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Reflecting on Users' Strategies for Resilient Interactions

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Abstract. One crucial contributor to the resilience and reliability of interactions with technical and sociotechnical systems is the resilience of users themselves. While the study of human factors has traditionally focused on the negative aspects or frailties of human performance, attention is increasingly turning to also consider the proactive and positive contributions human performance can make across a range of tasks and settings. In this position paper, we introduce the notion of *Resilience Strategies*, summarise some of our current work in this area and discuss examples of resilience strategies we have encountered during the course of this work. We also discuss how work into resilience strategies is situated in terms of broader work into the high-level resilience of sociotechnical systems, and interactions with technical systems.

1 Resilience as Individuals' Behaviour

Resilience Engineering has, to date, largely represented the pursuit of heightened resilience at a system or organisation wide level. At the same time however, a recent resilience-focused literature review [1] notes how resilience can be considered as a concept that scales down from high-level organisations, to groups and teams, and further still to an individual level. As an illustration of this, resilience could for example be considered in (i) the way in which emergency services respond to a large-scale incident (high level 'systems' resilience) and/or (ii) in the way resources are allocated by a team of dispatchers (the resilience of a small team within the system), and/or (iii) in the way in which an ambulance driver may for instance use conscious foresight to select a longer but faster or less traffic-prone route when moving to an objective (resilience demonstrated by an individual through the implementation of a resilience strategy).

While we acknowledge the valuable insight that can be gained from work into resilience at higher levels of granularity, in order to situate and contextualise our current perspective we note here that our work principally addresses the later of these levels; the resilience of individual operators or users. We propose that resilience at this individual level is perhaps most approachable when conceptualised in terms of *resilience strategies*, the

tangible behaviours and tactics that individuals deploy to mitigate threats and maintain performance.

Strategies leading to improved performance through resilient actions and interventions are nothing new, and examples are observable across a range of contexts. One challenging aspect of their investigation however is that as with the wider study of resilience, such strategies are generally underrepresented in the literature owing to a tendency to instead direct investigative scrutiny towards failures, adverse incidents and threats or frailties [2]. There are however some cases, particularly involving work of a safety critical nature, where examples have been reported that capture individuals deploying strategies and workarounds to remain resilient against threats.

Randell and Johnson [3], for example, noted how they witnessed hospital nurses 'tricking' portable monitor devices by removing and reinserting batteries. This overcame a feature whereby every fiftieth charging cycle would trigger a battery condition error, necessitating battery replacement regardless of remaining capacity. In actual practice, it was impractical to record charging cycles and thus predict when this arose, but nurses could utilise this battery-removal strategy when the error presented at inopportune moments. Mumaw et al. [4] describe a number of strategies that operators deploy in nuclear power plant control rooms, for example reducing superfluous alarms by adjusting threshold parameters (increasing the salience of more important alarms), or the strategic repositioning of physical items to serve as visual cues for assisting with prospective memory and progress-tracking. Malakis and Kontogiannis [5] similarly discuss further such examples of strategy use observed in the work of air traffic controllers.

Furniss et al. [6] note that while targeted work addressing resilience and other closely related subjects is available, the tendency for this work to be presented across differing levels of granularity and abstraction, and generally within specific and specialised domains, means it can be difficult to assimilate such phenomena and transfer findings between domains. In response, Furniss et al. outline the *Resilience Markers Framework*, which seeks to explore how common themes may be derived from individuals' concrete strategies, and traced vertically to broader strategy-type patterns of behaviour, and ultimately high-level resilience markers or principles that are transferable across domains.

Furniss, Back and Blandford [7] developed this idea at an individual-strategy level by establishing a categorisation scheme for different types of resilience strategy, which they derived from a basic thematic analysis of some 49 episodes of self-reported resilience, collected expressly for the purpose. Furniss et al. arrived at a seven-item scheme that provides structure for further

analysis in the form of a vocabulary for describing different strategy types. However, the authors note that this scheme may potentially benefit from further refinement and validation, owing to ambiguities in terms of 'overlapping' in their categories and potential gaps in coverage reflecting their reliance on a somewhat limited dataset.

2 Refining Categories for Resilience Strategies

Part of the work we are undertaking seeks to extend and develop the aforementioned Furniss et al. categorisation scheme, in collaboration with the original authors. To date, this has involved the collection and analysis of an extended set of resilience strategies, combining multiple methods including observations from a controlled lab study, a diary study and self-reported episodes collected via a purpose-designed mobile application (an enriched 'digital diary' with prompts to elicit relevant contextual information, and the ability for users to upload photos, further described in [8]). We have further supplemented this data with strategies observed and noted from two additional studies by colleagues, which comprised situated observations of home healthcare, and an online survey into habits surrounding medication adherence.

