Translating Resilience: A Framework to Enhance Communication and Implementation

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Abstract. The proposed framework enables a more holistic understanding the various fields of resilience research and makes communication across several domains more productive by placing the discussions into four types of resilience that are broad enough to facilitate discussion but specific enough to allow for the translation of resilience into specific policies, practices and outcomes.

1 INTRODUCTION

> Translate, v. To bear convey, or remove from one person, place or condition to another; to transfer or transport….
>
> Oxford English Dictionary

Most of us are familiar with the translation of languages. Many have been surprised at how a word or concept from another language gets converted by translation software or even professional translators who are proficient in both. Sometime words carry with them the culture and/or conceptual orientation of the speaker that are not shared by the listener. Misunderstanding is almost certain in such cases. But centuries of dealing with people who speak other languages or speak the same language but come from other cultures have given us some tools for managing the potential confusion and misconstructions. Interdisciplinary and international problem-solving is hard work and there are often communication errors so it is important to know what level of translation matters for the problem at hand. Does the problem require the participants to share broad definitions or to agree on very precise ones? We think there is another way. And while the definitional framework proposed here does not solve all problems it allows us to make progress in areas that are critical to human and technical systems now.

The increasing complexity of today's inter-connected social systems has resulted in calls for greater understanding and development mechanisms for coping with turbulence and uncertainty (Longstaff, 2005, Weick and Sutcliffe, 2007). Resilience has been studied and described by various academic disciplines as a potential answer to move beyond survival and even prosper in the face of challenging conditions (Carpenter, et al, 2012). These disciplines include: ecology (Holling, 1996, Walker an Salt, 2012), psychology (Masten, 2001), socio-technical studies related inter alia to safety management (Hollnagel et al., 2006), disaster research (Norris et al., 2008) and a broad range of organizational studies (Lengnick-Hall and Beck, 2005, McCann and Selsky, 2012, Sheffi, 2007, Weick and Sutcliffe, 2007). Publications concerning the concept have increased dramatically.

The concept of resilience has emerged relatively recently in the scientific debate. The number of publications dealing with resilience is strongly increasing over the last years. Taking into account a general increase in publications per year (about doubled since 1995), scientific articles containing the keyword resilience grew more than ten-fold since 1995, corresponding to a larger application of the resilience concept and a wider diffusion to other scientific areas. Picture 1 shows the number of publications dealing with resilience in all

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scientific disciplines. Searching for the keyword "resilience" in only scientific articles on the scientific database web of knowledge (www.webofknowledge.com) yields 9,272 results (Sept. 2011).

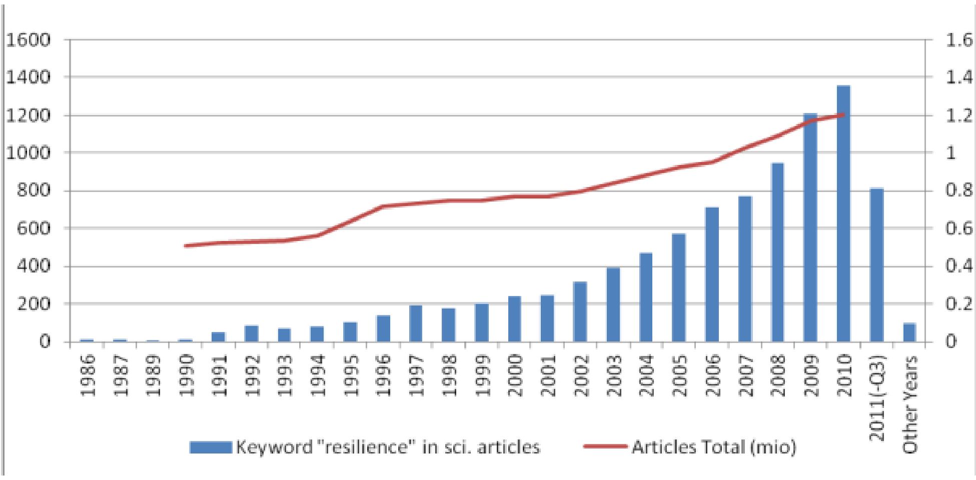

Fig. 2. Resilience Publications (1996-2013)

