Paper to be presented at the

DRUID Society Conference 2014, CBS, Copenhagen, June 16-18

Beyond Simple Rules: How organizations recombine in high uncertainty environments

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Abstract

This study provides a unique view on how organizations navigate under extreme uncertainty. In doing so we provide much-needed empirical support for and further clarify the concept of ?simple rules? proposed by earlier literature. Simple rules imply the use of heuristics to frame decisions and expedite decision making in high-velocity environments. However, we find that heuristics-based decision-making tends to break down in situations of extreme uncertainty, where organizational responses not only have to be fast but often need to be novel recombinations, departing from the organization?s previously learned patterns. We find that in such extreme uncertainty situations, organizations recombine through discontinuous improvisational productions. We argue that these should be considered capabilities because they intentionally open up new set of possible outcomes for the organization.

Jelcodes:M10,M

Beyond Simple Rules:
How Organizations Recombine in High Uncertainty Environments

The question of how companies can survive and succeed in fast-moving, uncertain environments has increasingly captured the attention of management scholars during the last two decades. Concepts such as "combinative capabilities" (Kogut and Zander, 1992) and "architectural competences" (Henderson and Cockburn, 1994) represent some preliminary theorizing in this area. The concept of "dynamic capabilities," whereby organizations modify existing routines rather than follow entrenched operating procedures, has sparked a flurry of scholarship (Teece, Pisano and Shuen, 1997; Eisenhardt and Martin, 2000, Zollo and Winter, 2002; Helfat and Winter, 2011).

Despite the high interest for the topic, theoretical development and empirical evidence remain insufficient. Even in the case of the concept that has gained greater acceptance, dynamic capabilities, leading authors admit that, "the core concept requires clarification and development of the conceptual underpinnings along with grounding in empirical observation" (Helfat et al., 2007). Dynamic capabilities have been defined, broadly speaking, as capabilities that allow managers to "integrate, build and reconfigure internal and external competencies to address rapidly changing environments" (Teece et. al., 1997, p. 516). Several authors suggest that, despite their local nature, capabilities to operate in uncertain environments can be learned. For instance, Eisenhardt and Martin state that "although dynamic capabilities are idiosyncratic in their details and path dependent in their emergence, they have significant commonalities across firms (popularly termed 'best practice')" being more "homogeneous, fungible, equifinal and substitutable than is usually assumed" (2000, p.1105). When trying to define more specifically what they are, authors often mention examples of specific organizational processes that can be associated with change and that relate internal processes with organizational performance, such as acquisitions (Zollo and Singh, 2004; Haleblian and Finkelstein, 1999; Hayward, 2002), alliances (Capron, Dussauge, and Mitchell, 1998; Gulati, 1999), new product development (Clark and Fujimoto, 1991; Helfat and Raubitschek, 2000),

and strategic decision making (Eisenhardt, 1989; Judge and Miller, 1991). Helfat and Winter (2011) emphasize that such processes have in common that are all intended to "alter the ways in which firms earn their living" (p. 1245).

One of the challenges with our existing understandings and definitions is that, even if we list a series of processes that may be related to an organization's ability to cope with uncertainty, these still make it hard to pinpoint what exactly differentiates organizations that navigate such uncertainty successfully from those that do not. For instance, before a period of rapid change and high uncertainty that affected the mobile telecommunications industry and that started around 2006 with the entry of new players like Apple and Google, business scholars and analysts often praised Nokia for having strong processes such as R&D, and new product development (Ammisetti, 2012). Despite having these apparent well-suited capabilities, the company could not perform well when fast and largely unexpected changes started to challenge the dynamics and competitive foundations of the industry.

There is therefore a need for more granular studies that detail what takes place "under the hood" of organizations and allow us to understand more precisely how they operate under high uncertainty conditions. Our study builds upon existing research to provide such level of granularity. By documenting key decisions points and respective consequences of an organization that is exposed to increasing uncertainty levels, and by further developing areas where existing theorizing has been less intense through the insights drawn from our clinical case, we provide both theoretical refinements and empirical evidence that complement the existing body of work aimed at better understanding how organizations operate under high uncertainty.

Prior research has provided insights on how organizations navigate dynamic environments. In particular, Eisenhardt and Sull (2001) argue that organizations in such contexts tend to use "simple rules," i.e. they use heuristics to come up with rules to expedite decision making. Eisenhardt and Martin (2000) point out that, in contrast to moderately dynamic markets where organizations can operate successfully with fairly routinized behavior,

organizations competing in high-velocity markets tend to use "simple (not complicated), experiential (not analytic), and iterative (not linear) processes. They rely on the creation of situation-specific knowledge that is applied in the context of simple boundary and priority-setting rules" (2000, p. 1113; parentheses in original). For instance, a simple rule could help managers decide which opportunities should be pursued and which ones should not, as in Eisendhart and Sull's example of Cisco guidelines for acquisitions that lead them to focus on companies with a certain maximum head count and a large proportion of engineers (2001, p. 111). Simple rules are, by definition, constructed upon past experience. Their purpose is to reduce complexity by using heuristics to simplify and speed up decision-making.

While the idea of simple rules is appealing and has thus gained some traction, very few studies have been conducted to explore their applicability and boundaries. Our study suggests that, while helpful in some dynamic contexts, simple rules are likely to break down under extreme uncertainty. In other words, our results suggest that heuristics are indeed valuable for organizations operating in dynamic environments, but that they have important limits. Exploring these limits requires taking a closer look at the concept of "dynamic" or "uncertain" environment, which is at the core of the related bodies of literature mentioned above. Different attributes of the environment have been proposed, classified and re-classified over time in the literature (Dess and Beard, 1984; Sharfman and Dean, 1991; more recently, Davis, Eisenhardt and Bigham, 2009). Taken together, they seem to point to two broad cases where environmental dynamics pose major challenges on organizations. The first one seems to require organizations to process information and make decisions at unusually high speeds, and is associated with what the literature often refers to as environmental "velocity" (the "speed or rate at which new opportunities emerge;" Davies et. al. 2009, p.420) and "complexity" ("the number of features of an opportunity that must be correctly executed to capture an opportunity;" Davies et. al. 2009, p.423; Kauffman, 1995). In this first case, given enough time, a particular organization could potentially perform well, but the velocity of the ongoing changes or the time it takes to process them due the environment's

sheer complexity, simply does not afford the organization enough time to perform effectively.

The second case does not seems to be mainly about a time compression or complexity that challenges the organization, but about the organization's ability to determine what is to be expected next from the environment and thus to identify the kind of actions that need to be undertaken. This is associated with what the literature refers to as "unpredictability" ("lack of pattern…in the flow of opportunities such that there is less consistent similarity;" Davis, Eisenhardt and Bigham 2005, p. 424), and "ambiguity" ("lack of clarity, such that it is difficult to interpret or distinguish opportunities;" Davis, Eisenhardt and Bigham 2009 p. 420). In this second case, the key challenge for the organization is being able to make sense of the situation and determine what the possible courses of action are. This can be difficult because in these cases the connections between actions and their consequences cannot be reliably established (March and Olsen, 1976 p.12), forcing organizations to make decisions on the basis of intuition rather than logic (Gerwin 1981).

Our theorizing is based on studying an organization that faces an environment that becomes increasingly fast changing and, at some point, highly unpredictable. Our field study is based on a mountaineering expedition to Mt. Everest through one of the most difficult sides of the mountain, the Kangshung or East face. The expedition we study is one of only three expeditions that have succeeded in reaching the summit through this route as of 2013. Our observations of how this organization behaved and performed are enriched by the direct experiences of one of our authors, who was a member of the expedition and actually reached the summit.

Our findings both complement existing research and bring fresh perspectives to our understanding regarding organizational capabilities in uncertain contexts, and can be summarized as follows. First, simple rules are very important when it comes to speeding up organizational responses to fast-changing conditions. Our research therefore supports existing research but also provides much-needed empirical evidence and details of heuristics in action.

