MEALS AND INGREDIENTS: COPING WITH COMPOUND RESILIENCE STRATEGIES

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Abstract

Human performance constitutes a crucial contributor to the resilience of sociotechnical systems. The actions and behaviours performed by actors can themselves be deemed resilient, when individuals deploy resilience strategies. We build upon existing work which has sought to provide a vocabulary for different resilience strategies. The key concept we explore in this paper is 'compound strategies'- where individuals combine multiple motivations and behavioural mechanisms in their pursuit of heightened resilience. We draw an analogy between the role of recipes in combining ingredients to produce a meal, and the manner in which underpinning mechanisms are synthesized to compose a resilience strategy. We further discuss and define compound resilience strategies and demonstrate some of the challenges we have faced in their investigation through real-world examples. We subsequently propose a conceptual framework for deconstructing and analysing compound resilience strategies, and share implications for researchers in this field.

1 INTRODUCTION

As has been recognised in the literature addressing resilience engineering, human performance can be conceptualised not only as an inherent risk or weakness in sociotechnical systems (traditionally a prevailing view) but also as a potential source for maintaining system performance and increasing resilience. This move away from focusing exclusively upon negative aspects of performance (errors, risks, frailties etc.) but towards also recognising the value of opportunities to proactively maintain or manage performance, at an individual level, echoes the more broad distinction which Hollnagel draws between *Safety I* and *Safety II* (Hollnagel, 2013). It is this propensity, for individuals to proactively recognise and respond to challenges and threats in order to manage or maintain performance, that this work aims to further explore.

1.1 Resilience as a Behavioural Phenomena

One feature of the current literature on resilience engineering is a tendency to consider the topic of resilience in the context of wider systems, processes and organisations. In so doing, we are able to ascertain a broad and holistic account of resilience, which can be extended and transferred across domains, tasks and settings. At the same time, however, a key challenge arises in terms of establishing how to instigate change or apply resilience-related insights in a tangible, effective sense. Focusing on the behavioural phenomena of human actors at the 'sharp-end' within sociotechnical systems represents one clear avenue through which such change may be realised, and affords us a more concrete way to deliver the application of our understanding into resilience.

The work presented here focuses on what we refer to as *resilience strategies*. These comprise certain tactics and behaviours which, when utilised by actors within a system or by individuals more generally, make a positive contribution to safety, efficiency and overall performance. Such strategies may be both proactive and reactive, and address not only safety critical work but also more everyday challenges across all manner of tasks.

1.2 Existing Work into Resilience Strategies

In common with resilience in general, one unfortunate feature of the topic of resilience strategies is that we lack a history of targeted investigation of the concept. Investigations instead have scrutinised adverse events, instances of failure, and recognised or identified threats and challenges. However, where individuals or operators deploy strategies that have had a positive effect on the outcome of a sociotechnical system, this is often overlooked. The focus on tracing failure cases leads to the absence of a report when threats are avoided. Thus, successful action goes unreported. Such work is consequently sublimated into normal or routine practice without remark, and can be difficult to identify and extract for study. This presents a major barrier in investigating all forms of resilience.

As a result, the literature that specifically addresses resilience strategies is fragmented and relatively embryonic. Where resilient episodes are recorded and discussed, they are often termed in a different way, or discussed within the context of a more established but narrowly-scoped topic. For example, work targeting cues (Altman & Trafton, 2004), checking (Patterson, Woods, Cook & Render, 2006), appropriation (Dix, 2007), dynamic task restructuring (Iqbal & Bailey, 2006) and other such topics are of relevance. There are also many anecdotal accounts of strategies and behaviours that are discussed in other contexts, and neither labelled or conceived in terms of resilience (e.g. Randel & Johnson, 2007) despite their value to the study of the topic. This issue of semantics makes it difficult to obtain a complete picture of the variety of resilience strategies deployed by individuals.

Recently, targeted efforts have however been made to articulate and analyse the variety of resilience strategies observable across a range of contexts. This work aims to provide a holistic account of these strategies, and establish a vocabulary to facilitate discussion and investigation. Furniss, Back and Blandford (2012) present a seven-item categorisation scheme that can enable the analysis of instances of resilience, a contribution that builds on the repertoire component of their *Resilience Markers Framework* (Furniss et al. 2009).

1.3 Investigating the Diversity of Resilience Strategies

While the work of Furniss, Back and Blandford (2012) proved useful in articulating and describing a variety of types of strategies, limitations in the original investigation existed. With regards to the category descriptors presented, the authors acknowledged that some of the categories appeared overlapping and ambiguities were still present, suggesting refinements in terminology but also potentially in framing and coverage may be possible. Additionally, the dataset upon which the categories were derived suffered from limitations both in terms of breadth (49 instances across 5 contributors) and depth (owing to a 140-character limitation in composing entries, reflecting the use of twitter for data collection).