The increasing popularity of the term 'resilience' has caused some (e.g., Lorentz 2010; Strunz 2012) to believe that resilience is in danger of becoming another linguistic fashion or buzzword with little or no meaning or validity. While there may be some transient fashion involved, the increased popularity of resilience also signals an alternative focus to the challenges of uncertainty and variability that arise from the increasing complexity and interconnectedness of modern systems. This has led to new worldwide efforts to recognize and deal with systems that cross traditional academic boundaries and corporate and governmental regulatory divisions. For example, the Resilience Alliance has developed an interdisciplinary "Resilience Thinking" as a framework for understanding change in social-ecological systems (Walker and Salt, 2012) (http://www.resalliance.org). An emerging community of engineers from a variety of subspecialties is developing 'Resilience Engineering' as "a new way of thinking about safety" (http://www.resilience-engineering.org/).

Against the backdrop of varied conceptual usage across multiple fields, it is not surprising that extant resilience research is surrounded by diversity and ambiguity of definitions, scope conditions, antecedents and outcomes e.g. Lorenz (2010) and Norris et al. (2008). Is resilience a metaphor, a capacity, a capability, a strategy, a goal, a guiding principle, a philosophy, a measure or a behavior? Although an elastic notion of resilience may facilitate communication across disciplines (or even divergent lines of research within a discipline (Brand and Jax, 2007, Strunz, 2012), a lack of clarity confusion may hinder operationalization in specific contexts and lead to unclear or even contradicting evaluations of results. A definition that is too broad would also hinder empirical research results and even cause some to question the relevance of the concept (Strunz, 2012, Suddaby, 2010). As Suddaby (2010) states, a clear construct might not only facilitate communication between scholars, it also "enhances researchers' ability to empirically explore the phenomena" and further enhance outcomes by "allowing managers to redefine problems in ways that are more amenable to resolution" (p. 352).

Unfortunately, a holistically agreed upon definition will be difficult and problematic in the short term. And the world cannot wait for the perfect definition before it begins to tackle the dangers and uncertainties from which we must bounce back. Fortunately, a variety of definitions can exist as long as they are acknowledged (Strunz, 2012) and there are people who can translate between them. The skills for translation between academic disciplines and between the academy and practitioners will almost certainly need to happen for productive discussions between ecologists, engineers, physicists and psychologists (who have all developed their own definitions and lexicon) in order to build new approaches to the complex problems facing many organizations and all governments. (Le Coze and Dupre 2008)

The framework proposed here will help begin the process of translation and this will help identify the modi operandi (strategies and mechanisms used) that are more likely to allow a system (such as a community or a technical system) achieve resilience. The four perspectives are broad enough to allow for differences in situations but concrete enough to allow for the discussion of how and to whom resources for recovery or adaption are allocated (Baker, 2009) and help identify other trade-offs with regard to the arsenal of resilience mechanisms and policies that are employed.

Notwithstanding some substantial communalities among the disciplines, substantial distinctions of the concept exist with regard to (1) the level of complexity that is assumed (reductionism vs. holism orientation) and (2) the degree of normativity included in the perspective (descriptive vs. normative orientation). After analyzing these meanings, we will discuss the applicability of our conceptual framework as a blueprint for facilitating real-world problem solving and cross-disciplinary resilience research by giving options for re-contextualizing the appropriate resilience type to the respective object of investigation. This allows for the concept of resilience to continue to evolve as disciplines begin to talk to each other and as practitioners discover new mechanisms for systems to recover from shocks they cannot avoid.

That does not mean that there is one best way to accomplish resilience, at least not at the moment. That is unlikely to be the immediate outcome of international, interdisciplinary, and inter-organizational efforts to deal with a wide variety of uncertainties. The first step in managing such an effort is to acknowledge all the potential opportunities and all possible difficulties. The next steps are to make the goal clear in each case, decide how success will be judged, and determine how (or if) the lessons learned in one place can be translated into another place or knowledge domain.

