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CROSS-CUTTING EDGE

Brittle threshold: When adaptive success is the warning sign

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Abstract

Context: What happens when a system keeps working—not because it is well designed but because people keep absorbing the strain? That question stayed with me after studying a community-led vaccination clinic during the COVID-19 pandemic. It delivered hundreds of vaccinations a day, with no formal chain of command or protocols. By any measure, it was a success. What it cost to sustain that success was never examined. Across my empirical work, I kept encountering the same pattern: systems functioning because people stretched roles, coordinated through workarounds and relied on relationships that were not designed to carry the full load. These adaptations were effective. Yet they were also hiding strain.

Conceptual Contribution: In this paper, I introduce Brittle Threshold as a concept for attending to this condition. Rather than treating adaptive action as evidence of success, Brittle Threshold frames adaptive action as diagnostic information: evidence of how a system is coping and how close it may be operating to its limits. Drawing on resilience engineering and on empirical patterns from studies of team adaptation and community crisis response, I argue that adaptive success and vulnerability regularly coexist. The more smoothly work appears to run, the more it may depend on fragile support.

Implications: Brittle Threshold offers three contributions. It translates what adaptive success conceals in health professions education, it shifts what counts as evidence of system strain and it unsettles the moralisation of endurance as professional virtue. The question it opens is not why systems fail, but when is endurance no longer enough?

1 | INTRODUCTION

Halfway through the COVID-19 pandemic, I was invited by a community organisation (a Rotary Club) to study a mass vaccination clinic in a small Ontario town. The clinic delivered hundreds of vaccinations a day using volunteers: retired clinicians, teachers and hockey parents. There was no formal playbook and no chain of command that could be cleanly drawn. Who was in charge depended on the hour. Protocols lived on whiteboards, shared documents, text threads or in someone's memory. Each day, the work required collective judgement about what problem mattered most right now: Was it vaccine supply, volunteer fatigue, weather, community mistrust?

From a formal systems perspective, the clinic should not have worked. It did! But not because it was well designed. It worked

because people continually stretched roles, relied on informal handoffs and absorbed uncertainty through relationships and personal effort. The clinic was widely described as a success. Yet its success depended on adaptive actions operating close to their limits, with little slack and growing reliance on a small number of people to hold the work together. This is akin to an elastic band held under constant tension: It continues to stretch and perform its function until one additional pull exceeds its elastic limit and it snaps. Collapse did not occur, but it could have happened at any time.

That observation stayed with me because the vaccination clinic was the kind of case often invoked to illustrate resilience, community capacity and effective improvisation under pressure. Yet across my empirical work, I kept encountering the same pattern.[1–6] Systems continue to function because people adapt, and over time, those adaptations become the primary means through which performance is sustained. Eventually, the very actions that hold the system together approach their limits. Systems do not fail because people stop adapting; they fail when adaptive action can no longer absorb additional strain. I refer to this limit as the Brittle Threshold. This paper takes up that problem in the context of health professions training and practice, where adaptation is routinely celebrated as a marker of competence and system strength while the conditions sustaining that adaptation often remain unexamined.

The stakes of celebrating adaptation without examining its limits are particularly high now. Health care systems emerging from the COVID-19 pandemic are not recovering into stability; they are adapting into conditions of scarcity, workforce strain and escalating demand. The question is not whether the next crisis will come but whether the clinicians and systems we are building today will know when endurance is no longer enough.

This paper is a conceptual synthesis informed by empirical observations across multiple studies conducted as part of the author's research programme.

2 | WHY ADAPTATION ALONE IS NOT ENOUGH

Adaptation is indispensable in health care and health professions education.[7–11] In this paper, health professions education is treated as the work systems in which care, learning and supervision are coproduced, rather than as formal educational activities alone. Learners adjust to uncertainty, clinicians improvise in the face of disruption and teams reorganise work to maintain care and learning despite shifting conditions.[1,12–18] Across educational and clinical settings, these adaptive actions are routinely cited as evidence of competence, flexibility and system efficiency. When work continues under pressure, adaptation is taken as confirmation that coping is sufficient.