Simple rules, however, seem to constrain organizations to variations and reconfigurations patterned in previous models for action. Second, partly because of their nature, simple rules appear to break down when the environment becomes highly uncertain to the point of being unpredictable, requiring novel recombinations that go beyond those that can be derived from heuristics. Third, when faced with such unpredictable environments, organizations tend to respond with an extreme form of "improvisational productions" (Miner et al., 2011, p. 309), which we refer to as *discontinuous improvisational productions.* A key characteristic of these novel recombinations is that they depart from previous models of action and open new possibilities for the organization. While accepted notions in strategy literature suggests that a capability "enables repeated and reliable performance of an activity, in contrast to ad hoc activity that does not reflect practiced or patterned behavior" (Helfat and Winter 2011, p. 1244), we argue that discontinuous improvisational productions during high uncertainty do qualify as organizational capabilities because they, (a) are intentionally enacted; (b) entail activities that recombine and extend the existing resource base in novel ways (c) open new paths of action for the organization that often have important implications for key organizational outcomes; (d) engender key collateral insights that are often retained and can potentially be re-used in the future (Miner, 1989).

RECOMBINATION, HEURISTICS AND IMPROVISATION

In his seminal book, Schumpeter saw innovation basically as the product of recombination and, like much of the recent literature, marked a difference between organizations capable of incremental change to existing routines or processes from those capable of creating truly new combinations:

> "To produce means to combine materials and forces within our reach. To produce other things, or the same things by a different method, means to combine these materials and forces differently. In so far as the "new

> combination" may in time grow out of the old by continuous adjustment in small steps, there is certainly change, possibly growth, but neither a new phenomenon nor development in our sense. In so far as this is not the case, and the new combinations appear discontinuously, then the phenomenon characterising development emerges. For reasons of expository convenience, henceforth, we shall only mean the latter case when we speak of new combinations of productive means. Development in our sense is then defined by the carrying out of new combinations". (Schumpeter 1934, p. 65-66).

This basic idea that recombination is at the center of major innovation and change has prevailed in bodies of management literature as diverse as industry lifecycle (Abernathy and Utterback, 1978; Suarez, 2004); organizational learning (Kogut and Zander, 1994), e.g. "firms learn new skills by recombining their current capabilities" (p. 383); and management of uncertainty (Weick and Sutcliffe, 2001), e.g. "skills of recombinations" (p. 15). Recombinations, however, as suggested by Schumpeter's quote above, vary in the extent to which they are based past patterns and continuous adjustments to them, or are discontinuous, novel combinations.

Recombinations can be the result of simply altering the order of existing elements, or including pre-learned elements or sequences into an existing "thing." These could be planned, by-design recombinations, or unplanned, simpler forms of improvisation that Weick (1998) has labeled "embellishment" and "variation" (p. 52), and that in turn are akin to Miner's (2011) concept of "improvisational productions." These forms of improvisation provide flexibility to an organization and also the ability to respond fast to an evolving situation, but they are bound to previous patterns and experiences. Using the example of jazz music, Weick (1998) notes that in both embellishment and variation, the relationship to the original melody is always recognizable.

Heuristics, "principle or device that contributes to the reduction in the average search to solution" (Newell, Shaw and Simon 1962, p. 85) can also lead to recombinations, but their use tends to confine organizations to recombinations that are ultimately based on existing, learned patterns. Indeed, our current

understanding of heuristics comes from Simon's pioneering work on "bounded rationality (1957), and more specifically by research by Tversky and Kahneman who noted that "judgment under uncertainty often rests on a limited number of simplifying heuristics rather than extensive algorithmic processing" (Gilovich, Griffin and Khaneman, 2002, p. 1). Their work characterized heuristics as fast shortcuts based on past experiences. For instance, availability heuristics, "the ease with which instances or associations could be brought to mind" are created by "associative bonds… strengthened by repetition… perhaps the oldest law of memory known to man" (Kahneman and Tversky, 1973, p. 207-208). Their research also showed that "when faced with a complex problem, people employ a variety of heuristic procedures in order to simplify the representation and the evaluation of prospects. These procedures include computational shortcuts and editing operations, such as eliminating common components and discarding nonessential differences" (Tversky and Kahneman 1992, p. 317). Simple rules and heuristics have also been used to explain self-emergent behavior without centralized control structures, for instance flocking birds (Waldrop, 1993). In other words, heuristics are minimal principles of action distilled from previous experience that allow individuals and organizations to navigate rapid and complex environments by expediting decision making.

The truly novel recombinations that we label discontinuous improvisational productions are less frequent but can be crucial when heuristics are no longer enough and novel solutions are also needed to confront highly uncertainty contexts. Unlike patterned capabilities such as those embodied in existing organizational processes or heuristics of the embellishments and variation type, discontinuous improvisational productions bear little resemblance with past-learned patterns. Weick (1998) discusses this type of novel recombinations and calls them simply "improvisation" (p. 52), to differentiate it from the less-novel embellishment and variation improvisation types. In music, discontinuous improvisational productions are characterized by changes that "radically alter portions of the melody or replace its segments with new creations bearing little, if any, relationship to the melody's shape" (Berliner, 1994, p. 77). This type of recombination places higher demand on organizational resources, and is harder and riskier to produce than those coming from

patterned recombinations (Hatch 1988; Davies, Eisenhardt and Bigham 2009); because of this, not all organizations are capable of enacting them. Quite the contrary, the response of most organizations to an increasingly faster environment tends to be precisely to move away from attempting novel recombinations; in such environments, organizations prefer to turn to heuristics or learned patterns instead attempting deliberate improvisation. Along these lines, Weick pointed out "managers hate [surprises]… we begin to see that improvisation may be absent from the organizational literature." (1998, p. 553), while Nelson and Winter (1982) stress that "mutations tend to be deletereous on average," and that organizations "tend to resist mutations" (p. 116).

Discontinuous improvisational productions may not be commonplace, but they can potentially be a key source of competitive advantage in high uncertainty, unpredictable environments – an underexplored link in our existing theory of capabilities. Discontinuous improvisational productions do not represent minor changes of localized significance but instead can sometimes have a large influence in the success and even survival of the whole organization; they therefore enhance our understanding of how organizations operate in unpredictable environments. Moreover, the learning derived from enacting them can be retained by the organization, and even passed onto other organizations. Patterns of selective retention and replication of less-extreme improvisational productions have been documented by several authors (Miner et al., 2011; Van de Ven and Polley, 1992). We argue that, in the specific case of discontinuous improvisational productions enacted in highly uncertain, unpredictable environments, retention is reinforced because of the high stakes that surround the organization's responses. Consequently, insights about how an organization enacted a discontinuous improvisational production when confronting an highly uncertain situation often find their way to other organizations in the form of myths and storytelling (O'Connor 1997; McKenzie 2011). When that happens, such novel recombinations can become a model to be copied by others through mimetic or normative isomorphism (DiMaggio and Powell 1983), or at least a major point of reference when encountering similar situations.

For instance, in the mountaineering world in which our field study is based, there are many such instances of previously untried recombinations to navigate unpredictability that became well known by the community at large. One such story refers to two British climbers who conquered Mt. Siula in Peru, described in the autobiographical book *Touching the Void* (Simpson, 1988). When descending, Joe Simpson fell and broke his leg, "*I´ve broken my leg, that's it. I´m dead*"(p. 64). His climbing partner, Simon Yates, recalled: "*He looked pathetic, and my immediate thought came without any emotion, You´re f***, matey. You are dead… no two ways about it! I think he knew it too.*" (p. 67). With no time to plan and no solution in sight, they decided to attempt an impossible self-rescue: In a heavy snowstorm, with almost no visibility, Simon would try to painfully abseil Joe down the steep mountain. At night, they reached a point where a big crevasse appeared. All of a sudden broken-leg Joe was hanging in the void, and Simon, without seeing or hearing him, was still trying to abseil Joe with his body weight. The conditions and uncertainty made the situation untenable. Simon remembers, "*I was shaking with cold. My grip on the rope kept easing despite my efforts. I can´t hold it. I can´t stop it… God, I had to do something!... The knife! The thought came out of nowhere… I need no pressure, the taut rope exploded at the touch of the blade, and I flew backwards into the seat as the pulling strain vanished. I was shaking*" (p.88-89). Simpson fell into the crevasse, and after an amazing ordeal punctuated by a series of bold decisions, he survived, crawling across the glacier to become one of the most famous survivors in mountaineering.

