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**Article**

# Exploring the Links between Neuroscience and Foresight

**Maree Conway**[1*]

[1]*Foresight Futures, Australia*

## Abstract

*This paper explores the connections between neurology and foresight in a cross-disciplinary discussion of how humans are able to imagine possible futures. Episodic foresight is identified as the primary neural mechanism that enables humans to construct images of the futures, providing explanatory power to further define and understand the processes that are invoked in futures studies and foresight activities. A top-level framework for making explicit these processes is provided, identifying brain functions, openness to experience and temporal preferences as the primary processes that inform construction of new images. The paper provides a new perspective on the design of Futures Studies and Foresight processes and deepens our understanding of the nature of those processes.*

## Keywords

Foresight, Futures Studies, Neuroscience, Brain, Episodic Memory, Episodic Foresight

## Introduction

This paper reports on research that explores how it is that we humans can imagine and construct images of the future. That we need to *imagine* the future because it does not yet exist is generally accepted as a truism as is the reality that people perceive the future in different ways (Rhemann, 2019). Exactly *how* we can imagine the future in ways that break open what is often called the 'official future' (van der Heijden, 1999), the assumed and expected future, the constraining future is, however, less well explored. That is, while people have always imagined the future, more attention is generally paid to process outcomes than the actual *thinking* that generates future images. Here the neurological and related processes that allow humans to imagine the future are explored.

## Images of the Future

Images and ideas about the future are constructed in people's minds and generate social, collective realities that are the construct by which our futures are made 'real.' The idea of images of the future emerged in the French 'prospective' school in the 1950s and 1960s, (Berger 1957; de Jouvenel (1967), while Polak's *Image of the Future* (1961) and Boulding's publication of *The Image* (Boulding, 1961) reinforced the power of the image when considering the future. In his seminal work, Polak (1973, p. 19) notes: "The rise and fall of images of the future precedes or accompanies the rise and fall of cultures" with images shaped by the degree of optimism or pessimism about the future and the degree of human agency to influence that future. Bell and Mau (1973, p. 2, italics added) draw on Polak's work when they discuss the key role of images of the future in society noting that:

* *Corresponding author*.
*E-mail addresses*: Maree.conway@thinkingfutures.net *(M.Conway)**.

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> it may be profitable to look upon society as less a problem of order and *more as a problem of steering* in which images of the future are of crucial importance [stressing] dynamism and change, the causal interaction of ideas – beliefs and values – and social structure, decisions, and the deliberate efforts of man to shape society.

Polak's focus on the image and its underpinning beliefs and values highlights the tacit nature of images that are as powerful as understanding more visible social change when thinking about the future. Like Polak, Vásquez (2010, p. 333) identifies images as carriers of the future and emphasizes the role they play in understanding the scope of social change – since images hold ideas about how that change may evolve over time. Vásquez (2010, p. 333) also points out that images have become less visible in the Futures Studies and Foresight (FSF) literature over time, perhaps because of the field's diverse background and its multi-disciplinary foundations, or because images are usually assumed or taken-for-granted. It is because images are tacit that FSF processes must be designed specifically to surface and challenge them in those processes.

This lack of literature does not mean that the centrality of images in FSF work is not understood. For example, Slaughter (1997, p. 619) suggests that images of the future convey abstract ideas and provide interpretative knowledge about near-term futures. Dator's (2005) First Law of the Future reminds us that the future does not exist: "Futures studies does not – or should not – pretend to study the future. It studies ideas about the future." Voros (2005, p. 38) points out that images inform and shape action and decision making in the present, and that identifying images, along with latent futures, beliefs and probabilities are the central aim of rigorous futures inquiry. He also notes, however, that the process of helping people to imagine futures that are different to the present and that challenge often deeply held assumptions requires a high level of practitioner skill and an awareness of how people use foresight methods. Voros suggests that if practitioners are not aware of how images are constructed, they can "easily produce results which are unsatisfactory, un-useful, and possibly even hurtful to the people involved" who will then exit such processes "disillusioned, disheartened, and disagreeable to any further foresight processes." This paper seeks to provide one perspective on how images can be explicitly included in FFS process design.

