance deals throughout the annual cycle and refer to a ratio of selecting approximately one out of any 15 deals that they appraise.

Data collection

Consistent with our interest in developing a contextualized understanding of the situated use of material artifacts when appraising risks, we adopted an embedded case study approach (Scholz and Tietjie, 2002). In this embedded approach, the process of reinsurance underwriting was our overall case context and underwriting managers, all conducting the same type of European property catastrophe business, were our subunits for analysis (see also Yin, 2009). Using this research design gave us depth in analyzing the typical behavior of underwriting managers in appraising risks (Scholz and Tietjie, 2002; Yin, 2009). We collected multiple data sources (Silverman, 2001), including non-participant observation, interview and documentary data, that enabled us to explore the types of material artifacts used in the strategizing process of appraising reinsurance deals. For this paper we focus

specifically on our shadowing of 23 underwriting managers who worked on appraising European property catastrophe risks. This ensured that similar types of material artifacts and activities could be observed across the dataset. We thus develop the analysis based on non-participant observations of these underwriting managers as the primary data source.

Specifically, we collected extensive notes from 83 incidents of shadowing these underwriting managers during which we observed their activity in appraising deals. In addition, we gained contextual understanding of their risk appraisal by attending internal meetings and engaging with them in some informal, social occasions, such as follow-ups over coffee or lunch. We took notes in the field during shadowing and then typed up these observational notes within 24 hours. We also audio-recorded and transcribed 39 interviews with these reinsurance underwriters and their line managers, such as heads of divisions, chief risk managers and CEOs, to supplement our observational notes and put their work within the broader context of the firm strategy. Interviews were typically one hour and were conversational in style, encouraging participants to articulate what they did when they were appraising a reinsurance deal, or what aspects of underwriting practice they felt were important, and to reflect upon and explain underwriting practice as a type of strategy work. We also collected documentary data, such as deal information packs and other materials, such as spreadsheets or graphs associated with deals, which provide further insights into the actual materials involved in appraising reinsurance deals. Multiple data sources enabled us to triangulate data, enhancing data trustworthiness (Guba and Lincoln, 1985).

Coding and analysis

While all qualitative analysis is interpretive, there are steps that researchers can undertake to ensure the consistency of their interpretations, such as looking for regularities in the data (Winch, 1958). In particular, consistent with guidelines for analyzing rich qualitative data, our analysis went through several interrelated steps (see Langley, 1999; Guba and

Lincoln, 1985; Miles and Huberman, 1994). The first step of coding occurred while in the field collecting data. As we observed underwriting managers appraising reinsurance deals at their desks, the role of material artifacts became strikingly obvious. Quite simply, a reinsurance deal could not be evaluated without drawing upon these artifacts. Across our sample of underwriting managers doing property catastrophe deals, we were struck by the repeated doing of reinsurance appraisal with similar types of artifacts, providing us with a very consistent phenomena to observe and theorize about (see Winch, 1958). Drawing on these initial observations we began to look more purposively at material artifacts in our fieldwork and to make specific memos about them, which we discussed a team. These memos then formed the basis for the following themes and codes when we imported our fieldnotes into the qualitative data analysis software NVIVO 8.0 for more rigorous coding. Specifically, we identified five categories of artifacts that, based on their repeated use by underwriting managers, we observed as typical to the appraisal process. We labeled these categories by their empirical names, in terms of what type of artifacts was used, deriving categories of photos to include all pictorial representations of the deal, such as pictures of buildings, plant and equipment; maps, to include all geographic representations of the deal such as printed maps and google maps; data packs to include all packs of information about the deal provided by the broker and client; spreadsheets to include all excel sheets used for rating the deal quantitatively; and graphs to include all charts –on which details of the deal were plotted, typically in a curve (see Table 1 for an overview). These material artifacts are presented in more detail in our findings section.

In the second step, we looked at the situated use of these artifacts when underwriting managers appraise a reinsurance deal; we were trying to understand not simply the empirical nature of the artifacts – what they were – but also how managers were using these artifacts in doing the work of appraising deals. We analyzed our observational field notes to uncover