This interpretation has been important. It has moved the field away from deficit-based accounts of failure and toward a more realistic appreciation of work as it is actually done.[8,19] Yet, it also carries a limitation. By treating continued functioning as an endpoint, adaptation becomes a self-justifying explanation: If the system is still working, then the adaptations that sustain it are assumed to be adequate. What is less often examined is how that functioning is being achieved, what it is drawing on and how close those adaptive actions may be operating to their limits.

Several scholars have cautioned that treating continued functioning as evidence of sufficient coping risks obscuring the strain that sustains it.[10,20] In this paper, I introduce Brittle Threshold as a way of attending to this condition. Rather than treating adaptation as an unqualified marker of success, Brittle Threshold frames adaptive action as diagnostic information, in other words, as evidence of how a system is coping and of the strain it is carrying.[21]

Brittle Threshold names the zone in which adaptation remains effective yet increasingly fragile. It is not a moment of failure but a condition of narrowing margin. Importantly, the exact location of the threshold cannot be known in advance. Until disruption occurs, systems cannot determine with certainty whether the next demand will exceed remaining capacity. What can be observed are the signals of diminishing capacity that indicate increasing proximity to that limit.

This lens does not question the value of adaptation, nor does it suggest that systems should function without it. Instead, it invites a different analytic posture. If adaptation is doing essential work, then understanding what it costs, what it replaces and how long it can be sustained becomes critical. Without such attention, adaptive success can prematurely close inquiry at precisely the moment it should open it.[22]

In this paper, Brittle Threshold is proposed as a sensitising concept that provides researchers, educators and leaders with a vocabulary and interpretive lens for recognising recurring social and relational manifestations of adaptive strain while performance remains successful. The concept directs attention to the period in which systems continue to function despite mounting demands, creating opportunities to examine how adaptation is being sustained; where its limits may be emerging; and what signals of saturation become visible before breakdown occurs.

To understand why adaptive success can so reliably hide strain in plain sight, I turn to resilience engineering.

3 | WHAT RESILIENCE ENGINEERING REVEALS ABOUT ADAPTIVE SUCCESS

Resilience engineering encompasses several distinct strands; the version most familiar in health care contexts is Hollnagel's Safety II, which reorients attention from failure to the everyday variability that makes work succeed.[23,24] The analytic tools most relevant to Brittle Threshold come from a different strand: Woods' work on how adaptive capacity is finite, consumed under load and approached as systems near their limits.[21,22,25–28]

Across this literature, adaptation is understood as a finite capacity that can be stretched and saturated, rather than as a reserve that can be drawn on indefinitely.[21,27] A central contribution of Wood's work is the identification of decompensation patterns: recurring trajectories in which systems initially absorb disruption through local adjustments,