## How Do We Imagine the Future?

Rhemann (2019, p. 51) provides a detailed discussion of the neural mechanism involved in thinking about the future and posits that bringing FSF and neuroscience together will generate a "cross-disciplinary approach to understanding how we think about the future." She points out that neuroscience and futures are "kindred spirits" and that it is time to surface connections in ways that can be of value to both fields. Rhemann identifies a range of possible intersection points and potential benefits between neuroscience and FFS (pp. 61-62) including the need for FFS practitioners to recognise how our brains actually operate when we are asked to imagine possible futures and the need to find new methods that engage the brain's anticipatory and sensory systems to expand and deepen visioning and similar processes. She suggests (p. 62) that: "Neuroscientists, working with futurists could deepen futures thinking and explore sub-segments, such as temporality, future scenarios, and disruptions to further understand connectivity between neural processing and varying levels of futures thinking."

Figure 1 provides a *conceptual* frame for defining the factors involved when we imagine possible futures, demonstrating how constructing images of the future draws on a range of neural and cognitive activities. The aim here is to identify underpinning factors involved in constructing images of futures and does not delve into the detail of how these factors connect and intersect to define the processes that enable individuals to construct images. Rhemann (2019, p. 63) does provide an example of methods that can be used in one FFS process along with action that could be taken to better integrate neuroscience and foresight in that process. The exact detail of how these factors might intersect in FSF processes to generate images of the future to develop a model or framework for use by practitioners is a topic for further research and development.

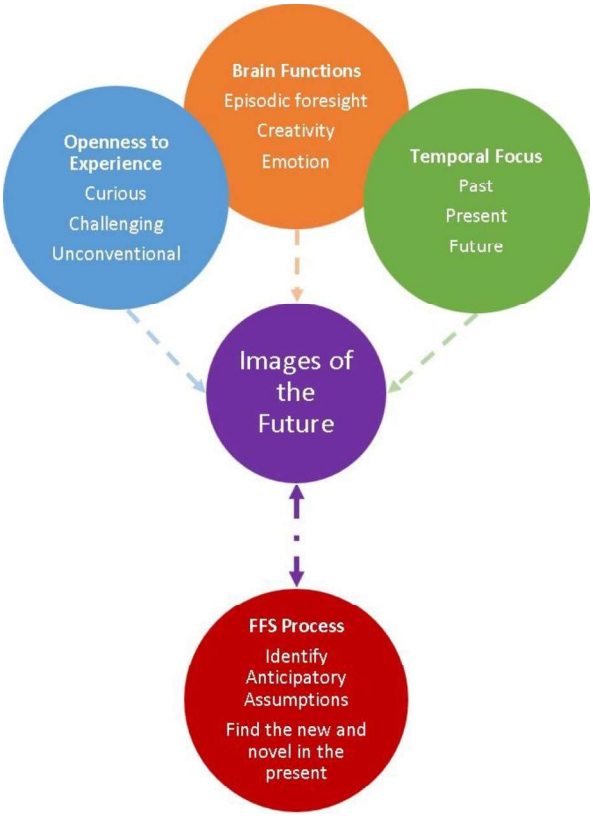


**Fig 1**: Factors Involved in Constructing Images of the Future

The three coloured circles at the top of Figure 1 represent invisible, interior processes – as indicated by the pale dotted lines – that are engaged when a person is asked to create an image of the future, shown as the purple circle in the middle of the figure. The two-way arrow between images of the future and the FSF process shown at the bottom of the figure indicates that to be useful in an organisational sense, an image must be constructed in a specific process designed for a specific context where anticipatory assumptions (Miller 2018) have been surfaced if desired strategic outcomes are to be achieved.

Ultimately, it is this intersection of tacit mental processes with a visible FSF process that enables an image to be considered worthy of consideration in the present – or rejected as invalid. A well designed FSF process then must include specific processes that activate both tacit and overt factors to ensure meaningful and useful images of possible futures can be imagined in that process.

Each factor identified in Figure 1 is discussed in the following sections.

## Brain Functions

### Episodic foresight

The neurological process drawn on to imagine the future is primarily episodic memory which Irish & Piguet (2013, p. 1) describe as:

> One of the most fascinating aspects of human cognition is our ability to withdraw from the current moment and to mentally transport ourselves to another time, place, or perspective. Collectively, the abilities to remember the past via episodic autobiographical memory … or to imagine possible future events, represent important expressions of the human memory system [that enable] not only the capacity

> for retrieval from our personal past, but also [encompass] the ability to imagine and envisage possible future scenarios, leading to a constructivist view on how humans might achieve such sophisticated acts of cognition.