2 A BRIEF WALK IN THE DEFINITIONAL THICKET

> Resilience, n. 1. The action or an act of rebounding or springing back; rebound, recoil. 2. a. Elasticity; the power of resuming an original shape or position after compression, bending, etc. b. The energy per unit volume absorbed by material when it is subjected to strain; the value of the elastic limit. …. 5. The quality or fact of being able to recover quickly or easily from, r resist being affected by, a misfortune, shock, illness, etc.; robustness; adaptability.
>
> Oxford English Dictionary

The English word "resilience" is derived from the Latin words resilire and salire, meaning to leap back, recoil, spring and spring again, re-flow, et cetera. Although, in general terms, resilience is often said to reflect any system's response to change or forces outside itself, the evolution of the term across different disciplines and fields of application leads to a diverse and sometimes confusing definitional lexicon. An extensive review of the literature reveals that the word resilience has been used to indicate a metaphor, a capacity of a systems and a strategy to cope with uncertainty (Norris 2008). Several conceptual and review papers have been written to clarify resilience in various fields: Klein, Nicholls, and Thomalla (2003) review resilience in natural hazards, Brand and Jax (2007) in sustainability science, Norris et al. (2008) in community resilience, and Strunz (2012) has applied resilience into the vague/ precise concept debate in philosophy of science).

After looking at the definitions of resilience from a wide variety of disciplines one can see that they almost always contain the basic idea of bouncing back from challenges or dangers that the individual or system could not resist (stop from happening). It involves the survival or persistence of something over time even if there is a change, a surprise and/or uncertainty. In this section we give readers a brief look at how the word is used in several disciplines.

For materials scientists, resilience is an expression of how a material responds to external force by either bending or breaking. A material is either ductile or brittle. A resilient (or ductile) material can bend when force is applied and return to its original condition once that force is removed. The material will exhibit "stretching" along with unfolding and refolding at the molecular level. This is referred to as "reversible unfolding. The more tightly bound a substance is at the molecular level the more brittle it is.(Campbell, 2008). The strength of molecular bond is measurable and so the ability of the material to bounce back is predictable.

But not all systems are predictable. Engineers have attempted to deal with complex organizational structures that are intended to develop complex technology with Concurrent Engineering methods that integrate design, manufacturing and downstream uses. But the uncertainties in this process has lead some to analyze it as a complex system that must deal with surprises. (Wolfram 1986; Efatmaneshnik 2007) They have noted that some technological systems have high sensitivity to small perturbations – a characteristic of many chaotic systems and conclude that Complexity x Uncertainty = Fragility. (Efatmaneshnik 2007) Others have concluded that these systems must avoid optimum solutions because this implies hypersensitivity to small perturbations and therefore fragility (J. Marczyk 2002). In fact, optimization may not be a meaningful term in complex and adaptive systems where order emerges from uncertainty – especially if one is trying to encourage adaptation or innovation. (Holland 1998) For some resilience engineering scholars a system's resilience is represented by the adaptations necessary to cope with the real world complexity. (Nemeth 2009; 2008) Engineered systems resilience might be measured by the time it takes to return to appropriate functionality. Sometimes this will be to bounce back to system specifications and sometimes this will mean bouncing forward to a new, adapted system that can cope with changed conditions. (Woods 2006, Mendonca 2008)

For ecologists associated with the Resilience Alliance (noted above), resilience is the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes. A resilient ecosystem can withstand shocks and rebuild itself when necessary. Resilience does not mean the system will look exactly like it did before the forest fire or the flood but many of the same species and their place in the ecosystem hierarchy will be preserved. It will still be a forest or a prairie even if the mix of species has changed. The ecosystem depends on the ability of individual species to adapt.