SETTING AND METHODS

Conquering Mount Everest and the Kangshung Expedition

Mount Everest (29,028 ft.) provides the unusual opportunity to have "quasi laboratory" to explore how organizations are affected and respond to different levels of environmental uncertainty. As expeditions ascend the mountain, the environment becomes increasingly fast moving and, at some point, unpredictable. There are at least two objective conditions that link altitude with uncertainty. First, at very high altitudes it is common to have sudden changes in

weather conditions such as strong winds, heavy snowstorms (blizzards), and extreme cold; these get more extreme and harder to predict the further up the mountain an expedition is. Second, the reaction of the human body becomes increasingly unpredictable at very high altitudes; hypoxia—the lack of oxygen supply—is the mountain's most powerful natural defense. The combination of hypoxia and strenuous effort can suddenly give rise to serious conditions such as cerebral edema, pulmonary edema (Fayed et al., 2006).

Broadly speaking, we can distinguish three levels of altitude that represent different sets of environmental characteristics. The first level or "low altitude" includes "base camp" and Camp 1, up to 23,000 ft. This is a hard but fairly predictable environment, to which the human body can get fully acclimatized in about 2 weeks. The proximity of the base camp provides alternatives to resolve emerging events in different ways. The second level or "high Altitude" includes Camp 2, and goes from 23,000 ft. to 26,000 ft. At this level, weather can change quickly and the human body has serious difficulties acclimatizing, which is often reflected in troubles to sleep and digest, and loss of weight. There is still some room for adjustments at this level (e.g. a sick climber can be replaced by another), but the options are more limited than in low altitude given that the organization carries fewer resources up the mountain. The third level is the so-called "death zone" which includes Camp 3, above 26,000 ft. Here, environmental changes and the human body response to them tend to be highly unpredictable. It is not possible for the human body to acclimatize, so time accelerates and resources are stretched to the maximum, leaving almost no room for error.

Our field study is based on a sports classic siege-tactic expedition through a most difficult route, the Kangshung face[1]. The fact that this route is even to date largely unexplored adds to the uncertainty that organizations face when trying to reach the summit. The level of uncertainty faced by a climbing organization depends largely on the route chosen and the level of additional support received throughout the ascent. As commercial expeditions to Mt. Everest have exploded

[1] Siege-tactic climbing considers a base camp and a sequence of stocked camps up on the mountain and is the prevalent system to climb very high mountains. The other major system is know as "Alpine style" where climbers attempt the route in just one continuous push without the help of fixed ropes, porters or camps.

in the last couple of decades, it is helpful to provide some historical context here (see Figure 1). The first sports expeditions to Mount Everest started in the 1920s, initiating a long era of conquest that led to the first successful summit only in 1953. Starting in the 1970s, sports expeditions emphasized style or "ethics," in an age of difficulty that led climbers to attempt new and more difficult routes with challenging topography and to add self-imposed additional challenges, such as climbing without supplemental oxygen (Messner and Habeler in 1978) or climbing in winter (Polish team in 1980). Starting in the 1990s, an age of commercial expeditions introduced Mt. Everest to a much larger number of climbers; these expeditions normally chose comparatively easier routes and provided considerable support. Despite the choice of routes and ample support, fatal accidents still occasionally happened (Krakauer 1998). Table 1 summarizes the routes used to attempt to climb Mt. Everest from 1953 to 2010, and shows that the 17 "technical routes" (non commercial) only account for less than 3% of total ascents, with Kangshung representing only 0.1%.

[Insert Figure 1 here]

[Insert Table 1 here]

Commercial expeditions differed markedly from sport expeditions not only in the difficulty of the chosen routes but also in the amount of resources that they carried and used. As an example, commercial expeditions consumed an average of 55 bottles of oxygen per client-member to reach the summit, and contracted extensive support of Sherpas (local manpower) to carry loads all the way up to the summit. In contrast, the members of the sport expedition we studied carried their own load and consumed 1 bottle of oxygen per member to reach the summit. Commercial expeditions rely on the experience and capabilities of their company guides through well-travelled routes, and are supported by Sherpa teams, while sport expeditions use their own members experience and capabilities to carry loads and overcome obstacles in much harder and lesser-known routes. As they deal with clients, commercial expeditions tend to be more programmed and conservative in their decision-

making (e.g. time to return to camps) and fairly hierarchical, relaying primarily on the guide's experience. Sport expeditions are horizontal organizations and have more variance in their behavior, being both more aggressive and innovative as they climb.

The Kangsungh expedition in our study was founded by two experienced climbers, Jurado and Galarza[2]. Both had participated in two previous sports expeditions to Mt. Everest that had been unsuccessful in reaching the summit, despite having chosen some of the least-difficult routes. For the Kangshung expedition, they tried an entirely different approach: a lean organization of only 6 climbers through one of the most unexplored routes. The Kangshung route included 4,000 feet of rock and ice walls and a steep glacier covered by powder snow with a high risk of avalanches. The fact that their earlier attempts had failed made obtaining resources (sponsorships) hard, so Jurado and Galarza had to proceed with a tight budget. Despite the route difficulty, the Kangshung organization progressed smoothly on the lower part of the mountain, even across the most dangerous sections. They spent a total of 41 days on the mountain, significantly fewer than the average 50-60 days for most successful expeditions. Against all odds, they were able to place three of their six members on the summit, with no serious accidents and with minimal use of artificial oxygen or other external support.

Data Collection and Analysis

We use an ethnographic approach to add depth and detail to our understanding of how the Kangshung organization operated under such highly uncertain environment. Our methodology allows us to capture "temporary, evolving phenomena in rich detail" (Langley 1999, p. 705), a key advantage given the purpose of our study. The use of more coarse-grained methodologies tends to "skim the surface of processes rather than plunging into them directly" (Langley 1999, p. 705), and would have therefore been less informative in our case. Direct observation and correct interpretation of facts in the highly demanding and uncertain environment of high-altitude mountaineering is critical and revelatory (Yin 1994; Corley and Gioia 2004), because organizational

[2] The names of all climbers have been changed to preserve anonymity

performance under high uncertainty can be idiosyncratic, path dependent, and sporadic (Van Maanen 1988; Weick 1993). We take advantage of the unusual fact that one of the authors of this study, an experienced climber, participated in the Kangshung expedition and formed part of the three-member team that reached the summit. His access to information and appropriate interpretation of events and dynamics, particularly at very high altitudes, were extremely important to our understanding of the context, the organizational culture, and the technicalities of the ascent. His deep involvement in the expedition, combined with his theoretical training in organizational theory, provided invaluable insights into the study of the organization performed in the most challenging conditions, and in the construction of first-order narratives based on participants' perspectives that are distilled to provide new insights (Glasser and Strauss 1967; Strauss and Corbin 1990; Langley and Abdallah 2011).

Our analysis is based on data collected through participative observation and additional sources of data, as summarized in Table 2. The participating author used a personal diary to take notes and record the progress and fine-grained details of the expedition such as difficult situations and key decision points. We also had access to the diaries of four other organizational members, plus some letters and non-edited videos, which helped us to create a detailed story and to ensure the consistency of our narrative. In addition, we conducted post-expedition, semi-structured interviews with the other team members, aside from the participating author: Orlando Jurado, Raúl Galarza, Ariel Duran, Ignacio Bernal, and Lucas Alonso. The recording sessions lasted from three to seven hours, and later they were transcribed. The data gathered was coded and sorted by the different stages of the ascent to facilitate the analysis. For this paper we focus on what occurred at high altitude and the death zone, i.e. above 23,000 ft., that represent the specific context for our theorizing (Miles and Huberman, 1990).