We sought to replicate this idea using an expanded dataset, in an effort to validate and develop the scheme. We analysed an extended pool of data from 6 studies incorporating multiple methods (ranging from self-report and survey data to observations from a lab study) resulting in a total of 120 resilience strategies from which a revised scheme was derived. One persistent source of complexity during this exercise however was the classification of complex, 'edge-case' examples. While many episodes could be classified with relative ease, others proved more challenging, dividing opinion within our inter-rater reliability analyses. Examining these led us to conceive the notion of compound strategies.

2 THE EMERGENCE AND INVESTIGATION OF COMPOUND STRATEGIES

One common pattern emerged from the further examination of the problematic cases encountered while using the existing categorisation scheme. In numerous cases, and despite refinements to the scheme, instances appeared to draw equally from multiple categories. Reflecting on this led us to reconceptualise the nature of our strategy episodes: rather than considering such instances to be individual, self-contained examples of resilience strategy use, we instead consider they can be compounds of multiple behavioural and motivational components. Taking this new approach, the 'problem' of assigning one episode to one category over another becomes redundant: instances can simultaneously reside in more than one category, if meaningfully deconstructed into their constituent components.

2.1 Examples of Compound Resilience Strategies

Finding an improvised post-it note, sellotaped to a parking payment machine, informing users which buttons to press and in which sequence to avoid a seemingly common error

This episode, collected as part of our ongoing collection of such instances, describes a strategy which seemingly contains two important aspects: generating an improvised note, and ensuring it is displayed front-and-centre so as to provide the information clearly and in a timely manner to users. It could be said to simultaneously involve generating an artefact in the form of the instructions, but also has strong elements of cueing, and improvising the attachment of the note onto the machine.

> *When out and about, and needing to take a copy of a receipt or similar, I will take a photo on my mobile phone. As I regularly check my photos, this is quite reliable*

While this again appears a relatively simple episode, this challenged the categorisation scheme as it features multiple resilient qualities upon closer analysis. One resilience strategy noted in the scheme is the improvised appropriation of items- in this example, the camera is appropriated as a means to create a digital copy. However the strategy is also compatible with the descriptors *creating an artefact* and debatably, *adjusting a routine or behaviour*.

2.2 Compound Resilience Strategies: Meals and Ingredients

The identification of these compound strategies motivated us to reconceptualise the application of the scheme categories, adjusting their nature and purpose. Rather than mere labels or descriptors, we have enriched their role to become representations of the underlying mechanisms from which strategies are composed. The analogy of meals and ingredients (inspired by Woolwych et al, 2011) becomes a useful way to illustrate the concept. Our shift in perspective represents a shift from considering strategy episodes as ingredients, instead to meals in their own right: products resulting from the synthesis of constituent ingredients that take the form of behavioural and motivational components.

3 A FRAMEWORK FOR THE DECONSTRUCTION OF COMPOUND STRATEGIES

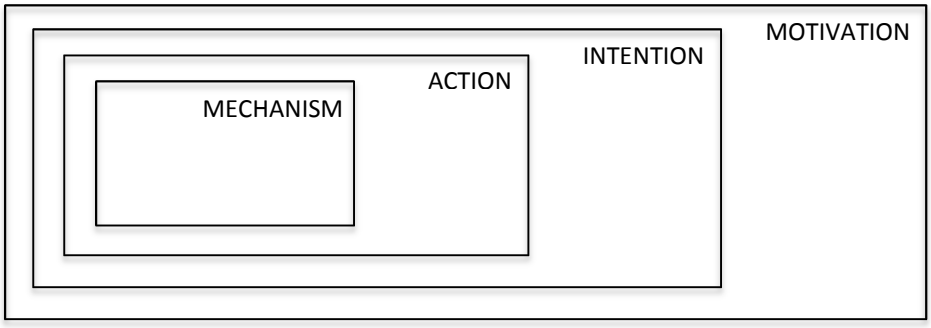

Figure 1. *A framework for the deconstruction of compound resilience strategies. The framework presupposes the breaking down of complex, compound strategies into components at four levels: high-level motivations, intermediary goal-based intentions, observable and concrete actions, and resilience mechanisms (formerly the descriptors or category labels in the Furniss et al, 2012 scheme). This representation of the framework also reflects how motivations encapsulate intentions, which in turn encapsulate actions, encapsulating mechanisms*

We propose a basic framework (represented in figure 1, above) to assist researchers and practitioners in analysing and making sense of compound resilience strategies by breaking them down into their components, or ingredients. Our approach is inspired by the GOMS approach to modelling human computer interaction (Card, Moran and Newall, 1983) which similarly deconstructs tasks into the motivations and mechanisms necessary for their completion. Our framework proposes the analysis of strategy episodes can be assisted by deconstructing them into four aspects at differing levels of granularity:

Motivations at the highest level represent the overarching broad goal that a strategy addresses. We conceptualise this in terms of risks and rewards, reflecting threats which impact the successful completion of a task or process, while opportunities to improve performance or efficiency. We posit strategies inherently address one of these two aspects.