As with the previous Furniss et al. investigation, and in a marked departure from much of the previous work into resilience strategies, we have opted not to limit the scope of our data collection to specific domains or tasks but to instead consider a broad spread of strategies from a variety of contexts. This reflects our objective of deriving a set of descriptors for types of resilience strategy which are independent of, and transferable across, domains and settings.

While this work is currently still in progress, this expanded dataset and subsequent analyses (particularly of 'edge-case' episodes of reported resilience) have already resulted in refinements to the scheme, and an increase in coverage and the total number of category descriptors. While the precise nature of much of this work extends beyond the current paper, we present here some examples of resilience strategy episodes we have collected as part of our data and discuss these in the context of the strategy categories they represent.

2.1 Examples of Individuals' Resilience Strategies

One such example of a resilience strategy was a diary study participant describing how they have purchased multiple chargers for their mobile phone. They either carry a spare with them, or leave it at their place of work. In so

doing, the participant is able to keep their phone charged while reducing the risk of a charger being forgotten. An indirect benefit of this redundancy would also be the continued availability of a charger in the eventuality of one becoming lost or developing a fault. We felt this strategy episode to be representative of the category descriptor *maintaining resource availability* and noted how strategies that primarily addressed this objective were a recurring theme in our dataset.

A second example of a resilience strategy, also recorded by a diary study participant, described how the participant had strategically customised the interface of a frequently used software package, reconfiguring toolbars for the purpose of reminding them about software functions that are otherwise hidden behind a menu. We characterised this as an example of the category descriptor *creating new cues*, as it represented an adaptation which utilises a visual cue to assist the user in avoiding a perceived potential memory slip error. We note that there are clear parallels between this onscreen cueing strategy, and the previously discussed Mumaw et al. [4] strategy describing how operators in a control room utilised physical artefacts as improvised cues.

A third example, which was reported by multiple participants across a range of contexts, described how smartphone users are increasingly utilising the camera functionality of their devices to quickly and conveniently capture a variety of information. Specific examples included capturing the contents of a whiteboard during a university class, generating a digital copy of a tube map, and transferring the contents of a digital calendar from a laptop screen to a tablet when the ability to synchronise was temporarily unavailable. We consider such examples to fall under the descriptor of *appropriating a resource,* since each case describes an improvised and unconventional use of the camera to generate externalised representations, which serve to offload working memory capacity.

Other such examples of types of strategy include *reinforcing an existing safety barrier* which can be observed when, for example, individuals set multiple 'back up' alarms to reinforce their effectiveness, *checking before or after an action* which describes checking variables prior to or following a task or subtask, and *separating task items* which involves disambiguating similar items or streams of information, for example the labelling or physical separation of two hard drives.

3 Implications for the Broader Study of Resilience

Returning to the broader investigation of the resilience of technical and sociotechnical systems from a HCI standpoint, while the 'micro-level'

accounts of resilience presented above may initially appear somewhat disconnected, we believe there is clear potential merit in the approach we are undertaking of adopting these concrete observable strategies as a base unit of analysis from which to derive more transferable principles at a higher level of abstraction.

These categories, originally proposed by Furniss et al. and currently the subject of refinement and validation, help us to articulate both the needs of users, and the resulting behavioural mechanisms by which they themselves proactively improve performance. We posit that by better understanding and nurturing these strategies, designers may in future be able to craft more resilient interactions, in turn improving performance and resilience in the wider encapsulating system.

We see two potential and complimentary avenues by which further insight of individuals' resilience strategies could be realised in the designs of future systems. Designers and practitioners could harness strategies for potential feature inclusions, using them to identify specific needs on the part of users. A HCI relevant example of this is the integration of automated checking in some modern email clients to prompt the user if an outgoing message is intended to be sent without an attachment, if the system detects the word 'attachment' in the body of the message. Alternatively, and perhaps more challengingly, designers and practitioners could endeavour to design-in capacity or flexibility to accommodate for, and facilitate, users developing and deploying their own strategies. One rudimentary example of this is the functionality in some file managers for arbitrary colour-coding or metadata fields for users to appropriate.

4 Conclusions

The pursuit of heightened resilience and reliability within complex systems represents a significant challenge. One route to achieving this might be through promoting the resilience of users at an individual or cognitive level. Variability in human performance has traditionally all too often been framed in a negative way. However an increasing body of work looking into individuals' resilience strategies demonstrates that users are not mere components of a system prone to fatigue, frailty and error. While it may be the case that in some cases, deviations in human performance can erode the resilience of a wider system, this does not negate the fact that frontline operators can and frequently do make a positive and largely underreported contribution to the resilience of a system. In displaying resilient qualities of their own, proactively recognising and mitigating potential risks and managing

threats to performance, users themselves represent a channel through which designers can enhance the resilience of system interactions.

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