[Insert Table 2 here]

We followed the following process to analyze our data. First, we gathered and then organized our different data sources (diaries, interviews, letters, and

videos) by stage of the climb, so that we could focus on the dynamics at high altitude and compare them with those in the lower mountain. Second, we coded the data by focusing on four key mountaineering processes (opening route, rope management, climbing, and planning), and the process of decision-making. We particularly looked for changes to those processes as the altitude increased, and evidence of changes that were considered unexpected. Consistent with Eisenhardt and Graebner's assertion that "theoretical sampling simply means that cases are selected because they are particularly suitable for illuminating and extending relationships and logic among constructs" (2007, p. 27), we looked for emerging patterns in our data, until they became sufficiently robust to construct conceptual categories (Eisenhardt 1989) and we reached a point of theoretical saturation (Glaser and Strauss 1967). We also used secondary sources as controls to confirm the validity of our findings, particularly as what can be considered regular practice in mountaineering. The sources included archival data from newspapers and mountaineering magazines (118 articles in total), a book about the Kangshung expedition (Jordan 1992). We also used information from other reports or personal histories of Mount Everest attempts (Unsworth 1991; Venables 1989; Gillman 1993) as controls.

FINDINGS

Simple Rules in Action

Whereas the life and activities of the climbing organization at low altitude, near base camp, was described by Bernal, one of the climbers as "A normal day…like a day in the office," the situation changed significantly when they passed the first critical threshold at 23,000 ft. where the environment turned more uncertain and body acclimatization much harder. As the conditions worsened, a feeling of awe and respect invaded climbers who could at times seem overwhelmed by the scale, dynamism, and brutality of the environment *vis-a-vis* the resources of the organization. Duran told us that, *"Something unique*

happens when you reach above 23,000 ft. Such sensation is only possible in the big highs of Himalayas. You can feel it immediately, it's the thin air, and it seems that you can't find enough oxygen to fuel your muscles for even the most minimal movement." Thin air, strong winds, and extreme cold make the effort exponentially more intense than in the lower mountain. Galarza pointed out: "*If you look our movements from the outside they would appear like those in any other climb, but at such altitude everything becomes harder and time is against you. It's like having a stopwatch on your side all the time, you need to keep energy but everything around you drags it out. You can't recover like you did at lower altitude, and this deterioration process is cumulative. Here is where the real battle with Everest starts."*

Above 23,000 ft., what worked well in lower elevations can start to show problems. Shifts to open route do not always gain ground due to shifting weather, goals for the day are not met, etc. Fighting fatigue and rapidly changing conditions lead some climbers to simply refuse to keep pushing on, which can become a problem for the organization as the cumulative and irrecoverable consumption of energy from additional days in high altitude reduces the probability of reaching the summit.

In order to meet these challenges, the Kangshung expedition consciously adapted processes as they climbed. A critical part of such adaptation consisted in what Galarza called "working in a sort of automatic pilot" when performing many of the activities that now needed to be done quickly and with minimal energy spending, from cooking in the tent to the mechanics of opening route. The climbers did that by following standard processes and also by applying heuristics-based solutions that expedited decision-making and reduced energy-consuming formal interactions. These rules reduced search and simplified coordination. For instance, one such rule was that climbers did not question the route chosen by whoever was leading at that point. Jurado told us that, *"After camp 1 [23,000 ft.] we almost stop talking, and everything just flows, with no instructions or a few words. When you see the others stopping, you stop; when the others eat, you eat; and all the rhythm of the day is set by the one who leads. We know it is better like this because we have done it in other mountains… You just*

climb and don't spend too much time thinking and analyzing; all your energy is focused in moving your body forward and sensing the danger".

We got similar accounts from other climbers of the type of norms and rules that the organization adopted in high altitude in order to operate in that environment. These rules allowed the Kangshung organization to move as quickly as the conditions permitted through challenging terrain, save energy and time to cope with unexpected situations. For instance, Galarza pointed out that, "*When you are on the lead, your only mission for the day is opening route as far as you can and save as much energy for the team as you can in the process. If you are behind, your premises are totally different but you also have norms to follow: first you serve and support the leader and that means you don't question the route unless the leader asks for your opinion. This puts all the responsibility on the leader and avoids second-guessing.*" This arrangement meant there was no top-down design and control over most processes, which left room for adaptation. Despite the rule that implied that the leader called the shots at any one point during the ascent, the Kangshung organization was all but hierarchical: in one moment one climber could be the leader, and after a while he could be behind. Matta concurred, "*… you don't question the leader's route unless he asks you. That gives him a lot of confidence, because he can do right or wrong without being questioned... This is complicated when the route he chooses becomes more difficult for the follower, for instance when you are in a traverse that the leader can overcome easily because he carries little or no weight but then you have to follow with 30, 40 or more pounds on your back and in addition have to clean all the protections. But we don't complain, because we know it works better this way than discussing and arguing about every decision in complicated spots*."

Managing ropes is another example of how simple rules expedited decision-making and allowed the organization to operate at higher velocity and with flexibility. Traditional siege-tactic expeditions use a centralized process from the base camp to manage ropes, and thus have a specific role to coordinate the fixing and replacement of ropes for the entire expedition. In this mode of operation, a climber that finds a damaged rope would radio the person in charge to report the problem and that person would decide who fixes or replaces the rope, and when. This mode of operation has the advantage of always providing

full information about the state of the ropes, allocating resources to the rope tasks in ways that maximize utilization of manpower, and allowing lead climbers to focus exclusively on opening route. However, it also presents some coordination challenges, can delay decision-making (climbers needs to wait for decisions made by somebody else), slow ascent progression, and have a non-trivial effect on radio battery life due to the additional use of communications.

The Kangshung expedition used more than 1 mile of ropes to climb the technically challenging Kangshung wall, but they had no point person in charge of ropes. Instead, in order to avoid delays and make sure ropes will always be ready for use, they issued a rule that required each climber to constantly check for damaged ropes as they climbed or descended the mountain, and to fix any damaged rope they found right on the spot. Jurado told us during an interview that the team's motto when climbing was "*if you find a damaged rope, you have to fix it, no matter what… This means that you need to be alert all the time, feeling the rope fibers with your hands while rappelling (descending using the ropes), sensing for possible damages – even very minor ones -- all the time. It can be extra work at times when you just want to descend, but it really works well because you know the others are doing the same all the time, and you can hang on the ropes with confidence*".

The Limits of Simple Rules

While rules to expedite decision-making were effective and important to allow the Kangshung organization to successfully operate at high altitude, new challenges appeared when the expedition reached the death zone at 26,000 feet. At this extreme altitude, nothing seemed stable or safe, and climbers had to progress under great uncertainty with respect to how, and even if, their bodies would respond, and what the weather and the mountain would next throw at them. This lack of predictability, an inability to plan for what would come even in the next hours, added to the challenge of having limited and diminishing resources. Jurado recalled the experience, "*No matter how much you train – and we did a lot! – a mountain like Everest is hostile and unpredictable… is not like the Andes that we know well. Only 14 mountains in the world rise above 26,000 ft., and*

all of them are in the Himalayas. When you have to climb and spend the night at such altitude, it is a totally different game…"

The "different game" was literally a singular situation, unlike anything these skilled climbers were used to or had experienced. At that extreme altitude, uncertainty manifested in an ever-present feeling that much was out of their control, including their ability to predict how their own bodies would respond. Matta's description of his recollection of Camp 3 is quite illustrative, *"In our last camp [26,000 ft.], nobody talked, except for a few, sporadic short sentences like 'give me that' or 'I'll do it.' We used commands, signals, and very few words. Without artificial oxygen you cannot sleep… you have to stay awake all day and night, often seated in the tent to force your breathing… I felt like being drunk or unconscious, lying in the corner of the tent. I recalled being in a sort of 24-hour trance, breathing desperately all the time. We started climbing towards the summit at 23:50 hrs. and returned 17 hours later. When we started, we would walk 10 to 15 steps and stop. Towards the end, we could only manage to do 3 or 4 steps and then had to stop… I lost around 20 pounds in 48 hours, and returned with internal hemorrhages and absolutely worn out. It was extreme, and you feel you are at the edge of life and death in every moment. When we finally returned to Camp 2, I could feel the density of the air in my mouth."*