Intentions represent context dependent, task-oriented goals that an individual intends for their strategy to address. Depending on the nature of the strategy and the threat it addresses, there may be more than one intention present in a strategy.

Actions represent the concrete, observable action that an individual/operator takes to achieve their

intention(s). The actions available again reflect the context of a strategy (i.e. task and environment, resources/expertise/ability available to the operator etc.) Each intention generally has at least one corresponding action, however multiple actions may be used to resolve one intention. A single action may also address multiple intentions.

Mechanisms describe a set of prototypical mechanisms that underpin a strategy and describe how or why it works. Each action will correspond to at least one mechanism, however multiple mechanisms may be achieved in one action. These mechanisms are transferable across domains, tasks and settings, and constitute the reconceptualization of the category labels or descriptors in the Furniss et al (2012) categorisation

3.1 Applying the Framework to Instances of Resilience Strategy Use

To illustrate how the framework can assist with the analysis of accounts of compound strategies, we now deconstruct the two examples of previously presented in section 2.1.

Regarding the example of the improvised note on the parking machine, the motivation is the avoidance of an error, reducing the chance of a threat preventing the completion of the task (MO1). The intention can be divided into two goals, the primary being to generate supplimentary instructions to assist the user (I1) and a secondary or subgoal being to ensure this information is available when required (I2). The observable actions can thus be considered as composing the note (A1) which addresses I1, and sellotaping the note onto the device (A2) which addresses I2. In terms of mechanisms, based on the category descriptors derived from our expansion on the Furniss et al (2012) scheme, we identify *ME1 creating an artefact* (mapping to A1 in terms of producing an informational artefact), *ME2 creating a cue* (relating primarily to A2 in ensuring the prominent location of artefact, prompting users in their interaction) and *ME3 reinforcement* (reflecting the use of sellotape to provide additional security in keeping the note in place, addressing I2 and reflecting A2).

Regarding the second example, we see two motivations emerge: the broad goal of addressing the threat represented by data loss (MO1) and a secondary motivation of improving performance, by making the the file more easy and quick to locate (MO2). In terms of intentions, the user in this case has an intention of generating backup versions (I1) and also distributing backups across multiple locations (I2). The observable action the user takes is simply to copy their file to multiple locations (A1), which addresses both intentions I1 and I2. In terms of mechanisms, again based on the aforementioned category descriptors, we identify *ME1: adjusting a procedure or behaviour* (in terms of incorporating additional task steps), *ME2: reinforcing an existing safety barrier* (where I2 reduces impact of lost backup), and *ME3: Managing resource availability* (addressing secondary motivation MO2).

4 DISCUSSION

The relative immaturity of the literature specifically addressing individuals' resilience strategies presents a challenge to structured and consistent analysis. All too frequently, interesting and insightful episodes and accounts of resilient behaviour are reported only anecdotally, if at all, which limits the value contributed by this potential resource. Recent efforts to provide an analytical foundation for investigating and discussing resilience strategies have proved problematic, due to the complex nature of some recorded instances of resilience, which seemingly combine multiple interrelated ingredients. The framework we propose here provides a means to unpack and deconstruct these compound strategy cases, enabling structured and in-depth analysis of the mechanisms and motivations that underpin such strategies. We move beyond looking at strategies as indivisible wholes to consider the ingredients upon which they're made (high level motivations, intentions and goals, observable actions and underpinning mechanisms) and recipes in terms of how they're put together (exploring the relationships between the ingredients).

At this point, we acknowledge however that this framework and the specification of the mechanisms are a work in progress, and may be subject to further revision or refinement. The 'motivation' component for example, while providing an framing device to situate an episode and elicit reflection on the nature of the threat or opportunity, may bring only limited insight, and in some cases result in increased ambiguity. We would however reiterate that the framework in its current form, as with the categorisation scheme before it, is first and foremost a tool to stimulate discussion, structure analysis and provoke further insight. It is not intended to be seen as a formal or rigorous apparatus, and some level of ambiguity in terms of identifying the ingredients or specifying the recipe is to be expected.

Despite this, we maintain that the framework plays a useful and as yet largely unaddressed role in facilitating

the analysis of compound resilience strategies. In providing insight into resilience episodes observable across a broad range of contexts, we suggest this work assists not only analysis of domain-specific existing accounts of resilience, but potentially facilitates transfer of resilience strategy insight across domains. By deconstructing complex strategies and understanding why (motivations) and how (mechanisms) they work, one is in a stronger position to accommodate and manage the implementation of resilience strategies at the 'sharp-end' of interactions with future sociotechnical systems.

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