The brain regions responsible for our ability to recall the past also enable us to imagine possible future events. Since Ingvar (1985, p. 127) coined the term 'memory of the future' in his study of the neurological mechanisms responsible for the human ability to experience the past, present and future, episodic memory has become a significant area of brain research (Irish 2020). The neurological basis, design and discussion found in this neurological research is well beyond the scope of this paper to explore in any depth, but its findings are clear in terms of how the brain allows us to imagine the future and to generate new ideas about those 'simulations'.

Notably too, is that episodic memory has been associated with a particular type of consciousness – autonoetic or self-knowing – a self-reflective capacity that emerges when we remember the past or imagine the future and that enables us to consciously reflect on our experience in those mental spaces (Tulving 1985; Klein 2016; Natsoulas 2017), or as Tulving (1985, p. 5) describes:

> A normal healthy person who possesses autonoetic consciousness is capable of becoming aware of her own past as well as her own future; she is capable of mental time travel, roaming at will over what has happened as readily as over what might happen, independently of physical laws that govern the universe.

The capacity to imagine the future and to locate ourselves in those futures is as innate and subconscious as remembering the past. It is a primary human capacity, which in FSF terms is called foresight.

Episodic memory is not the only type of memory: semantic memory is also critical in constructing images as it helps us remember events and facts *outside* of constructed simulations (Irish & Piguet, 2013; Madan, 2020); procedural memory helps us acquire skills and use them in the present; and implicit memory is drawn on when past experience is recalled unconsciously without first thinking about the experience (Madore & Schacter, 2016). Rhemann (2019 p. 25) identifies 'boundary extension' as a neurological process that uses both episodic and semantic memory to allow us to construct possible futures to move beyond temporal restrictions. But it is primarily episodic memory that helps us engage in 'mental time travel' both back to the past and forward into the future (Madore & Schacter, 2016; Suddendorf & Corballis, 2007). Significantly, research has shown that if a person is unable to remember past events because of brain damage, that person will also be unable to imagine the future (Tulving, 1985), therefore supporting hypotheses that it is episodic memory that allows humans to think about the future (Szpunar & Radvansky, 2016).

Ingvar (1985, p. 128) also posits that our memories of futures can be remembered, creating what he called a memory of the future. But these memories are useful for generating new actions and strategies in the present *only* if people can remember that content, which they are more likely to do if their future thinking explores a period closer to the present, and if the future simulation is imagined frequently (Schacter et al., 2012). Suddendorf (2010, p. 101) suggests that memory systems (particularly episodic and semantic) allow humans to "recursively combine and recombine basic elements into *novel* scenarios and evaluate these in terms of their likelihood, desirability and so forth" in the present in the process he calls episodic foresight.

**Creativity**

If humans are able to recombine past events to generate novel future events in the present, a second neurological process then becomes of interest. If the goal for an FSF process is to enable people to imagine a future that is *not* a projection *from* the present, it follows that the part of our brain that enables us to think *creatively* in the present needs to be engaged. This act of creativity is not confined to the right-hand side of the brain as is commonly thought (Koontz, 2019), and recent research shows that areas of the brain in both hemispheres interact to allow us to generate new ideas, and that those areas activate to different degrees at different parts of the creative process (Kaufman, 2013). Schacter et. al (2012, p. 681) in their review of this recent research note that:

> the finding of greater neural activity for future relative to past events reflects the more extensive constructive processes required by imagining future events relative to remembering past events. That is,

> whereas both past and future event tasks require the retrieval of information from memory, imagining future experiences – but not remembering past experiences – requires that details extracted from past experiences are flexibly recombined into a novel event.

It appears then that this recombination process is what has the potential to generate new perspectives and understandings of the present. Koontz (2019) reports on the work of (Beaty et al. 2018)) that used imaging experiments to test divergent thinking where individuals were asked to imagine novel uses for everyday objects. This research revealed that stronger connections and increased activity across three neural networks in people able to identify a new use: the *Executive Attention Network*, responsible for decision making and action; the *Imagination Network* that allows humans to daydream and brainstorm (and imagine the future); and the *Salience Network* that is responsible for focus and attention. The latter network monitors our consciousness and responds to external sensory input to make decisions about which information is relevant for problem solving by essentially deciding which information we pay attention to and which we ignore.