Authors studying the resilience of human organizations and human-technical systems organizations refer to organizational survival when encountering unexpected, adverse conditions that result either from large-scale disturbances or the accumulation of several minor disruptions (Vogus & Sutcliffe, 2007, Woods and Hollnagel 2006). Initial work on organizational resilience was undertaken by Weick (1993) who analyzed the behavior of a group of smoke jumpers in the Mann Gulch disaster and drew conclusions on factors contributing to organizational resilience, including an ability to improvise, virtual role systems, organizational wisdom, and respectful individual and social interaction.

Further work by Weick and his colleagues focused on how organizations find ways to deal with challenging conditions as they occur and before their effects escalate, rather than trying to prevent them from happening (e.g., Weick and Sutcliffe 2007, Weick & Roberts,1993; Weick, Sutcliffe, & Obstfeld, 1999). Their research suggested that resilience is brought about by the underlying stability of organizations (i.e., mindful processes of understanding, detecting, evaluating, and revising unexpected situations), which is leading to their reliability. This definition emphasizes the ability of organizations to rarely fail and maintain their performance despite encountering unexpected events. (Linnenluecke 2010) In other research, the resilience mechanisms or dimensions identified remain tied to specific functions of the organization or sub-functions within it. For example, Lengnick-Hall, Beck, and Lengnick-Hall (2011) wrote of strategic human resources management. M, Sheffi (2007) cited supply chain management and Riolli and Savicki (2003) discussed resilience in an information systems context.

The reader will have noted that there are clearly ideas that are common among one or more of these disciplines. In fact, there is some evidence that resilience is most likely to be found in systems that:

- Build the right amount of diversity and robustness for increasing options and spreading risk
- Increase their range of knowledge for learning and problem solving
- Create opportunities for self-organization, including strengthening local functions, building cross-scale links, and building problem-solving networks
- Organize with the right balance of tight and loose coupling
- Increase resilience at the right scale.

(e.g., Berkes, 2007; Woods 2006; Dorner 1996; Longstaff, 2005)

For human organizations that are good at dealing with uncertainty:

> "The traits of resilience include experience, intuition, improvisation, expecting the unexpected, examining preconceptions, thinking outside the box, and taking advantage of fortuitous events. Each trait is complimentary and each has the character of a two-edged sword."
>
> (Nemeth 2008, p. 7)

Therefore there is hope for some sort of definitional structure that is broad enough to allow for translation between them all even as we allow for the particulars to remain at the disciplinary level.

3 MULTIDISCIPLINARY RESILIENCE FRAMEWORK

There are two main differences that must be bridged in translating resilience ideas between disciplines. First, the various disciplines differ with regard to their assumptions about their system's potential for stability and equilibrium. Some have a Newtonian outlook (everything can be counted and predicted) while others take complexity/unpredictability outlook (the system has so many dimensions or variables that it is mathematically intractable and/or emergent properties that make prediction difficult or impossible) (Kauffman, 1995; Lewin & Regine, 1999; Mitleton-Kelly, 2003). And second, the degree of normativity (resilience as a coping capacity vs. a desirable outcome). The framework presented below puts these two differences in a framework that allows us to make some distinctions that are broad enough to find commonality put narrow enough to recognize differences. It is the contention of this paper that these fields are not mutually exclusive and that a fuller understanding of resilience would encapsulate many (if not all) of these views.

We have also differentiated resilience that is seen as a capacity or a capability of the system. The choice of these terms is somewhat arbitrary but reflects (we think) the most commonly understood ideas behind those words.[2] We use the term capability to denote human/animal skills that can be brought to bear on a challenge. The term capacity is used for anything you can hold/ measure. There are obviously no bright lines between the two because you can sometimes measure skills. But the distinction is worth noting because it affects how disciplines look at the systems they study and how they describe and (sometimes) measure what they call "resilience."

The Multidisciplinary Resilience Framework outlines four applications based on the differing fields of study. The boxes on the left of the Framework focus on system's level of complexity. In the upper box, the state of the system and the impact of a disturbance are both predictable and measurable. In the lower box the system has multiple possible states due to high levels of complexity/non-linear behavior and there are often high levels of uncertainty. Measurement and prediction in the bottom box is thus more problematic.