those routinized activities underwriting managers perform in doing strategy work with artifacts, continuously asking ourselves what activities were being enacted when managers used these five types of artifacts we had identified. By this we mean that we searched the observational data for regularities and similarities (Winch, 1958) within the activities that are typically performed when an underwriting manager was doing appraisal with that artifact. We also examined the interview data for participants' explanations of the appraisal process, coding the way that they referred to some of the artifacts as supplements to, or forms of judgment that helped them to evaluate the quality of any particular deal. As the three authors each conducted observations and did the analysis, we were able to discuss emerging themes and then examine the data to check whether they were consistent with our observations and experiences in the field, adding to the veracity of our analysis and counteracting the bias of a single researcher's interpretations (Guba and Lincoln, 1985; Weick, 1989). For example, an emerging theme arose around the use of photos, where we felt that managers were looking at some physical element of the deal, such as a building. Naturally, they could not look at a photo of each physical element, such as every building, but we noticed that when they looked at photos they were referring to the physical characteristics of buildings of that type. We then further examined the data in NVIVO to check consistency of the theme across all examples of using photos, finding that managers were probing the physical characteristics of the deal. Our interview data and our notes on the informal discussions we held with them about our observations further confirmed this impression. We thus clustered the data on using photos under the label of 'physicalizing' by which we meant using photos to connect to the physical properties of the deal.

Using a similar analytic process, we identified five practices, which are constitutive of the work that managers do with material artifacts, which we labeled: physicalizing for doing appraising with photos; locating for doing appraising with maps; enumerating for doing

appraising with data packs; analyzing for doing appraising with spreadsheets; and selecting for doing appraising with graphs. We carefully compared the data coded to these practices and found that they were distinct from each other and grounded in the use of specific artifacts – that is, locating was always the use of various types of geographical representations, physicalizing was always the use of various types of photographs or pictures of physical properties of the deal, analyzing was always the use of spreadsheets and so forth (see Table 1). We explain these practices in the findings, through the use of representative vignettes that show both the artifacts and the specific work that is performed with them as part of an underwriting manager's appraisal of reinsurance deals.

Although these practices were each a distinct and different type of strategy work, they sometimes overlapped as activities and were not linear in the way they unfolded. For example, while managers typically had the data packs when they started appraising they did not begin by enumerating but would look at photos and maps to do physicalizing and locating, before turning to the data pack for enumerating. It seemed that they were doing different aspects of strategy work with different artifacts, but that all were key to the strategizing process. Hence, having analytically distinguished between five artifacts and the practices of using them in strategy work, in a third step we zoomed out from the micro interactions (Nicolini, 2009) to identify how the situated use of these artifacts shapes the strategizing process. As part of this analysis, we iterated with the literature in order to conceptualize our findings, turning to the literature on epistemic objects (e.g. Knorr Cetina, 1997; 2001) as a way of explaining the situated use of artifacts to perform different aspects of strategy work. Building from the five practices, we identified an increasing level of abstraction that sustains the use of material artifacts. That is, in the practice of using an artifact to do strategy work, each material artifact was further abstracted from the physical properties of the actual

reinsured deal. We thus termed this process *abstraction*, as one implication of doing strategy work with material artifacts, which we will introduce in the discussion section.

We further analyzed this abstraction, which we identified as a somewhat layered process of doing appraisal with a series of different artifacts, each of which performed a different aspect of appraisal. We termed this layered process *substitution* because the situated use of an artifact captured some of the previously performed practice and so substituted for the work accomplished with other artifacts. The notion of substitution takes our findings to a more conceptual level of unpacking what the situated use of material artifacts does in a strategizing process. We will elaborate on these two concepts, abstraction and substitution, in the discussion section. While substitution is associated with abstraction, it is conceptually distinct. Substitution refers to the process of using increasingly abstracted artifacts, each of which builds on the situated use of other artifacts in the appraisal process.

FINDINGS

In qualitative research there is always a trade-off between showing the rich data upon which findings are based and the constraints of an academic manuscript (Eisenhardt and Graebner 2007; Golden-Biddle and Locke 2006). This trade-off is particularly pertinent in presenting episodes of underwriting managers' appraising reinsurance deals, where situated activities must be analyzed. In the findings we therefore present each of the five artifacts and the work that underwriting managers enact in appraising a reinsurance deal (see Table 1) using a richly detailed representative vignette of the strategizing process¹. The vignettes are presented below to progressively illustrate the conceptual points about the relationship between abstraction and substitution that we will develop in the discussion.

¹ As we draw upon all of our data sources to present the vignettes, we use a combination of verbatim quotes from fieldwork observations, notes from fieldwork observations, and interviews. Specifically, all italicised sections in quotation marks are actual extracts from our field notes. Where we refer to something that was spoken and is quoted verbatim we use (vb. field note) and where we refer to something that is an observation, reproduced exactly as it was written up in the field notes, but that was not something spoken, we use (obs. field note), while interviews are marked (Interview).