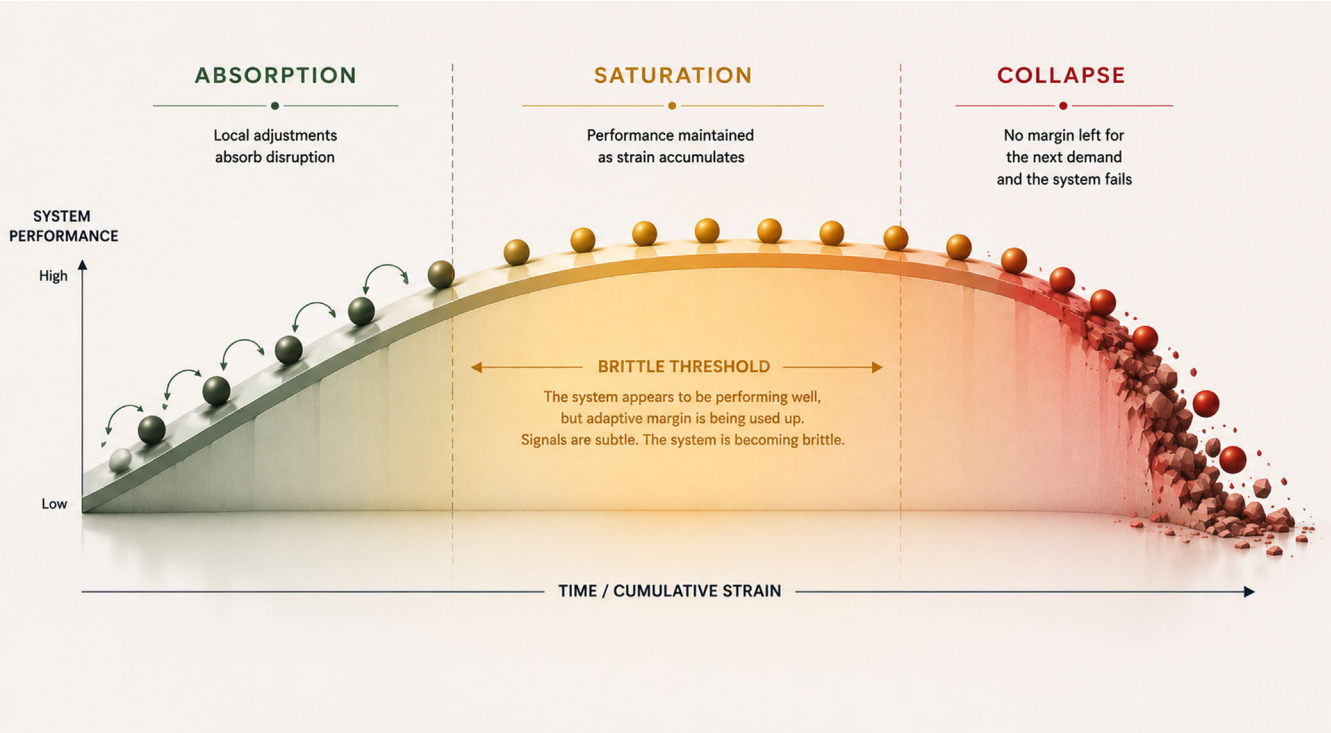

FIGURE 1 Brittle threshold within Woods' decompensation trajectory.

workarounds and compensatory control, maintaining performance even as strain accumulates.[21] Adaptive systems may therefore appear stable under increasing strain because compensatory actions temporarily mask underlying deterioration.[21,25] These dynamics are characteristic of how complex sociotechnical systems respond to load.

This is what drew me to this literature. Systems can look fine precisely *because* they are not fine.

What makes this more complicated, and critically relevant to health care, is that these dynamics rarely unfold in isolation. Health care teams, for example, operate within units, organisations and wider service networks, each with their own constraints and demands. From a resilience engineering perspective, local adaptive actions that preserve performance at one level may shift strain elsewhere, increasing coordination burden, workload, or vulnerability in adjacent or higher-level systems.[22,27] In this way, adaptation may be locally effective while creating brittleness across the broader system.

Related concepts further elaborate these dynamics. Woods' account of brittleness describes how systems can appear robust across a wide range of operating conditions yet exhibit steep performance degradation near boundary regions.[26] Performance may be sustained precisely because adaptive work is actively managing strain, even as this work consumes the margin needed to respond to future demands.[22,27] The theory of graceful extensibility brings these ideas together by emphasising that resilience depends on the ability to stretch capacity in response to surprise—and that this extensibility is inherently finite.[27]

These concepts show that adaptive success and vulnerability often coexist. Woods' brittleness describes what happens at the boundary. Brittle Threshold names what is happening before it—the period in which performance holds while fragility quietly accumulates and in which that accumulation can still be read and acted on.

Building on Woods account of decompensation trajectories, Figure 1 depicts how systems maintain performance through local adjustments as strain accumulates over time. While collapse occurs only when adaptive margins are exhausted, the Brittle Threshold refers to the preceding zone in which performance remains acceptable, but the system is becoming progressively saturated. By directing attention to this period of apparent success, the concept shifts attention from collapse itself to the recurring social and relational patterns through which adaptive strain becomes visible while the system is still functioning.

The distinction matters because threshold proximity is rarely experienced as impending failure. If Brittle Threshold is to be useful, it must be possible to recognise these dynamics while systems are still functioning. Section 3 examines how this became visible across several empirical studies of health care and community crisis work.

4 | SEEING ADAPTATION ACCUMULATE: EMPIRICAL PATTERNS ACROSS CRISIS WORK

Brittle Threshold emerged from a recurring empirical pattern across multiple studies of crisis work in health care and community settings. Across these cases, what I found intriguing was not whether adaptation occurred but how ongoing adaptation became embedded in

Box 1 Illustrative case: Implosive adaptation.