The boxes on the top of the matrix focus on the level of normativity that is applied to describing the resilience of a system, that is, the extent to which humans determine how things should be, how to value the state of the system, and which strategies are good or bad. Normativity can be contrasted with Positivity which is generally described as producing factual statements that attempt to describe reality.

[2] The terms capacity, capability and ability are often used interchangeably. There appears to be much ambiguity surrounding which is future orientated. Some say capacity if potential and the deployment of you skills to be successful. See 2 contrasting sources:
http://northtemple.com/journal/2008/08/18/beethovens-heiligenstadt
http://www.des.emory.edu/mfp/AbilityCapability.html

With regard to computing the term seems to support the single and multiple equilibrium i.e. capability for single (simple) and capacity for multiple (complex):
http://www.appro.com/blog/capability-computing-vs-capacity-computing-what%E2%80%99s-the-difference-does-it-matter/

Degree of Normativity / Level of Complexity	**Low: Descriptive** ***Perception of Deviation:*** *symptoms of change and strain* ***Conceptual Orientation:*** *Outcome and capacity*	**High: Normative** ***Perception of Deviation****: To be avoided/reduced symptoms of adversity and inefficiencies* ***Conceptual Orientation****: Process and capability*
Low: Reductionism ***Aspect of stability:*** *Single State* ***Environmental characteristics:*** *Short-term, Linearity and Predictability* ***Dominant Logic:*** *Bounce back (absorb and recover)*	**(I) Capacity to rebound and recover** • Elasticity (capacity to absorb deformation[1]) • Rapidity/rate (**time required** to return to pre-defined state/normalcy[2]; • Robustness (resistance against perturbation)[3].	**(II) Capability to maintain desirable state:** • Maintaining systems identity and functions[9]; • Ability to withstand and recover within acceptable parameters[10];
High: Holism ***Aspect of stability:*** *Multiple States* ***Environmental characteristics:*** *Long-term; Non-Linearity and Uncertainty* ***Dominant Logic:*** *Bounce forward (adapt and transform)*	**III) Capacity to withstand stress** • Magnitude of disturbances[4]; • Elasticity threshold[5]; Transition probability between states[6]; • Emergent system property[7]; • Balanced contingency between system and its environment by adjustments[8].	**(IV) Capability to adapt and thrive:** • Inherent and adaptive responses to disasters[11]; • dynamic process encompassing positive adaptation within the context of significant adversity [12]; • Degree of capability to self-organize, adapt and learn[13].
1(Timmerman, 1981; Wildavsky, 1988), 2 (Pimm, 1984; Zobel, 2011), 3 (Antunes 2011; Grimm/Wessels 1997; Zobel 2011), 4 (Gunderson/Holling 2002; Holling 1996), 5(Folke et al., 2004; Walker 2004), 6 (Holling 1973; 2001; Brock et al., 2002), 7 (Boin/McConnell 2007), 8 (Lorenz 2010), 9 (Cumming, 2005; Walker/Salt 2006), 10 (Aiginger 2009; Aven 2011); 11 (Rose 2004), 12 (Luthar 2007), 13 (Carpenter, 2001 ; Folke 2006; Walker et al. 2002).		

Fig. 3. Multidisciplinary Resilience Framework

Type I Resilience: The Capacity to rebound and recover (low complexity/low normativity): The systems/disciplines that fall in this box see resilience as a purely descriptive measure of elasticity against perturbations and the rapidity of the recovery to a pre-defined (usually intended) state. Resilience can be seen as a system property or measure of stability. This view of resilience is predominantly adopted in traditionally engineered and other designed systems. It is most feasible in situations where the normal system state is assumed to be a reliable (if not necessarily optimal) state for the system or the adaption of the previous system state toward an alternative state is too difficult in terms of time and/or costs.