In such unforgiving environment, the Kangshung organization not only continued to stretch their resources and expedite decision-making through simple rules, but also came up with bold ad-hoc responses to situations they encountered for the first time. This resulted in solutions that were novel, risky, and that departed from previous experiences and practices. One such departure from past patterns was the fact that the team decided to spend three nights in the death zone without proper supplies or equipment, while most expeditions do not spend more than one night up there without artificial oxygen. Spending additional time at such extreme altitude lengthens the exposure to a destructive environment that weakens the body at an alarming rate and thus reduces the chances of success in reaching the summit. Such course of action was not even considered within the set of possibilities by the members of the Kangshung organization, as the following quote from Jurado suggests,

"*No one intended, not even imagined staying more than one or at most two nights above 26,000 ft; It was extremely dangerous. If you were trapped by a storm, or if you had any kind of minor accident at this altitude, you would die in a matter of hours! If you had asked me before the trip: 'If you have to spend 3 nights at 26,000 ft. with almost no artificial oxygen to reach the summit, would you dare it'? I would have probably said no. It would have been like leaving a suicide note to my daughters.*"

Another major departure from past experience and practice was to allow one of the supporting team members, who was not supposed to be part of the summit attempt, to stay in the death zone without proper equipment (no oxygen or even a sleeping bag) and then, against all standard practice and even their own calculations, to join the summit attempt. Although this decision, made on the spot, represented an unprecedented step and a huge risk for the organization, the Kangshung members figured that, given the uncertainty about how the two-man summit team would respond to the severe conditions in the last stretch, an additional member who apparently happened to be in a (relatively) good condition to participate in the summit attempt could potentially increase their overall chances of success. The bet paid off, as the support climber, Matta, indeed reached the summit. He later described the unexpected turn of events,

"*Our original plan had been to attempt the summit with three well-equipped climbers. But you know, things happen. At first camp, Duran had to abandon because of broken ribs. We discussed the situation and came to the conclusion that we could now only support two climbers to the top. In one day our plans had totally changed. We reached our second camp and decided the names of those who would attempt the summit. However, next day, climbing at 24,500 ft. things changed once again as Lozano, who was in support, decided he had to go back, to Camp 2. In addition, I was feeling well enough to attempt the summit. We had a brief radio conversation and I said, 'I feel well and want to go to the top.' I had no sleeping bag for Camp 3 and there were no supplies for me, so*

allowing another person to stay and attempt the summit implied sharing some of the scarce resources we had for the two who were supposed to go up and we all knew that the summit team had priority over the rest. There was a silence, and then I heard Jurado's voice: 'OK. We have more chances with 3 than with 2, so it's fine'. The decision was made in seconds, and for the next three days I was part of the team that reached the top. We never imagined that things would turn out this way."

Jurado explained how they made that decision:

"Allowing a third member to stay in the death zone with gear and oxygen only for two seems crazy, but it really was not. All of us were aware that our situation was one of extreme risk. We knew that at such altitude, if somebody had a problem, it was almost impossible to help him. Matta said he was feeling apt to attempt the climb; he knew he was on his own and that we didn't have any obligation to share oxygen or sleeping bags with him. None of us knew how our bodies would react and behave. Messner's classic words in his way to the top: 'I am nothing more than a single, narrow gasping lung, floating over the mists and summits,' was always in our minds. With three climbers we had more chances that at least one of us would make it to the top. We knew that we were helpless and independent souls at the same time."

The examples above illustrate our concept of discontinuous improvisational productions. They refer to a type of recombination that, far from being based on existing processes, past experience, heuristics or simple rules, challenges most of what had been learned and practiced earlier by the organization. For the Kangshung expedition, using rehearsed processes and heuristics-based rules worked well below 26,000 ft., but apparently these, while still important, were not enough in the death zone. Bernal recalled that *"we all knew that during the last attempt everything could change in a moment for good or bad, that we needed to be totally open and flexible... I said to myself, the only important thing is moving forward."* Decisions were made on the spot, based on local and specific information about the alternatives available at the moment, and not based on what had worked in the past, what was planned or expected or

what the "standard practice" in the mountaineering community was at the time. The recombinations were unorthodox and risky, but the organization enacted them in order to keep open as many options as possible.

Table 3 summarizes the different types of capabilities that are most salient at each level of uncertainty. Operational capabilites, rooted in routines, are most salient in predictable environments. Simple rules or heuristics, rooted in learned patterns, are important in high velocity environments. Discontinuous improvisational productions that lead to novel solutions are most salient in extremely uncertain environments.

[Insert Table 3 here]

DISCUSSION

Navigating uncertain environments

It has become widely accepted among scholars and practitioners that being able to operate and succeed under uncertainty is a key advantage for organizations in many modern markets today (Kogut and Zander, 1992; Helfat and Winter, 2011). The literature has achieved less consensus, however, as to what organizations actually do when they navigate such environments. In particular, there has been a lack of empirical studies of organizations operating under high uncertainty (Teece, 2007); partly due to the difficulties of collecting data and obtaining access to organizations when these are going through these challenging times and the fact that they tend to happen in narrow time frames.

Our study provides a fresh and rather unique view on how an organization was able to cope with increasing levels of uncertainty. We find that, as argued by existing theory, once it entered high altitudes, the Kangshung organization relied heavily on heuristics or "rules of thumb that provide shortcuts in problem solving," particularly in "situations in which there is limited time and information" (Eisenhardt, Furr and Bingham, 2010 p. 1266). For instance, their rule to always empower the climber who was in the lead with making the important decisions at all times, allowed the expedition to navigate uncertainty without experiencing the delays or even inertia that organizations often suffer from in such situations (Christensen, 1997). Decisions were made

not based on careful and lengthy analyses, or detailed planning meetings, and often not even quick consultations – there was simply no time for that. The organization relied on simple conventions and time saving shortcuts resulting from their previous experiences in other mountains (Eisenhardt and Sull 2001; Eisenhardt and Tabrizi, 1995).

The reliance on heuristics to make decisions was particularly important when it came to rapidly evolving situations. For instance, when describing his role following the lead climber in one of the most challenging part of the ascent, Duran recalled "*We were at the Kangshung Wall, with huge stones incrusted in the steep ice; rocks and chunks of ice were constantly falling from above. Sometimes I would see [the climber on the lead] moving without hesitation, placing his piolets and crampons just in the right spots. But sometimes I could not see him; I only heard when he would hit the ice with his tools. By the calm and firm sound of the tool in the ice I knew that everything was O.K., so I kept going.*" The simple rule here could be described as something like "if the sound of the tool in the ice is firm, soft and clear, go ahead." Relying on heuristics like this allowed the Kangshung organization to make rapid progress on the mountain, which would be crucial to their ultimate success.

The Kangshung organization's use of heuristics during uncertain periods required that each organization member knew the rules and was disciplined in their application. This was facilitated by the fact that heuristics come from learned patterns (Moorman and Miner. 1997; Weick, 1998); in the case of the Kangshung organization rules came from previous climbing experiences, including Mount Everest, and intensive training. Indeed, the Kangshung climbers had fresh memories of previous experiences and the lessons they took from them. Bernal recalled, *"In our previous expedition [also to Mt. Everest] we had the figure of an Expedition Leader whose role was to coordinate everything from the base camp. He made all the critical and logistical decisions, and I often felt his decisions were not the best for the team. We had to constantly ask for approval or wait for instructions, a lot of precious time went on that. The decisions were also the object of permanent discussions among us. No one felt responsible for results that came from somebody else's decisions."*

The Kangshung organization left decision making to the member in the lead. At that moment in time, up above from the others, the climber on the lead has more information about what comes next than those in the base camp *"miles away from the action"* (Bernal), of those climbers that follow the leader's track. He can better see and assess the terrain and determine what is possible, he is the first to detect subtle changes in the ice or rock wall. In addition, the danger of taking too much time to make decisions becomes acutely salient during the most challenging situations: snow avalanches, falling rocks, and the ever-present risk of hypothermia or dehydration due to long stretch of extenuating climbing are staunch reminders of what is at stake and the importance of moving fast. Galarza, who also took part of the previous expedition described just above, contrasted the more process-oriented previous expedition with the Kangshung's: *"Big expeditions are like big machines and most of the time the logistics of the day isolate you from the pure naked fight against the mountain. But you know, this naked feeling is exactly what you need to succeed and survive in high altitudes… In the Kangshung [expedition] we opened route as freaks, we set our limits alone when we were leading the climb; we saved radio batteries and our energy was focused in gaining altitude."*