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Appraising deals with photos: physicalizing practices

Underwriting managers frequently look at photos of the properties that they are reinsuring. While they cannot possibly look at photos of all of the properties in an insurance deal, or even be sure that the photos they do look at are representative of all properties, looking at some photos, which may be provided in the information pack about the deal, or be accessed on Google, are typical of the appraisal process. Our analysis of situated use of photos shows that they provide a connection to the physical source of the deal, bringing it into the situated context of appraising a reinsurance deal. Seeing the properties as a representation of the physical risk gives underwriting managers a sense of ‘what’ is actually insured. A property is not just a property. For instance, a photo illustrates the type of property such as a flat in the United Kingdom (UK) or a semi-detached house in Germany, which are defined and differentiated by structural components such as wall types, etc. Underwriting managers have often seen these structural components on client visits, and they discuss the structures as they look at photos of properties, so bringing the physical characteristics of the risk into the situated context of appraising the deal. We term this practice *physicalizing*. To illustrate physicalizing as the situated practice of doing risk appraisal with photos, we draw upon a representative example of an underwriting manager, Caroline, appraising a reinsurance deal from a client that insures blocks of residential flats in the UK against windstorms. When visiting the client several years ago, Caroline saw two newly built blocks of flats on the harbour front in Liverpool that are part of the insurance deal. The client had also explained the structural components of these high-value blocks of flats. To recall the physical property of the risk, she opens the client’s website and looks at photos of blocks of flats similar to those she had seen. Looking at these photos provides a material reference of the actual risk. While

making a note to herself about the physical property of the risk, Caroline explained to the researcher about these types of flats;

“... these buildings are quite new. But that doesn't always mean good construction. But this deal, [client's name] has really taken care about what properties they insure. So there's less chance of damage with good construction. I don't want a loss from some small storm” (vb. field note)

Not only do photos represent the physical property of the risk, they can also illustrate the damage to property caused by a particular peril. The following example stems from an observation of an underwriting manager, Jeremy, about to appraise a deal from a client that he has reinsured in the past, but who has a recent loss that resulted in pay-outs by the reinsurer for damage triggered by windstorms. The claims on the reinsurer were substantial, arising from a severe storm with snowfall that caused the roof of an aircraft hanger on a small airstrip in Sweden to collapse. At a recent client meeting, the client provided a photo of the hangar, which Jeremy now takes out as he starts to appraise the deal. As described in our fieldnote, *“the photo shows a hill covered in snow, the area is all white, and the lump that is apparently the hangar could potentially be anything”* (obs. field note). Placing the photo on his desk the underwriting manager points to it and says *“Do you see this? This is a hangar storing historic airplanes that are used for airshows”* (vb. field note). He types a search into Google that brings up a photo of airshows, saying; *“this sort of plane”* (vb. field note). While the photo represents a heavy snowfall on the damaged hangar, Jeremy is using it to connect his own appraisal with the physical nature of the risks he is reinsuring; these are actual properties, with valuable contents, that will be affected by perils such as snowstorms against which they are reinsured.

Appraising deals with maps: locating practices

Maps are another material artifact that is typically used by underwriting managers. They bring the geographical location of the actual risk into the situated process of appraising a reinsurance deal. They involve the practice of *locating* the risk by illustrating geographically, where, a client's insured properties are in relation to the peril. While this information is included in the quantifiable information that comes with the deal, underwriting managers also look at a map of the properties and their exposure to the peril. It helps them to understand the deal in terms of its proximity to a flood zone or the path of a windstorm, which indicates the likelihood of damage from such a peril. The following example demonstrates how an underwriting manager uses a map to situate the deal he is appraising within its proximity to possible damage from a particular peril. In this case, the reinsurance deal covers wind and hail storm damages to agricultural farms in France. The map shows France's landscape (including Corse) and illustrates dominant land use differentiating between forest, grassland, cropland (wheat, sugar beets, corn), olives, vineyards, etc. For instance, France's north east between Lille and Rouen and the south west close to the Spanish boarder are dominated by crop farming whereas France's north west, around Nantes to Brest, is dominated by grassland. On the basis of the map, the underwriting manager explains that most of their business is located in the North East and South West due to the dominant policies for insuring crop farmers against windstorms.

In another example, an underwriting manager, Kevin, evaluates a reinsurance deal covering an Italian client against property damage caused by an eruption of the Mount Etna volcano. Muttering to the researcher, the underwriting manager points out that maps enable him to locate a client's insured values in relation to nearby towns in Sicily. In this case, it enables him to "*identify the towns that, you know, are located nearby the volcano, and work out **where** [added emphasis] the client's insured values are in relation to the vent location*" (vb. field note). To work out where lava will flow and how close particular townships, like

Pedara, are to the vent, Kevin iterates between the lava map, illustrating different lava zones by square kilometre, on his desk and examining the location of the towns on Google maps. When talking to the researcher later over a coffee break he says; “*Of course that information is all in the numbers – insured value of properties and their exposure to perils, but I like to look at it. Just get feel for how close it all is; what it looks like*” (vb. field note).