Cristancho et al. (2022) studied the experiences of 20 health care providers across Ontario hospitals during COVID-19, examining how teams navigated on-the-ground disruption through a process they called implosive adaptation: a reality check, a scramble, and a pivot.[1]

The scramble stage is particularly instructive here. Teams adapted by covering unfamiliar roles, bridging across specialties and holding team cohesion through personal effort: 'We adapted, but it was an implosion, it was not a successful adaptation'[1](p215). Early on, these adjustments felt temporary. As waves continued, they persisted. Team members no longer resisted redeployment but simply said 'plug me in where you need me'.[1](p217). What had initially been a crisis response became normalised as expected performance.

The study did not set out to examine saturation. But that moment when improvised responses stop feeling exceptional is exactly where threshold proximity becomes visible in this case.

everyday work and what this revealed about the limits of adaptive capacity.

In our study of health care teams during the COVID-19 pandemic (see Box 1), adaptation unfolded through what we described as *implosive adaptation*: a process in which teams scrambled to reconfigure work under conditions of scarcity, shifting rules and competing priorities.[1] Participants adapted by working outside scope, repurposing expertise and informally redistributing tasks. These actions were not episodic responses to discrete disruptions. They intensified over time, becoming embedded in everyday practice. What initially appeared as temporary accommodation gradually became expected performance. From the perspective of Brittle Threshold, these patterns signalled proximity to adaptive limits, rather than robustness.

A similar dynamic appeared in our studies of *team plasticity*, where teams maintained function by becoming interchangeable or exceeding formal role definitions (see Box 2).[2,5,6] Team members learned to anticipate each other's needs, step into gaps and coordinate through cues and shared situational awareness. These capacities enabled rapid response under pressure and were often celebrated as markers of expertise. At the same time, they depended heavily on tacit knowledge, emotional labour and sustained attentiveness. Hochschild's account of emotional labour[29] helps specify what is being drawn upon when teams exercise plasticity. Absorbing uncertainty demands cognitive adjustment, emotional regulation, sustained morale and steadiness under strain. These are finite capacities. As they accumulate without replenishment, the zone of Brittle Threshold narrows.

Box 2 Illustrative case: Team plasticity and its limits.

Gaudet et al. (2026) studied the experiences of 19 nurses and physicians in rural Ontario emergency departments, introducing plasticity as a collective capacity that sustains team functioning under conditions of scarcity.[5] What that capacity draws on became clear quickly: not formal protocols but relational responsibility, informal peer learning and sustained attentiveness to each other's limits. One nurse described the informal knowledge networks that made role-stretching possible, such as teaching a colleague over FaceTime, from a campsite, how to operate a rarely used piece of equipment, because 'it's something that is hard to teach outside of experiential learning'[5](p14).

The study distinguished two variations: acute plasticity, episodic and often experienced as rewarding, and chronic plasticity, the ongoing expectation that practitioners absorb non-traditional tasks because no one else is available. It is in the chronic form that accumulation becomes visible. As one nurse described it, the work felt like 'all these demands pushing you down and pushing you down'[5](p10). Participants described the situation as 'an elastic that's just stretched way too thin'[5](p16).

Eckert et al. (2024) observed the same dynamic in military surgical resuscitation teams[2]: small team size meant 'there's no redundancy', and the training and deployment demands that sustained adaptability placed continuous pressure on team members' well-being[2](p7). Functioning continued. But what sustained it was being steadily consumed.

Across those same studies, coordination increasingly relied on a small number of individuals who could flex across boundaries, making the system both effective and fragile, akin to Wood's decompensation patterns.[21] In HPE, Lingard's concept of collective competence helps clarify this dynamic.[30] Competence, in this view, is not an individual attribute but a distributed property of the team. Yet distributed capacity has its own saturation point. When collective competence depends disproportionately on the informal bridging work of particular individuals, the system's apparent robustness rests on relational infrastructure that is currently neither trained for nor monitored.