Simple rules based on previous experience can save time and allow the organization more rapidly, while allowing at the same time for certain degree of flexibility. This type of patterned-based recombination resembles the simpler forms of improvisation that Weick termed embellishment and variation (1998 p. 544-545). By following simple rules, the organization expedites decision-making along certain bounds stemming largely from learned patterns. This points to another factor explaining the successful use of simple rules that we observed in the Kangshung organization. Kangshung members had prepared intensively for two years before attempting Mount Everest. They had trained six days a week for two years with a "zero-tolerance" policy when it came to missing training sessions. During many of their long training sessions, the climbers did extensive analyses of what had gone wrong in previous attempts to Mount Everest, including those that several members had taken part of. During their practice days in the mountain, they rehearsed different possible strategies to overcome obstacles. The result of this long and intensive training was a heightened sense of

shared expertise which would become key during the Mount Everest ascent, allowing members to improvise based on heuristics when facing dynamic situations. As Berliner (1994) has pointed out, the "simplistic understanding of improvisation belies the discipline and experience on which improvisers depend, and it obscures the actual practices and processes than engage them" (p. 492). He continues, referring to the jazz music example, by stating that, "Improvisation depends, in fact, on thinkers having absorbed a broad base of musical knowledge, including myriad conventions that contribute to formulating ideas logically, cogently, and expressive" (p. 492). Like the jazz musicians in Berliner's example, the Kangshung members in our study had achieved a broad base of mountaineering knowledge and conventions that allowed them to compress their routines and turn to heuristics to navigate the difficulties of high altitude with speed and nimbleness.

Why Heuristics are not enough

As the Kangshung expedition continued to climb into the "death zone," the situation became not only extremely difficult but also extremely uncertain; in particular, it was impossible to predict how the body would react even in the next few hours, or what the weather conditions would be. Additionally, at such altitude and with so much at stake, small variations that can first go unnoticed can lead to serious consequences in a matter of hours (Waldrop 1992; Weick and Sutcliffe, 2001; Vaughan 1999). When facing unpredictable situations, some of the on-the-spot decisions made by the Kangshung organization departed markedly from previous patterns: "*We had to decide right at the moment; we felt all alternatives were open as long as they helped us reach the summit,*" said Galarza. Kangshung members knew that, as Jurado recalled, "*In the last part of the climb, we were going all out."* The fact that two members in a support role stayed extra nights in the "death zone" lacking adequate amount of oxygen, food, or even sleeping bags, and moreover the fact that one of them was allowed to take the unprecedented step to attempt and conquer the summit, are good example of this "going all out."

When faced with extremely uncertain circumstances, most organizations do not come up with responses that are markedly different from their learned patterns and past experience. Research shows that, when faced with high uncertainty, organizations lean towards "regression to first learned responses" (Allnut 1982, p. 11; see also Barthol and Ku 1959), tend to operate by "narrowing the focus of attention" (Hammond, 2000, p. 8) and exhibit less requisite variety (Weick, 1990). By narrowing the focus of attention, the organization reduces search and attention by focusing only on those factors that are filtered by past experience (Wickens, 1987). These heuristics concentrate the organization's dynamics around a selected set of memories, resources and alternatives, thereby providing speed and flexibility in decision making, but at the same time limiting the total possible repertoire of responses and recombinations to those that are consistent with learned patterns. Jurado recalled one such instance from the prior, failed expedition, when the climbers "set their last camp at 25,000 ft. and decided to wait…for the weather to improve." As it turned out, after the second night one climber developed a thrombosis and the rest decided to give up their attempt. Jurado explained that waiting for good weather was something that climbers would have done if they were climbing in the Andes, but added, "in the Himalayas, it was a terrible mistake."

Instead of relying in heuristics coming form learned patterns, the Kangshung expedition came up with new, previously untried discontinuous improvisational productions in the death zone, that emerged in real time and bore little, if any, relationship with past patterns. This is the most important difference between the organizational responses we observe under extreme uncertainty and those variations derived from heuristics that tended to predominate just below the death zone. In heuristics-driven variations, the search for elements of recombination is almost invariably bounded by the prior knowledge and experiences that the heuristics-in-use are based on. This is a general observation that seem to apply to other settings, not just mountaineering. Theatrical improvisation, for instance, has been shown to happen within patterns of dialog and interaction among the actors that closely follow learned patterns (Crossan et al., 1996). Similarly, jazz improvisation takes place "under the pressure of a steady beat" (Weick, 1998, p. 49). Indeed, most improvisation

of the types "embellishment" and "variation" are produced by "*reworking pre-composed material and designs in relation to unanticipated ideas conceived, shaped and transformed under the special conditions of performance*" (Berliner, 1994, p. 241).

Our finding that, under extreme uncertainty, organizations tend to rely more on out-of-the-box, discontinuous improvisational productions, raises one important question. If the responses enacted by the organization in such environment did not spring from existing processes and learned patterns, what were they based on? Where did they come from? Our study cannot fully answer this important question, but the Kangshung story suggests that the answer can be found in what a handful of management scholars have stressed: intuition. Hatch (1997) and Crossan and Sorrenti (1997), for example, highlighted the importance of intuition for improvisation. Intuition goes beyond the learned patterns of an organization because, by its own nature, it ultimately draws from an individual's whole memory and thus is free to disrupt action in favor of novel solutions (Weick, 1990). Intuition facilitates the emergence of new scenarios and recombinations that can help organizations make bold decisions on the spot, a sort of "just-in-time strategy" based on "reflection in action" (Schön, 1983). In such situations, intuitive insight "facilitates the identification of a range of possible creative solutions" (Crossan and Sorrenti, 1997, p. 37). Recent research in intuition suggests that it is based on tacit knowledge and preconscious awareness of reality and that it seems to be especially present in organizations that are exposed to high risks or what has been labeled "edgework" (Lyng, 2005, p. 858). Indeed, studies of edgework organizations (firefighters, fighter pilots, etc.) have concluded that they seem "to have an ability to grasp and respond to dangerous situations quite effectively when they have almost no time available to reflect on alternatives" (Zinn, 2008, p.444). Recent research suggests that intuitive skills can be found in organizations operating in context that are not of extreme activities. For instance, Klein (1998) studies how nurses in a neonatal intensive care unit make on-the-spot decisions regarding the rapid development of septic conditions in babies and decide whether to begin immediate treatment, thus saving lives.

Intuition has long been associated with the creation of novel solutions in situations where full analytical information is lacking, or when time constraints do not permit a complete analysis (Agor, 1986). Mintzberg (1976), echoing evidence from brain studies, argued that intuitive insights are handled by the right hemisphere of the brain, unlike what happens in most decision-making situations where the left hemisphere –responsible for analytic, linear thinking – predominates. In a similar fashion, the Kangshung expedition, when faced with unpredictable situations, responded with discontinuous improvisational productions to create novel solutions. For instance, when Duran had to abandon due to broken ribs and Lozano had to retreat to Camp 2 due to exhaustion, the new situation prompted the novel, untried and risky recombinations described earlier that ended up re-configuring the team that went to the top. While the characteristics of our study do not allow us to establish a causal relationship between these recombinations and the success of the expedition, we know from our interviews that the Kangshung expedition members tried them precisely with the aim of maximizing their chances to reach the summit. At that moment and place at least, in the thick of uncertain events, they believed those novel recombinations would give the organization a better chance to succeed. Based on our study, we propose that, as the uncertainty increases in the environment, there is a point where organizations need to resort to discontinuous improvisational productions in order to better navigate extremely uncertain situations.