Appraising deals with the data pack: enumerating practices

Data packs are the information that is provided for an underwriting manager to perform financial analysis of the deal. They put this data pack on their desks when they begin appraising a deal, leaving it open as they perform the practices described above of physicalizing the deal using photos and locating the deal using maps. An underwriting manager develops a numerical understanding of the geographical exposure of a client’s insured values on the basis of the data pack. Specifically, the data pack provides details on the reinsurance deal’s terms and the cover against a particular peril, such as a windstorm or an earthquake. Typically, properties are grouped by area codes and bands into different insured values that indicate *what* is in the deal. For instance, a data pack will provide information on how many insurance policies on properties within a particular deal are worth between €100k and €500k. Moreover, the data provides numerical information on *where* these insured values are located, in terms of geographical locations such as area codes. These codes indicate location and, hence, potential exposure to perils, as some area codes are more exposed than others to, for example, floods or windstorms. Thus the deal’s insured values are grouped by area codes. We term this practice of doing appraisal with data packs *enumerating*.

The following example is drawn from an observation of an underwriting manager, Phillip, reading the data pack of a client based in the Netherlands. The data pack provides detailed information on the specific reinsurance deal; “*The data packs can have a lot of information, the Total Insured Values, then broken down into bands for specific property*

values, banding by territories and exposure to perils. It's very detailed and, you know, should have all the quants [quantitative information]" (Interview, underwriting manager). In case of the Dutch client, it illustrates that the reinsurance deal covers windstorms to which the Netherlands are prone. Phillip flips through the data pack, which shows the insured values by area code in tabular form. To evaluate the specific reinsurance deal and to look at the client's exposure in the geographical location, he prints a map that shows area codes across the Netherlands and places it on his desk, next to the keyboard. Looking at the map, he sees exactly where are the areas with the client's highest exposure to windstorms, highlighting those columns on the tables in the data pack in blue. While the data pack provides detailed numbers about the deal's exposure (grouped by area codes), the example demonstrates that maps are used to link the numerical information about a deal's exposure to its geographical location. In this way, enumerating the deal as columns of figures about insured values and their exposure is linked to the specific nature of the risk being appraised. As Phillip notes, it is a way of making the numbers 'real'; *"You know, think about the total insured values; where they are, what the numbers mean. Sort of a reality check"* (vb. field note).

Appraising deals with spreadsheets: analyzing practices

The spreadsheet is another material artifact that is commonly used. It forms the basis for analyzing the reinsurance deal. The spreadsheet builds on information provided in the data pack, enabling the underwriting manager to analyze a deal's exposure in relation to the actual peril. The numbers sitting behind the spreadsheet represent the value of properties, where they are in terms of the geographical location and how much of the total value of properties in the deal might be exposed to the specific perils against which it is to be reinsured. The spreadsheet converts the raw data on property values by area codes, working out the number and total value of properties above the threshold at which a reinsurance pay-out would come into effect if a loss-making event occurred. It then estimates the probability of an event

occurring, for example, as probably 1 in 100 or 1 in 250 years. We term this practice of using spreadsheets *analyzing*. In analyzing the deal, the underwriting manager generates price ranges for reinsuring the particular properties in that deal, given their specific value and proximity to a possible peril.

Using a spreadsheet enables an underwriting manager to perform the work of analyzing, which is not simply a matter of letting the formulas in the spreadsheet determine a price, but rather involves the underwriting manager drawing together information gained from doing appraisal with the previous artifacts to make a judgment about the likelihood of a pay-out that will justify a particular price. As one underwriting manager notes; *“It’s useful as a guide but you know, you’ve got to look at reality, you’ll have your own views on, say, the level that the client’s buying at. Obviously the historical output that something’s giving you information of. You might have hundreds of years of data of losses and you know, if the spreadsheet’s saying one thing and the deal’s never had a loss, and you know those types of properties stand up well to wind, then you would take your own judgment on that as well.”* (Interview, underwriting manager).