Our studies of community-based crisis responses revealed the same pattern outside formal health care institutions. Returning to the Cobourg Community Centre mass vaccination clinic case that opened this paper, coordination emerged through improvisation across volunteers, clinicians, municipal staff, and community organisations.[3,4] The clinic delivered hundreds of vaccinations per day at speed and scale, despite the absence of a formal chain of command or

standardised infrastructure. The clinic's apparent smoothness was itself the signal, as informal leadership and relational trust had quietly replaced the formal coordination infrastructure that was never built. The clinic did not collapse; it closed having met its targets. What remained largely unexamined was what it took to sustain that level of adaptive action day after day and how vulnerable the system would have been had demands continued to escalate.

Across these cases (see Boxes 1 and 2 and opening story), a common pattern emerged: Performance remained acceptable while the resources sustaining it became increasingly concentrated and difficult to replenish. The apparent smoothness of the work often concealed growing dependence on particular relationships, forms of expertise and ongoing adaptive effort.

Seen through the lens of Brittle Threshold, such patterns make threshold proximity empirically visible. They show how systems can continue to function while quietly exhausting the relational, cognitive and temporal resources that make that functioning possible. In this way, these empirical cases do more than illustrate adaptation; they reveal how adaptive success itself can be read as information about system limits.

5 | THREE REASONS TO TAKE ADAPTIVE SUCCESS SERIOUSLY AS A WARNING SIGN

Brittle Threshold offers a way of interpreting adaptive success when the quiet and invisible work sustaining it is accumulating and approaching its limits. Its value lies in what it translates, what it makes visible as evidence and what it unsettles about how adaptation is morally interpreted in educational and practice contexts.

5.1 | Proposing a vocabulary for what adaptive success conceals

One contribution of Brittle Threshold is to provide a vocabulary for recognising a condition that often goes unnamed while systems continue to function. In health professions education, when teams manage to 'make it work', that success is often celebrated as evidence that the system is coping well. Brittle Threshold names what gets obscured in that moment: the ways our interpretations of success can hide how close the system is to its limits.

Over time, this interpretive pattern can produce what Diane Vaughan described as the *normalisation of deviance*, where risky workarounds gradually become accepted as the expected standard of performance.[31,32] Brittle Threshold reframes these moments as occasions for further inquiry rather than confirmation that coping is sufficient. What appears as adaptive success becomes a signal of threshold proximity—prompting questions about what the system is resting on to sustain performance and how close it may be to saturation. By naming the zone in which care and learning are maintained while adaptive capacity is being exhausted, Brittle Threshold gives researchers, educators and leaders a way to recognise and discuss the social and relational manifestations of adaptive strain that often remain difficult to articulate before breakdown forces attention.

5.2 | Shifting what counts as evidence

How we study adaptation matters as much as what we study. Brittle Threshold directs attention toward the conditions that sustain performance while systems continue to function.

Gittell's theory of relational coordination helps specify what is being consumed.[33] Effective coordination under conditions of high interdependence, uncertainty and time pressure depends on relationships, shared goals, shared knowledge and mutual respect—relational conditions that must be actively built and sustained. These features are what make coordinated action possible in the first place. When informal coordination accumulates and roles stretch beyond their formal boundaries, we are therefore not simply observing extra effort. We are observing the erosion of exactly this relational infrastructure.

While the precise location of a threshold cannot be known in advance, increasing proximity to this limit may become visible through recurring patterns in everyday work. In our own studies, these patterns included nurses simultaneously functioning as clinician, ward clerk, registrar, and laboratory technician because support roles were unavailable; experienced staff managing clinical situations outside their usual scope because colleagues were already committed elsewhere; senior leaders spending increasing amounts of time maintaining relationships and resolving issues informally rather than through organisational structures; and teams relying on personal networks, text messages and tacit understandings to coordinate work across shifting boundaries. Other manifestations included difficulties retaining or onboarding new staff because essential aspects of the work depended on local knowledge that could not easily be taught and cultures in which individuals felt unable to signal limits because continued adaptation had become an expectation of professionalism. None of these patterns indicate imminent failure on their own. Rather, they suggest that performance is being sustained through ongoing compensatory effort and that adaptive capacity may be becoming increasingly saturated.