Recombinations and Improvisation as Organizational Capabilities

As noted in the introduction, an important issue that deserves a closer look is whether the type of discontinuous improvisational productions that we observed under extreme uncertainty should be considered organizational capabilities. Scholars grounded in strategy and evolutionary economics tend to consider organizational capabilities as "high-level routine (or collection of routines)" (Winter 2003, p. 991) and place much emphasis on "replicability" or "reliability" as a distinctive feature of capabilities (Dosi et al., 2000; Winter, 2000, 2003). This view suggests that an organizational capability, to be such, needs to be replicable by the same or another organization in a reliable manner. Helfat

and Winter (2011) stress that an organizational capability "enables repeated and reliable performance of an activity, in contrast to ad hoc activity that does not reflect practiced or patterned behavior" (p. 1244). Zollo and Winter (2002) further claim that, "an organization that adapts in a creative but disjointed way to a succession of crises is not exercising a… capability" (p. 340).

However, the responses that organizations enact under uncertainty, such as those we described here for the Kangshung expedition, although at a quick glance may appear "creative but disjointed," do not appear to be random and can even be replicated sometimes (Miner et al., 2001). If discontinuous improvisational productions are indeed intentional, can potentially be retained and replicated, and most importantly, they can have a critical and permanent effect on the overall performance of organizations under extreme uncertainty, it is hard to justify leaving them out of our conceptualization of organizational capabilities. At the end of the day, the essence of an organizational capability must be related to potential performance and the scope of probable outcomes, i.e. the "actual ability to do different things" or the "actual opportunities" that an organization has (Sen, 2009 p.253). Our study shows that the Kangshung organization used both heuristics and discontinuous improvisational productions, at different stages of the mountain and different uncertainty levels, to achieve their ultimate goal of summiting. Thus, these two capability types should be viewed as complementary, given their different nature and the contexts in which they are most useful. Table 4 provides a useful comparison between the two.

[Insert Table 4]

A key issue seems to hinge on the extent to which there is retention and replication from these novel recombinations. Retention refers to the degree to which the insights coming from the improvised productions are made a permanent part of the organization's artifacts, processes, or knowledge (Miner, 1989; Van de Ven and Polley, 1992; Moorman and Miner, 1997, Crossan and Sorrenti, 1997). Replication is simply the re-enactment of those insights in a different situation. Miner et al. (2001), drawing from a longitudinal study of the

product development activities of two organizations, conclude that improvisation is "a special type of learning" (p. 331).

It is possible that the current literature's focus on retention and replication as a key characteristics of capabilities spring from the fact that empirical studies of capabilities have largely been based on organizations operating in environments with low to medium uncertainty. Indeed, even most of the existing studies of improvisation, including those cited above by Miner (2001) and others such as Eisenhardt and Tabrizi (1995) and Kamoche, Pina e Cunha (2001), are also based on environments with low or moderate uncertainty, including those focused on new product development processes. In-depth, longitudinal studies of organizations under high or extreme uncertainty such as ours are rare, due to the difficulties in securing access and organizing data collection. Our study suggests that the capability to enact novel responses quickly when faced with highly uncertain situations may be more important that the organization's ability to retain and replicate such responses; in other words, a focus on the performative aspects of capabilities instead of the retention aspects may be more useful to understand how organizations operate under high uncertainty. Moreover, in some contexts, the responses can indeed be retained and diffused to other organizations in the form of word-of-mouth survival stories. For instance, in the mountaineering community, much of the learning comes from what Duran called, "the circular process of reading stories in climbing magazines and books, and then discussing them for hours and hours in base camps all over the world." Storytelling is especially powerful when it deals with what the relevant community considers a major breakthrough or a very unexpected, good or bad, result.

CONCLUSIONS AND FURTHER RESEARCH

The Kangshung expedition succeeded where many other organizations had failed, with relatively few resources and through one of the most technically difficult routes. Given that our methodology allows us to follow the organization through all of the major events and decisions as these unfold, our study provides a unique window to improve our understanding of how organizations navigate high uncertainty environments. We have shown that, in addition to having solid

climbing skills (operational capabilities), the Kangshung organization relied heavily on heuristics as they entered the high altitude zone and the environment became more uncertain and fast-moving. Our study also showed that when uncertainty levels became extremely high, the Kangshung organization added another form of response: on-the-spot, discontinuous improvisational productions. We argue that, given the make-or-brake situation that organizations operating in highly uncertain environments face, these discontinuous improvisational productions that depart from past patterns can be retained by the organization, diffused to a larger community of organizations, and potentially used in the future by the focal organization or others facing a similar uncertain situation. We further argue that, given that discontinuous improvisational productions seem to be important in opening new courses of action in the most unpredictable situations, they should be considered part of the set of capabilities that organizations need to possess in order to navigate situations of extreme uncertainty.

Our field study is exploratory in nature, but it provides a fresh perspective that adds to our existing theorizing of organizations and uncertainty. Our findings open avenues and raise questions for promising further research. For instance, one set of questions relate to how discontinuous improvisational productions are retained and transferred. We suspect that what we observed in the Kangshung study as far as retention and diffusion goes is not entirely transferrable to other contexts. The mountaineering community is extremely open, sharing both successes and failures, and the situation may be different in other communities or industries that, for instance, could try to hide failures from public view. Another issue to explore is the potentially symbiotic relationship between organizational capabilities and the level of uncertainty in the environment. When interviewing the members of the Kangshung expedition, we often found them surprised of what they had accomplished as an organization, to the point of disbelief. Of course they always harbored the hope of reaching the summit, but they never thought they could do it in such an uneventful way while taking risks that went well beyond what they ever imagined. In a sense, the Kangshung organization "rose to the occasion" as it encountered obstacles and situations they had never experienced before. It is of course not possible to argue

that their capabilities were prompted or enhanced by the challenging environment, but our interviews suggest that the organization would not know today the extent of their true potential and capabilities, had they not attempted the Kanshungh route. Our interviewees coincided in that the difficulty and unpredictable nature of the route was instrumental in getting the best out of them as an organization.

REFERENCES

Agor, W. 1986. The logic of intuition: How top executives make important decisions. In *Organizational Dynamics,* 5–18.

Allnutt, M. 1982. Human Factors: basic principles. In R. Hurst & L.R. Hurst (Eds.) Pilot error (2nd Ed.) 1-22. New York: Jason Aroson.

Ammisetti, A. 2012. Nokia: The troubled king of the Indian handset market. The Indian Journal of Management, 5:14-20.

Barthol, R.P and Ku. N.D. 1959. Regression under stress into first learned behavior. Journal of Abnormal and Social Psychology. 59: 134-136

Berliner, P. F., 1994. Thinking in Jazz: The Infinite Art of Improvisation. University of Chicago Press. Chicago. IL.

Capron, L., Dussauge, P., and Mitchell, W. 1998. Resource redeployment following horizontal acquisitions in Europe and North America, 1988-1992. Strategic Management Journal. Jul98, Vol. 19 Issue 7.

Corley, K. G., Gioia, D. A. 2004. Identity ambiguity and change in the wake of a corporate spin-off. Administrative Science Quarterly 49: 173-208.

Christensen, C. 1997. Innovator's dilemma: When new technologies cause great firms to fail. Harvard Business School Press Books.

Clark K, Fujimoto T. 1991. Product Development Performance. Harvard Business School Press: Boston, MA.

Crossan, M., Lane, H.W., Klus, L. and White, R.E. 1996. The improvising organization: Where planning meets opportunity. *Organization Dynamics, 24* (4), 20–35.

Crossan, M., and Sorrenti, M. 1997. Making sense of improvisation. In Advances in Strategic Management. Mary Crossan and Marc Sorrenti, 155–180. Greenwich, CT: JAI Press.

Davis, J.P., Eisenhardt, K.M. and Bingham, C.B. Optimal Structure, Market Dynamism, and the Strategy of Simple Rules. Administrative Science Quarterly, 54 (2009): 413–452

Dess, G. G., Beard, D. W. 1984. Dimensions of organizational task environments. Administrative Science Quarterly 29(1) 52–73.

DiMaggio, J. & Powell, W. 1983. The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields, American Sociological Review, Vol. 48: 147-160.