In the following example, an underwriting manager, Ian, uses a spreadsheet to do the work of analyzing a reinsurance deal from a UK client that insures policyholders’ properties against flood. With the spreadsheet, he converts the deal’s exposure, presented by area code data in the data pack, into the threshold at which the reinsurance payment is triggered. In this case, the deal comes into effect in the event of a flood destroying more than £20m of the client’s insured values, which would require his firm to pay a claim for the damage sustained. He flicks through the various cells on the spreadsheet to work out the extent of exposure (how many properties of a particular value are in a key peril zone). While explaining to the researcher, Ian points with his finger to a line on the spreadsheet explaining that there are the about 25 properties located in a luxurious area in the London commuter belt, which

accumulate to well over the threshold for pay-out. He says these homes include some “*captains of industry that you see in the papers. If I really thought these were exposed to flood, this deal wouldn’t be worth it, but it’s not very likely they’ll get damaged. I’m really analyzing how likely it is that these smaller properties that make up the bulk of the TIV [total insured values] will get hit by some big flood. Not too likely but we had that flood with Severn Trent in 2007, so you can’t be too sure. Really it’s my ... my gut feel about where the properties are, what precautions the insurer has taken*” (vb. field note).

Appraising deals with graphs: selecting practices

Graphs are another material artifact that we observed underwriting managers typically using as part of the process of appraising reinsurance deals. Having used the data pack and the spreadsheet to establish the parameters of the deal and the extent of its exposure to a particular peril, the deal is compared to other deals using graphs. For example, an underwriting manager, Mark, and his assistant, Sarah, sit together at Mark’s computer. They have generated a graph that has numerous curved lines, each in a different color that represents a different deal according to what price they can get for it, against the expected threshold at which a loss would be payable. While all the deals are from France, each one has a slightly different threshold for pay-out, or the price is slightly different because of the type or location of the insured properties within it, so that the curves do not exactly mirror each other. They look at the curves and Sarah leans forward to tap the orange-colored curve, saying “*this seems to be about the average; what we can expect from this region this year. That deal [mentions client’s name, while indicating the blue curve] is a real outlier, but not surprising, given the growth in their exposures*” (UW assistant, vb. field note).

Graphs thus comprise material artifacts that are part of the practice of *selecting* deals from amongst the range of possible deals that the underwriting manager has been appraising. It informs the underwriting manager about which deal to place capital on. The following

observational note stems from shadowing an underwriting manager, Jim, who is selecting which of several German reinsurance deals on which to place capital. Jim currently has about 10 reinsurance deals of German clients seeking reinsurance cover against flooding. Each of these deals has already been separately through the appraisal process already outlined, in terms of using photos and maps for physicalizing and locating the deal, and data packs and spreadsheets for enumerating and analyzing the deal. Bringing these analyses together, Jim imports each analysis into a new file, plotting them onto a graph, saying; “*I’ll just compare premium against exposure*” (vb. field note). He imports the particular deal into the comparative spreadsheet and models all programs from Germany as separate curves. While looking at the results he says “*On this curve, [specific client] is coming out quite nicely on top of the curve*” (vb. field note). As he does not want to write much German business this year, he selects this and one other as the two deals he will place capital on for the region.

DISCUSSION

Despite increasing calls for research into strategy practices as those ‘things’ that comprise much of the work of strategizing, such as spreadsheets, flipcharts, post-it notes and whiteboards (Jarzabkowski and Whittington, 2008), there is still little empirical evidence on strategizing with stuff (Vaara and Whittington, 2012). This paper therefore set out to address a research question that was motivated by a gap in the strategy-as-practice literature: *what role do material artifacts play in accomplishing strategy work?* In this discussion, we develop our findings on the five practices performed through the situated use of material artifacts, into a typology based on their level of abstraction from the physical risk. That is, abstraction progressively replaces the physical details associated with initial appraisals of the deal with more abstracted representations of those details within spreadsheets and graphs. Drawing on this typology, we develop an additional layer of theorizing about substitution. We suggest that

the situated use of each specific artifact encompasses and substitutes for the appraising work that has taken place with the other artifacts.

INSERT TABLE 2 AROUND HERE

Table 2 summarizes our findings and introduces the concepts of abstraction and substitution. First we show how each practice benefits from the features of epistemic objects that are used. The material artifacts that Table 1 identifies are indeed epistemic objects – that is artifacts that assume knowledge properties in the process of doing knowledgeable work (see also Gerardi, 2010; Miettinen and Virkkunen, 2005). For example, in our study, a photo or a map has a particular knowledge status in the professional process of appraising reinsurance deals that these same artifacts would not have in a different context. A key feature of epistemic objects is that they are continuously unfolding according to their situated use. That is, the object does not have a single property and use to which it can be put, but rather is a representation of the knowledge work being performed, and so attracts particular types of knowledge in the process of use (Ewenstein and Whyte, 2009; Knorr-Cetina, 2001). For example, in our case maps are representative of exposures to perils, associated with potential financial pay-out, rather than simply geographic representations of a territory; they have a particular status in representing a part of the knowledgeable process in which underwriting managers engage in appraising a reinsurance deal. As artifacts are used, they thus represent different elements of appraising the deal that is meaningful to underwriting managers in the situated process of appraisal, rather than adhering to the artifacts *per se*.