By treating these features as data rather than background conditions, Brittle Threshold supports forms of inquiry that can identify vulnerability before collapse occurs. It makes it possible to study limits prospectively rather than retrospectively and to learn from success without assuming it is sustainable.

5.3 | Interrupting the moralisation of adaptation

In health professions education, adaptation is both technical and moral. Resilience, responsibility and stoicism are deeply embedded in training cultures.[34] This moral undercurrent operates through the hidden curriculum[35]: the informal transmission of values and expectations that shape professional identity beyond formal instruction. Within this hidden curriculum, the capacity to 'make it work' despite

systemic gaps becomes a marker of worth.[36] This way of thinking is captured by the familiar adage, 'if it ain't broke, don't fix it'. As long as performance remains acceptable, there is little incentive to ask what that performance is depending on.

Brittle Threshold offers a way to unsettle this moral undercurrent without devaluing adaptive work. By framing adaptation as information about system strain rather than as evidence of individual virtue, it shifts responsibility away from persons and back toward the system. Endurance is no longer read as professionalism but as a structural condition that systems may be relying on, often implicitly, to compensate for misalignment between expectations and support.[20,28]

This reframing is particularly important in educational settings, where learners and early-career clinicians may internalise expectations of limitless adaptability without having the authority to alter the conditions that make such adaptation necessary.[37] Brittle Threshold creates conceptual space to ask not only whether people are coping but also whether systems are using that coping as information to change the conditions that make it necessary.

5.4 | Practical implications

Brittle Threshold has practical implications for researchers, educators and leaders. For researchers, it expands what counts as evidence of system functioning by directing attention to the hidden work sustaining performance: who is taking on multiple roles, where coordination depends on personal relationships rather than formal structures and which individuals have become essential for holding the work together. For educators, it provides a language for examining adaptation without automatically celebrating it. Rather than treating flexibility, improvisation or resilience as straightforward markers of competence, educators can ask what conditions made those adaptations necessary and what they reveal about the demands being placed on learners, supervisors and teams. For leaders, it shifts attention from outcomes alone to the mechanisms producing those outcomes. A service may continue meeting targets, a team may continue delivering care and a training programme may continue functioning effectively while increasingly relying on a handful of people to bridge gaps and absorb work that formally belongs elsewhere in the system. The central question therefore moves away from whether performance is being maintained and toward what is currently sustaining it and how long those supports can reasonably be expected to hold. Across all three groups, Brittle Threshold encourages a shift from asking, 'Is the system working?' to asking, 'What is the system drawing upon to keep working?'

Although the examples presented here emerge largely from crisis contexts, Brittle Threshold is not limited to periods of acute disruption. The dynamics described in this paper can also arise in everyday clinical and educational settings when chronic workforce shortages, growing service demands, fragmented systems or resource constraints require individuals and teams to absorb increasing amounts of coordination work to maintain performance. Similar dynamics may also be found in other settings characterised by sustained pressure and constrained resources, including humanitarian response, disaster recovery, community services and other forms of complex collective work. The concept is therefore intended not only as a way of understanding adaptation during crises but also as a lens for recognising how vulnerability can accumulate within systems that appear to be functioning normally.

6 | CONCLUSION

In this paper, I proposed Brittle Threshold as a sensitising concept for recognising when continued success may conceal growing vulnerability. By directing attention to the period before breakdown, the concept provides a vocabulary for examining what successful performance is drawing upon and what that success may be obscuring. Its contribution is not to predict when systems will fail but to make visible a condition that is often difficult to discuss while systems are still functioning. What might we learn by asking, earlier and more explicitly, when work has come to depend on endurance rather than on the systems intended to support it?

AI DISCLOSURE

Claude (Anthropic) was used during the preparation of this manuscript to support editing and refinement of language. Specifically, the author used Claude to workshop abstract drafts, explore phrasing alternatives, create a conceptual figure and tighten prose for concision and flow. All conceptual development, argumentation and final editorial decisions were made by the author.

AUTHOR CONTRIBUTIONS

Sayra M. Cristancho: Conceptualization; investigation; writing—original draft; writing—review and editing.

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The author declares no conflict of interest.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

ETHICS STATEMENT

Ethics approval was not applicable for this manuscript as no data were collected.

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