Dosi, G., Nelson, R. and Winter, S. Eds. 2000. The nature and dynamics of Organizational Capabilities. Oxford Universily Press, New York.

Eisenhardt, K. M., 1989. Making fast strategic decisions in high velocity environments. Academy of Management Journal. Vol, 32, No, 3, 543-576.

Eisenhardt, K. M., and Tabrizi, B. N. 1995. Accelerating adaptive processes: Product innovation in the global computer industry. Administrative Science Quarterly 40(1) 84–110.

Eisenhardt, K. M. and Martin, J. A. 2000. Dynamic capabilities: What are they? Strategic Management Journal(21): 1105-1121.

Eisenhardt, K. M. and Sull, D. 2001. Strategy as simple rules. Harvard Business Review. January: 106-116.

Eisenhardt, K. M. and Graebner, M. E. 2007. Theory building from cases: Opportunities and challenges. Academy of Management Journal 50(1): 25-32.

Eisenhardt, K.M., Furr, N. R., and Bingham, C. B. 2010. Microfoundations of Performance: Balancing Efficiency and Flexibility in Dynamic Environments. Organization Science 21(6):1263-1273.

Fayed, N; Modrego, P.J.; Morales, H. 2006. Evidence of brain damage after high-altitude climbing by means of magnetic resonance imaging. *The American Journal of Medicine* (Elsevier) 119 (2): 168.

Gerwin, D. 1981. Relationship between structure and technology. In P.C. Nystrom & W.H. Starbuck (Eds.), Handbook of Organizational Design (Vol. 2) New York: Oxford University Press.

Gillman, P., Ed. (1993). Everest: The best writing and pictures from seventy years of human endeavor. London, Little Brown and Company.

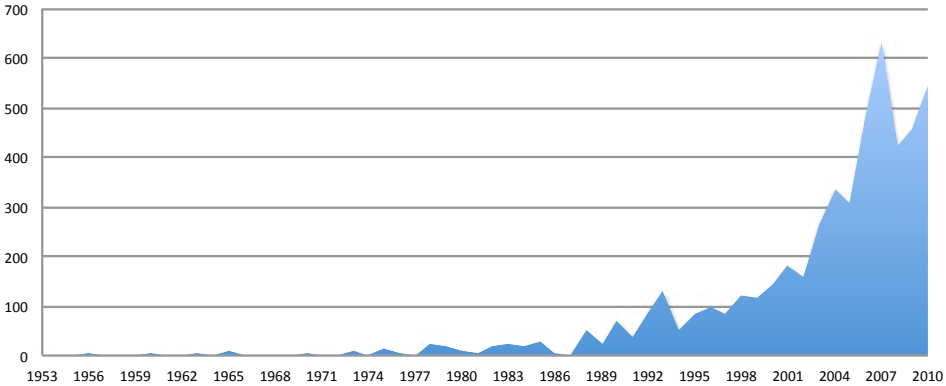
Gilovich, T., Griffin, D. and Khaneman, D. 2002. Heuristics and biases. The psychology of intuitive judgment. Cambridge UK. Cambridge University Press.

Glasser, B. G., Strauss A. L. 1967. The discovery of grounded theory. Strategies for qualitative research. Hawthorne, New York, Aldine de Gruyter.

Gulati, R. 1999. Network location and learning: The influence of network resources and firm capabilities on alliance formation. Strategic Management Journal. May99, Vol. 20 Issue 5, p397

REFERENCE LIST CUT SHORT DUE TO DRUID SPACE LIMIT. APOLOGIES.

Figure 1. Number of ascents of Mount Everest: Three eras.



Age of Conquest		Age of Difficulty		Age of Commerce	
1921	First attempt Howard-Bury	1975	First ascent to the South West Wall. First technical ascent.	1988	In a single week 22 climbers reach the top
1924	First tragedy, Irving & Mallory disappear	1978	First ascent without artificial oxigen. Messner & Habeler	1992	In 6 days 58 climbers reach the top
1930-40´S	World War II interruption	1980	First winter ascent. Polish team.	1996	12 climbers die on a single day
1953	First Ascent, Hillary & Norgay, Nepal normal route	1980	First solo ascent, by a new route. Messner.	1996	8 climbers die on a single day
1960	First ascent through the normal Tibetan route, North Col	1983	First ascent to the Kangshung face.	2007	633 climbers reach the top in this season
1963	First American ascent and traverse				

Table 1. Summary of Individual Ascents to Mt. Everest by Different Routes 1953–2000

	Routes	Name	# Ascents	Route %	Totals %
Routes and Ascents	Nepal Normal Route	South Col	2994	58.7%	
	Tibet Normal Route	North Col	1973	38.7%	
	Total Normal Routes		*4967*		97.4%
	Technical Routes except Kangshung (16)		130	2.6%	
	Tibet East	Kangshung	7	0.1%	
	Total Technical Routes		*137*		2.7%
1953-2010	TOTAL		5097		100%

* Only Normal Routes through the South and North Col are considered commercial because these are the only alternatives available to guided (paid) ascents.

Table 2. Methods overview.

Data Collection		**Analysis**
During the Expedition	**Post-Expedition**	

• Participant Observation
Personal Diary
• 12 hrs. Non-edited Videos
		• Transcription
		• Coding
		• 1st by Stages in the Expedition
		  • Low Altitude (Base Camp – 23.000 ft.)
		  • High Altitude (23.000–26.000 ft.)
		  • Death Zone (26.000–29.028 ft.)

	• Semi-Structured Interviews to Members (5)
	• 3 to 7 hours each.
	• 3 Member Diaries.
	• Access to 52 letters.
	• 1.250 Photographs.
	• 118 Publications and interviews in Newspapers and Magazines.
	• 1 Expedition Book
	• 2 Commercial videos
		• 2nd by Key Processes.
		  • Opening route, rope management, climbing, planning.
		  • Decision making.
		• 3nd Comparisons and validation among processes at different altitudes. Contrast with expected outcomes and previous assumptions.
		• 4th. Validate with secondary sources in Mountaineering Literature.

Table 3. Salient Capability Types at Different Levels of Uncertainty

	Relative Dynamism of the Context		
	Predictable Environments	**High Velocity Environments**	**Extremely Uncertain Environments**
Salient Capability Type	Operational Capabilities (Nelson & Winter, 1982; Zollo & Winter, 2002)	Simple Rules (Eisenhardt and Sull, 2001; Davis, Eisenhardt and Bigham 2009)	Discontinuous Improvisational Productions (proposed here)
Foundation of the capability	Routines (Formed gradually by practice and continuous improvement)	Heuristics (Created from a base of routines and past experience)	Intuition (Enacted starting from a strong base of routines and heuristics)
Key objective of the capability	Efficiency (In the execution of tasks)	Speed (Fast decision making, flexibility, managing complexity)	Breakthrough (Novel, untried recombinations to open up new courses of action)
Examples from existing literature	Ford's Assembly line; regular hiring process (Zollo and Winter, 2002)	Yahoo's Mergers and Acquisitions; Autodesk's compression of product development schedules (Eisenhardt and Sull, 2001).	N/A NASA's rescue of Apollo XIII (Lovell and Kluger 1995); Mann Gulch disaster (Weick, 1993).

Table 4. Heuristics and Discontinuous Improvisational Productions Compared

	Heuristics	**Discontinuous Improvisational Productions**
Defining Characteristic	Rooted in the organization's learned patterns	Depart from the organization's learned patterns
Internal Logic	Acceleration (Cut, edit, shortcut)	Opportunism (Out-of the-box solutions, reflection-in-action)
Search	Reduce Search (Focus on rules derived from the organization's past experience)	Amplify Search (Draws from a large pool of experiences; looks for novel recombinations)
Replicability	Successful heuristics tend to be retained and replicated inside the organization. They can also be transferred to other organizations through the diffusion of "best practices."	Discontinuous improvisational productions can be retained, particularly when they have a major effect on the resulting organizational outcome in a challenging situation. They can also be transferred to other organizations through storytelling and word of mouth.