Second, we use the concept of epistemic object to develop the notion of abstraction, in which the practices involved in using material artifacts each unfolds at a further level of abstraction from the physical risk. The concept of abstraction draws from Knorr-Cetina's (1997; 2001) work, in which particular epistemic objects are constructed as part of the process of doing 'expert' or professional work. In the process of abstraction, actors reorganize

existing knowledge that is represented in some artifacts into the unfolding process of knowledgeable work (Hershkowitz, Schwarz and Dreyfuss, 2001; Schein, 2004). Abstraction progressively replaces the detail associated with initial representations with more formalized representations of those details (Irwin, 1977; Weick, 2005; 2011). This theorizing about the situated and nested nature of epistemic objects also informs our concept of substitution. However, first we unpack the concept of abstraction to show how, within the practices of physicalizing, locating, and so forth, artifacts such as photos and maps are constructed as epistemic objects that are central to the process of appraising reinsurance deals.

The first level of abstraction we identified occurs within *physicalizing* (A1), which is associated with photos and pictures of the actual insured risk. Physicalizing enables the underwriting manager to represent the physical properties of a reinsurance deal, such as a building's structural components or wall types and their potential for damage, within the situated context of appraising the deal. The second level of abstraction occurs in the practice of *locating* (A2), which is doing appraisal with maps that represent the exposure of the deal to particular perils. An underwriting manager uses a map to locate how exposed a client's insured properties are to a specified peril, such as being in the path of a windstorm. Locating with maps is thus further abstracted from the physical properties of the deal than physicalizing the structural aspects of the deal with photos. The third level of abstraction involves *enumerating* (A3), which occurs through doing appraisal with data packs. In an appraisal, data packs represent the numerical properties of the deal in terms of columns of figures that show how many properties of particular types and values are located in which regions, so enumerating the deal within specific parameters. As epistemic objects, data packs are further abstracted from the maps that represent the geographical exposure to the peril and photos that represent the physical properties. The fourth level of abstraction occurs in *analyzing* (A4), which is performed in the situated use of spreadsheets. Spreadsheets represent the deal as a

financial transaction by converting the numerical data from the pack into a meaningful pricing structure for placing capital. This is a further level of abstraction, as the spreadsheet enables underwriting managers to perform specific financial analysis of the deal, which is abstracted from its numerical properties, its geographical location to the peril, and its physical properties. The fifth level of abstraction is *selecting* (A5), which occurs through using graphs. A graph represents the deal as a financial trade and enables selection of one deal in relation to the other possible financial trades that the underwriting manager might perform. Selecting is thus another level of abstraction from analyzing, because it places any particular deal in relation to other deals on which to trade.

Third, our findings on abstraction provide the basis for developing a concept of substitution that explains how types of artifacts, conceptualized as epistemic objects, substitute for each other at increasing levels of abstraction (Irwin, 1977; Weick, 2005; 2011). Substitution refers to the nesting and linking of epistemic objects within an unfolding and layered process of knowledge construction (Hershkowitz et al, 2001; Knorr Cetina, 1997; 1999; Miettinen and Virkkunen, 2005). Thus, each object takes on or encodes elements of the knowledge already constructed within the appraisal process (Gerardi, 2010; Irwin, 1977; Knorr Cetina, 1997). We term this substitution, which means that the situated use of a particular artifact substitutes for the work that has taken place in the situated use of other artifacts during the process of appraisal. It is related to but distinct from abstraction. In substituting, the features of using a different artifact are invoked in using the current artifact, thus making these other artifacts part of the performance of the current strategizing practice. We summarize this process in Table 2, which shows the specific material artifacts, their layers of abstraction in the practice of physicalizing, locating, enumerating, analyzing, and selecting; and also their progressive substitution. We label each act of substitution as S1, S2, and so

forth, to show how performing appraisal with increasingly abstracted artifacts follows an unfolding process of substitution from one artifact to another.

The concept of substitution can be explained at any level of abstraction, but we illustrate it now through the situated use of our most abstracted artifact/epistemic object; a graph being used to perform the activity of selecting. The use of a graph illustrates the reinsurance deal within a single curve, in relation to other curves. The curve itself is a simple line plotting the relationship between two axes. It illustrates the rate of return of the specific deal on the x axis against the potential risk for a payout at a particular threshold on the y axis. Appraisal with the other artifacts that have enabled the deal to be represented within this single curve are all implicit within the graph, that is: analyzing the deal as a financial transaction within the situated use of a spreadsheet (S4); enumerating the deal in the situated use of the data pack with its tables of insured values and their price bands (S3); locating these bands of properties geographically by their proximity to perils using maps (S2); and physicalizing the deal as a set of actual buildings with specific structural elements, by looking at photos (S1). The practice of selecting using the curve is thus substituting for all the other practices and artifacts that have taken place in appraising the deal; they are implicit in performing appraisal with the curve.