Creative thought depends on the constant interaction of these three networks, under the control of the Salience Network. A new idea begins with increased activity in the Imagination Network, which is recognised by the Salience Network that, noting this idea is new, switches the idea to the Executive Attention Network to create working memory that is retained by the brain. Koontz (2019) writes that "The connections between these three networks, and the speed at which they interact, are predictors of how creative a person will be. Individuals with more connections are more likely to think outside the box and think of new solutions and possibilities." This difference in the number of connections across these three networks might then provide a possible explanation for the variability of workshop participant responses when asked to imagine the future, although this is conjecture here. It highlights the fact, however, that imagination, daydreaming and visioning – mental time travel – need to be an essential part of the design of FSF processes.

**Positivity/Negativity**

One final finding from more recent neurological research of interest here is reported by Schacter et. al. (2012, p. 688) on whether we have a bias towards positivity/optimism when thinking about possible futures events. People with a positivity bias are more likely to remember positive events and to view such events as more plausible, especially when simulating a future event is repeated. Research in psychology also has a significant literature set related to exploring the impact of positive and negative affect on futures orientation.

Aspinwall (2005, pp. 219–220), for example, suggested that a positivity bias helps determine willingness to consider action in the present that has only long-term benefits, while negative emotions instead generate short-term thinking at the expense of longer-term benefits.

While her research is not specifically focused on thinking about the future in the sense that it is discussed here, this finding that a positivity/negativity bias affects how we think about the future reflects Polak's work (1961) on optimistic or pessimistic social images of the future and is also explored in the Polak Game (Hayward & Candy, 2017) which explicitly seeks to enable people to surface and discuss this bias in an FSF experiential exercise.

**Openness to Experience**

Psychological research and more recently brain research (Sun et al. 2018) have found that creativity/imagination and 'openness to experience' are related. Openness is one of the five elements of the Five-Factor Personality Model first identified in the 1960s and further developed in the 1980s and 1990s (Digman, 1990; McCrae & Costa Jr., 1987; McCrae & John, 1992). It consists of five dimensions: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. The openness to experience dimension is of specific interest here because it identifies the "most important ways in which individuals differ in their enduring emotional, interpersonal, experiential, attitudinal, and motivational styles" (McCrae & John, 1992, p. 175). This is significant because it is these differences among individuals that, it is suggested here, may lead to an understanding of why some people are open to the future and others are not – that is, put simply, some people have open minds to the future while other have closed minds.

Openness is described by a range of terms: curious, imaginative, insightful, original, wide interests – that are identified in surveys and inventories by terms such as: wide range of interests, value intellectual matters, judges in unconventional terms, aesthetically reactive (McCrae & John 1992, p. 179) … and "unusual unconventional thought" (p. 198). While not perfect, the disposition is now defined as: "**People who are** "open to experience" tend to be intellectually curious, *creative and imaginative* (bold in original; Smillie 2017), who see the world differently and are more open to diverse ideas and beliefs including those which challenge existing assumptions (Waude 2017).

Openness to experience is also similar in nature to the Openness to Alternatives dimension of the Futures Consciousness scale (Ahvenharju et al., 2018; Finland Futures Research Centre, 2019; Lalot et al., 2019) which includes capacities such as "creativity, imagination, critical thinking and openness, and it is strongly linked to the capability of embracing and appreciating change, seeing the value of alternative ways, and questioning established truth" (Ahvenharju et al., 2018, p. 10). In terms of thinking about possible futures, people who are open to experience and alternatives are likely to be better able to challenge their assumptions about the present and future that, in turn, would allow them to generate a range of new and novel possible futures in the present.

## Temporal focus

This innate prospective capacity to imagine the future is also limited, however, precisely because the brain constructs the future by re-constructing the past in new ways. 'Time perspective' enters the equation here, which Zimbardo (1999, p. 1271) describes as "a fundamental dimension in the construction of psychological time [that] emerges from cognitive processes partitioning human experience into past, present, and future temporal frames" – different temporal allocations mean some people might make decisions based on reconstructions of the past, while others use anticipation and expectation of a desired future state. A cognitive bias can emerge when a person, over time, focuses on one temporal frame at the expense of others when making decisions and taking action, a stance derived from a range of cultural and social factors that shape how one engages with the world.