Type II Resilience: The capability to maintain a desirable state (low complexity/high normativity) This is described in systems/disciplines that have a low level of complexity and focuses on the maintenance of some predetermined state or equilibrium that is judged to be either a desirable outcome or as a process of positive adjustments that leads the system back to that predetermined, desirable state. (Luthar et al., 2000; Matson & Gadgil, 2007). Predominantly employed in business, psychology and other social studies; resilience in these systems is regarded as something positive and bouncing back to an approved equilibrium proves the existence of resilience.

Type III resilience: The capacity of the systems to withstand stress The disciplines in this box often describe resilience as the relationship between the current system state and a potential system shift that will flip the system into a different state often called a "regime shift." The focus is on persistence thresholds. The distance between the current state and a potential flip is a measurable indicator of resilience levels. High resilience implies sufficient robustness and buffering capacity against a regime shift and/or the ability of system components to self-organize and adapt in face of fluctuations. If resilience is low, the system loses its original identity and moves toward a new regime or "basin of attraction." None of the potential system states or regimes is preferable to the system itself since it cannot make good/bad distinctions.

Type IV Resilience: The capability to adapt and thrive Resilience in social systems and psychology is often conceptualized as skill that an individual or group can bring to a disturbance that will allow it to reach a level of functionality that has been determined to be "good." Human beings and human systems have high complexity and a determination of what is good or "adaptive" in these systems is often highly high normative. The disciplines in this box acknowledge the existence of multiple possible states, but also explicitly call for a successful adaption before or after a disturbance occurs. This contrasts to Type II resilience, which focuses on a successful return to an assumed normal state. Hence, a positive adjustment can involve different desirable states ranging from a worse, but acceptable level to an even better post-disturbance state. Managing resilience as a normative activity or outcome involves human capabilities such as anticipation, sense-making and learning.

4 USING THE FRAMEWORK FOR TRANSLATION

The categories in the descriptive boxes of the framework will allow participants to ask questions about how the other participants see the level of complexity/ predictability of the system(s) they are trying to deal with. The framework will also help them discuss how they see the role of shared norms. A discussion of the four Resilience Types will further identify shared or differing goals (e.g., bounce back or bounce forward). So, for example, people in government are likely to be in category II with a high degree of normativity about outcomes and a seeking short-term, linearity and predictability for their actions. Engineers at the table may be less sure of predictability for anything that requires a human interface but less interested in the norms that applied to outcomes so they would be in category I or category III. Ecologists may be more comfortable with designing systems that can adapt so might be in category IV.

Once the similarities and differences have been identified the next steps are to make clear what the goal is in each case, how success will be judged (or measured), and how (or if) the lessons learned in one place can be translated into another place or knowledge domain. Does the problem require a capacity or a capability? Does the system have to be maintained as it is or should it be capable of adaptation? How will that adaptation be judged? Can the adaptation be designed in advance or will it have to emerge from the conditions that are presented? Once these questions are answered the group can narrow down its search for definitions and mechanisms that are found in similar systems to the Resilience Type they are dealing with.

Of course there is the possibility (and in some cases a likelihood) that a particular problem will involve multiple types of resilience. In those cases the role of translators becomes critical as two stems attempt to work in consort toward resilience for both without unanticipated harm to the other system. If the resilience of one requires the rules of the other to be ignored for a time how does that get decided and by whom? If action by one or both is called for in response to some danger (or opportunity) does this require the measurement of something that they measure differently? This does not require that the two systems (or disciplines or organizations) respect each other's methods but it does require agreement on the goals and that they actually understand what the others are saying.

5 CONCLUSION

It seems certain that the need to find ways to make things bounce back will only continue to grow. The groups who come together to deal with these issues will only become more diverse. The framework proposed here allows researchers and practitioners from various disciplines and/or economic sectors to communicate and concentrate their efforts on specific types for resilience goals by allowing broad definitions where that is possible and identifying where specific definitions are necessary to deal with the issues at hand. The words used to designate these efforts will undoubtedly adapt, splinter into subgroups, and go in and out of fashion. Translation and translators will only become more important.

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