Without the abstraction and substitution process, the selection of a deal on the basis of this curve would not be possible. That is, a curve is a simple representation of the relationship between points that is not a meaningful material artifact in itself as the basis for selecting a deal. Rather, a curve is an epistemic object that has nested within it the knowledge constructed through the situated use of other objects, which make it a representation of the entire process of appraising a reinsurance deal (Irwin, 1977; Knorr-Cetina, 1997; 1999). Abstraction and substitution make it possible to appraise a physical deal, such as insured buildings, within a curve and select that particular deal from other deals that are also

represented by curves. These two concepts, with their associated typology summarized in Table 2, comprise a conceptual framework that contributes to understanding about how material artifacts are implicitly engaged within the performance of strategy work.

CONCLUSIONS AND IMPLICATIONS FOR THEORY

This study makes a contribution to strategy-as-practice. While a number of scholars have called for research into strategy practices, those ‘things’ that are part of the everyday doing of strategy (e.g. Jarzabkowski, 2004; Vaara and Whittington, 2012; Whittington, 2003; 2006), there is a dearth of empirical research in the field. In part this is because of inconsistent and overly broad definitions and theoretical conceptualizations of strategy practices (Carter et al, 2008; Jarzabkowski and Spee, 2009; Reckwitz, 2002). Our study thus contributes to the nascent body of empirical work that looks at material artifacts in strategy-as-practice (e.g. Kaplan, 2011; Molloy and Whittington, 2005; Spee and Jarzabkowski, 2011; Whittington et al, 2006). Aside from our empirical contribution of identifying specific types of material artifacts that sustain particular practices, we also provide important conceptual extensions by examining these artifacts as epistemic objects that are both shaped by and also shape the strategizing process. Our study showed how the situated use of material artifacts is inherently involved in accomplishing strategy work. In particular, we extend previous research by providing a typology of artifacts and their situated uses, which shows how each artifact comprises an epistemic object at a greater level of abstraction (Irwin, 1977; Weick, 2005; 2011) in the doing of strategy work. Our study demonstrates how strategy work is socially accomplished as a knowledgeable process, within the situated use of material artifacts (Knorr Cetina, 1997; 1999). In particular, our concept of abstraction shows that strategy work does not inhere within the artifact itself but in the practices that are performed with the artifact; a map, photo or spreadsheet is not innately strategic but rather represents knowledgeable strategy work because of the practices in which it is engaged within a situated context.

We further developed this notion of situated use of material artifacts with our concept of substitution that shows how artifacts are embedded within practices that evolve with the unfolding use of further artifacts. Previous studies have hinted at this process. For example, Whittington et al (2006) show how a cultural artifact encodes the outcomes of a strategy workshop, and this artifact, ‘the cube’ then further evolves as the strategic change initiative evolves. Our study goes further by showing how a succession of artifacts are linked to each other and how the strategy work performed with each goes through a process of substitution. Thus, an artifact such as a curve in a graph is only meaningful because it represents all the knowledgeable strategy work that has already taken place in order to arrive at a situation of selecting a particular deal on which to place a firm’s capital.

We thus go beyond existing approaches that treat objects as ‘things’ that people employ – so called ‘practices-in-use’ (e.g. Jarzabkowski, 2004) – to focusing on them as practices in their deeper sense as an integral part of *doing strategy with* stuff (Reckwitz, 2002; Whittington, 2007). In particular, by showing the entire process of a particular type of strategy work, appraising reinsurance deals, we show how those artifacts that are more typically associated with strategy work, such as spreadsheets, financial analysis and graphs, become representations of the underlying physical assets and capital allocations of a firm, and how these artifacts may be linked to other artifacts that are less apparently ‘strategic’, such as maps and photos. A spreadsheet or curve becomes strategic because it represents something that people do in the name of strategy work. Our study thus illustrates that what is accomplished in the name of strategy is embedded within multiple situated practices and artifacts that, taken by themselves, may appear quite mundane.