Shipp et al. (2009, p. 1) in their work on the impact of temporal focus on organisational behaviour suggest that while people can move across past, present, and future times, they tend to develop preferred temporal tendencies that influence responses to new information. More "past-focused individuals tended to be more negative [while] current and future-focused individuals tend to be more positive" (p. 16). Using a different time frame can also alter how individuals perceive situations and events at different points in time (p. 18). Karniol and Ross (1996, p. 594) explore temporal focus in terms of motivation for action in the present. They noted consideration of the past and possible futures generates images and ideas that are social constructions that "can be idiosyncratic or culturally held, more or less stable, and more or less realistic". They identify (p. 596) three relevant points for this paper: **one**, that an individual's action in the present may be based not only on practical use today but also on that person's morals, norms and values; **two**, that people are likely to imagine a small set of possible futures or to avoid imagining futures that do not align with personal values and beliefs; and **three**, that action in the present may be related to the degree to which people can link representations of themselves in the present with imagined futures – that is, by creating future "images of possible selves, representations of how they might act, look, or feel in the future." It is then possible to see how tacit understandings of the self and how we 'sense-make' can enable and constrain the emergence of possible futures.

Our understanding of time is a primary factor in FFS work (Dator, 2019; see for example, Inayatullah, 2017a), since moving people beyond perceptions of time as linear, moving from the past to the present to the future, is critical if possible futures are to be considered as worthy of attention in the present (Inayatullah, 2017b). Ensuring people in an FFS process are aware of their time preference is therefore essential.

**Assumptions and Imagining the Future**

While humans have the neurological capacity to imagine possible futures, our worldviews ensure that our ontological assumptions about what is 'real' and what is not *also* shape the degree to which we are able to accept the not yet real as worthy of consideration in the present. That we have assumptions that influence how we think and see the world is well understood. However, as Coates (1999, p. 97) suggests, people rarely engage with the tacit, taken-for-granted, and unchallenged assumptions in our minds because there are few instances where those beliefs can be made overt. Most FFS work includes discussion of the need to challenge assumptions – because those assumptions shape the images we construct - but exactly how those assumptions can be challenged in those processes is not well documents.

In the context of how we use the future in the present, Miller (2018) sought to make assumptions explicit by identifying six anticipatory assumptions (AA) which shape how we imagine the future. Miller regards anticipation as a ubiquitous activity and defines AA as:

> a descriptive mapping of the ontological and epistemological attributes of anticipatory activities … these assumptions are necessary for all 'uses-of-the-future' because 'imagination' can only be elaborated on the basis of the underlying assumptions. Conscious human AA include choices about what kind of future to anticipate and which methods to use to think about a particular kind of future.

That is, it is only when our AA are surface and made visible, do we understand that nature of choice we can make about how we imagine possible futures. For Miller, 'using the future' takes place in two ways: anticipation-for-the-future (AfF) and anticipation-for-emergence (AfE). Both construct different types of future: the former generates futures we desire or plan for in the present, while the latter "is a use of the future to sense and make sense of aspects of the present, particularly novelty, which tends to be obscured by AfF" (p. 22). AfE then seeks the *new in the present*, not a specific future. It generates a "disposable construct, a throwaway non-goal that need not be constrained by probability or desirability (p.20).

It is difficult to do justice here in any attempt to explain the context for, and the detail of, the six AA that underpin different types of futures (Miller 2018, Figure 1.1, page 24). A brief summary only is provided here to demonstrate how different assumptions underpin different futures:

AA1: Forecasting – future based on closed models using statistics, benchmarking – colonisation of the future;

AA2: Destiny: imagined futures are based on deterministic stories or entrenched myths, already foretold – atrophy of the imagination;

AA3: Creative reform – futures are used to address wicked problems for a specific goal, within a specific paradigm, that lead to "continuity futures" that assume "immortality" (p. 32) – deterministic creative imagination;

AA4: Self-improvement – futures are consciousness oriented, but seek pre-determined futures using "experience induced attitudinal or consciousness changes" (p. 32) – introspective adaptive imagination;

AA5: Strategic thinking – anticipation for sensemaking in the present by "identifying system boundaries, identifying the parameters of paradigms – including existing paradigms … that were previously invisible or partially hidden" (p. 33) – imagination using known processes; and

AA6: 'Wisdom–Tao–being' – finding emergence in the present specific to a context indicated by "discovery or invention of novelty – coining new words and/or missing words, recognising and/or establishing relationships at time-place specific/ephemeral/process levels."