Finally, our conceptual framework furnishes insights to develop this nascent research agenda within strategy-as-practice (Spee and Jarzabkowski, 2009; Vaara and Whittington, 2012). Our study, while richly contextualized due to the embedded case study method (Scholz

and Tietjie, 2002), is also constrained by the context of a single sector. Specifically, we have looked at a particular type of strategy work; appraising reinsurance deals in order to enact planned portfolio targets. However, we suggest that our study provides the basis for future research into the role of artifacts in performing strategy work in other contexts. While the specific artifacts that we found may vary in different strategy contexts, our strategy practices are likely to be applicable to other strategy work. For example, we could envision our practices being relevant to the expansion strategies of retail firms, such as supermarket chains. When supermarkets look to expand, they identify suitable physical properties, such as greenfield or brownfield sites necessary for their different store formats, (*an example of physicalizing*) and establish the suitability of their geographic location with regards to access for both customers and consistency of the supply chain (*an example of locating*). Numerical information on inhabitants' demographics and wealth distribution in the geographical area (*an example of enumerating*) provides a basis for identifying the potential of future business, which occurs in *analyzing*. The actual analysis of such data culminates in information on the profitability of the potential expansion, which is displayed in graphs/curves. The decision to go ahead with the expansion will be partially based on discussion of these curves which illustrate break-even points, projected revenues and revenues, as well as the supermarket chain's value growth over the coming years (*an example of selecting*).

Our conceptual framework of abstraction and substitution thus provides a basis for future studies to examine the implications of material artifacts in accomplishing strategy work in other strategy contexts. Future research may find how flip charts, graphs and other artifacts abstract from more physical bases for assessing the strategic opportunities of mergers and acquisitions, such as their specific plant and assets, and become embedded within artifacts such as projected profit and loss and growth curves.

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Table 1: Overview of material artifacts

Material artifacts	Empirical examples	Situation of use and practice
Photos	A photo of a destroyed block of flats A photo of new condominiums	To look at recent losses; to familiarize with the type and structures of the properties that comprise the deal <i>Physicalizing</i>
Maps	Google earth; Google maps; Lava maps; Maps illustrating fault lines; maps with color shading, e.g. to illustrate density of forests, or coastal areas	To familiarize with territory, to look at parishes, counties and cities according to their proximity to a potential peril <i>Locating</i>
Data packs	Pile of paper with numerical information, presented in tables and columns, about number of properties and their location	To identify the number of properties, their insured values, and their geographic location according to area or postal codes, which are expressed as Total Insured Values (TIVs) banded by different types of properties and different locations. <i>Enumerating</i>
Spreadsheets	Excel spreadsheet that is used to convert numerical properties of a deal, as provided in the data pack, into an analytic structure	To convert the deal from numerical data into a specific financial transaction that can be allocated a particular price range. <i>Analyzing</i>
Graphs	Displaying excel spreadsheet data on different deals as a graph with a series of colored curves, each representing a different deal	To convert each specific financial transaction into a graphical representation for selecting a particular deal from amongst multiple comparative deals. For example, an underwriting manager looks at five different curves, each curve representing a different deal, in order to select the deal s/he believes is best. <i>Selecting</i>

Table 2: A typology of artifacts – levels of abstraction and substitution

Practice	Abstraction and Substitution
Physicalizing	<ul style="list-style-type: none"> - Abstraction 1 (A1): bringing the physical properties of the deal into the appraisal process; - Substitution 1 (S1): substitutes for the actual physical nature of the deal by providing pictorial representations of the types of properties that comprise the deal
Locating	<ul style="list-style-type: none"> - Abstraction 2 (A2): bringing the location of the deal in terms of the exposure of the physical properties to perils in the appraisal process; - Substitution 2 (S2): substitutes for the physical properties of the deal (S1) by providing geographic representations of their actual location in terms of proximity to perils.
Enumerating	<ul style="list-style-type: none"> - Abstraction 3 (A3): bringing the quantifiable parameters of the deal into the appraisal process; - Substitution 3 (S3): substitutes for the deal as a package of physical properties (S1), with different geographic exposures to risk (S2) by providing these as a set of figures about the value of properties in banded columns according to price and exposure.
Analyzing	<ul style="list-style-type: none"> - Abstraction 4 (A4): bringing the numerical information together to analyze the deal as a financial transaction; - Substitution 4 (S4): substitutes for the physical properties (S1), location (S2) and numerical parameters (S3) by providing a pricing range for the deal as a possible financial trade.
Selecting	<ul style="list-style-type: none"> - Abstraction 5 (A5): bringing the entire appraisal process together within a single curve that can be used for selecting one deal compared to another deal; - Substitution 5 (S5): substitutes for the entire former process by representing the physical (S1), locational (S2), numerical (S3) and financial (S4) elements of the deal within a single curve that enables comparison with other deals that are also represented by curves.