The last AA is open to possible futures through a process of reframing the present – to understand in the present in new ways, to seek emergence as well as the known – leading to a reframing of assumptions about possible futures.

Miller's work at UNESCO with a wide range of people from around the world is designed to define a Discipline of Anticipation and to provide a proof-of-concept of Futures Literacy Labs to 'activate' our capacity for futures literacy. These labs are designed around a customisable three phase process that is variable in terms of creative and cognitive effort (Miller 2018, p. 98):

Phase 1: Reveal: tacit to explicit,
Phase 2: Reframe: creative, inventive, experimental – difficult, and
Phase 3: Rethink: compare, reflect, consolidate – easier.

This sequence allows individual and collective conscious awareness of the type of assumptions being used to imagine the future to be identified, and recognition that there are a range of types of futures that can be imagined as a result – all valid in particular contexts. This recognition is, for Miller (p. 97), the critical outcome of the labs – that participants can recognise the type of anticipatory assumptions they are using by making them explicit. People are then able to discern the types of futures they have imagined but also to understand the assumptions to use when a particular type of future they will create when these apply those assumptions in their consideration of those futures.

Futures literacy then is essentially the capacity to identify which AA is being used in particular contexts and for particular purposes – that is, how and why we are thinking about the future in this context at this time. Miller makes clear that all assumptions can be valid in a defined context, but that knowing exactly what assumptions you are using to imagine the future is critical. The Futures Literacy Labs are one example of a redesigned FFS process specifically structure to integrate tacit assumptions with visible change in context.

## Concluding Comments

Sardar (2010, p. 443) writes:

> Imagination is … the only tool … which takes us from simple reasoned analysis to higher synthesis. While imagination is intangible, it creates and shapes our reality; while a mental tool, it affects our behaviour and expectations …The kind of futures we imagine … would depend on the quality of our imagination.

This paper has explored how it is we can imagine possible futures and the factors involved in that imagination process. For FSF practitioners, the design of processes becomes important not only to ensure that people are introduced to pathways into their possible futures in their visible present, but also because without active consideration of the anticipatory assumptions present in a workshop, the ability of people to break down constraining assumptions will not increase, and resistance to engaging with the future not yet visible or defined will be maintained, or even increased.

Suddendorf and Corballis (2007, p. 299) suggest that the ability to think about the future provides humans with an evolutionary advantage, one that allows us to foresee, plan and influence futures, while also having an impact on the planet, although not always with positive outcomes. To take advantage of this evolutionary advantage, we first need to not only to be able to construct an imaginary possible future, but also to be able to then remember the detail of that future, to describe its content in sufficient detail in the present, and to see ourselves in that future. We then need to use that future in our conversations in the present so that it becomes more acceptable and plausible. Here creativity, openness to experience and alternatives, temporal focus and anticipatory assumptions were identified as critical elements of any FSF process design to ensure that participants have the best opportunity to both recognise their foresight capacities and anticipatory assumptions, to challenge those assumptions to see the new and novel in the present and then to act in new ways. Only then will we be able to grasp the reality of alternative futures and seek out diversity in those futures. As Dator (2017, p.7) importantly reminds us:

> One of the biggest lessons we need to learn … is that there is no such thing as a "normal" future from which all other futures are exceptions. No "most likely" future, and no "least likely" future either. There are no wild cards, no black swans, no images of the futures that are more plausible or implausible than any others.

Fundamentally, there is no such thing as 'the future'. We have multiple possible futures, limited only by our understanding of just how we imagine those futures. As Rhemann (2019) notes, the intersection of FFS and neuroscience provides insights for FSF practitioners to further expand and deepen their knowledge and practice and

potentially, the outcomes for people who participate in FSF processes. Exactly how that expansion and deepening might occur is a topic for future research and case study development to surface and define how practitioners are using futures in their work in the present.

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