



I'm Will Gallego, a software engineer. This is typically where I tell you places I've worked and give all sorts of bona fides, but I won't. Instead, I'll tell you I'm average. Mediocre folks, like me, pick boring technology that powers the internet and makes sure things just work.

I do love learning about how things work, though, and not just how the software in our systems interact. New languages, new technologies evolve and deprecate for something new to follow. What stays is how people work within these socio-technical systems.



Right off the bat, **I want to make a bet.** I'm going to say by the end of this talk, you'll all be able to go back to your jobs and do just a little bit of Resilience Engineering. **That's a lot, and you may not realize what that means.** I don't think you need to master it - and I don't believe anyone ever has. I will say that **once you fall through the looking glass**, you won't look at your systems the same. And considering how talented, how skilled, and how much you all here are wanting to learn, I think it's very doable.

Resilience is Adapting to the unexpected

As best I can, I'm going to **avoid wordy definitions**, but I do **need grounding when I say "Resilience"**. It will be **incomplete**, but that's ok. For the purposes here, we're going to say **resilience is adapting to the unexpected to keep your system stable**. Entire books written by preeminent folks in this field do a better job. I'll also say the Venn diagram of their definitions aren't a perfect circle, either, so I'm ok with that as a rough estimate. People, adapting in their socio-technical systems, is resilience.

But you need people to do this.

**Adaptive Capacity is
developing an adaptive system,
not the adaptation itself**

Additional clarity - **fixing the thing, or even making the change on the fly, is not the same as adaptive capacity.**

Example: You **detour from your runbook during an incident.** The adaptation is the work around. The **adaptive capacity is the resources that allow you to make that decision, to develop an alternative, and to work through that in process.** That can be the **experience** you've developed, coworkers looking to **assist in reviewing,** and any **other change in expected process.**

Let's think of something practical that anyone with tenure has dealt with: **Re-orgs. Priorities, bands of comms, roadmaps and ownership of projects.** Can we say our next failure was influenced by that? Maybe. Adaptive Capacity plays into managing these gaps.



On Magic

A quick story before we get further. Favorite book series, Kingkiller Chronicle. Master Elodin, who knows the hidden names of fire and water and stone and all sorts of things in the world and therefore has control over them opens up a lesson. **“We must understand things that are beyond our understanding. How can it be done?”** Will throw a rock in 15 minutes, where would you hand need to be to catch it. Best students in the University fail. Elodin calls an 8 year old boy, says “Catch!”, and the boy succeeds in less than a second. How? **We’re constantly processing so much more, the unpredictable and the unknown. This is key to finding the signals to Resilience to improve upon it.**

Beyond Incidents and Investigations

Part of this “**seeing the invisible**” comes from **knowing where to look**. So much of our focus is on incidents and the investigations after. It makes sense - they’re very clear delineations of a part of our socio-technical system, and they’re critical to much of our learning. I’d like us to **look at the every day as well, the invisible work we do that prevents so many more failures, or minimizes** them from becoming full on outages, **without waiting for the next big explosion**. This is exceptionally difficult, because there’s so much information to constantly take in and only so much time. We also want to **understand when we’re *approaching saturation***, at risk of capacity. For folks who love retrospectives, though, near misses and *successful* projects also make useful inflection points.



And this is the challenge before us. How are we, individually sure but hopefully collectively, **gaining insights such that we can adequately gauge where best to invest our time and energy.** Performance is **more than just removing all the errors.**

Gary Klein: **How do we trigger insights**, what interferes, and what fosters them

This includes freeing people to be able to think such as **reducing fatigue (seeking adaptive capacity!), letting ideas form** without worrying about putting them into words too quickly, and **validating the ideas** (an A/B experiment, for example).

Intuitions - patterns already learned

Insights - discovering new patterns

Strengthening Adaptive Capacity

We want to be able to be adaptive, strengthen AC - how? **Networks and sharing**. A major portion of the adaptive capacity of our socio-technical systems is leveraging the networks we're part of. Part of that is **sharing expertise - as we're developing it, in moments of insights, and when it's been established**.

Understanding and exploring ways of discovering where the edge of failure exists in our systems before deviating into it. Try

- Asking what **toilsome** tasks folks avoid
- Reviewing **unfrequented code paths**, the dark parts of our codebase we're afraid to venture into
- Look at **features with multiple owners** (requiring high coordination)
- Discuss **support coverage** - both on call *and* customer support teams

Describing and mapping the pressures, potential outcomes, hazards, and opportunities that define the problem space of a real work domain

Sustaining Adaptive Capacity

Gaining AC isn't enough - it needs continual **renewal**. It's not enough to have a "**hack week**" for adaptive capacity. **Victim of own success** - it needs to explore new areas, as **previous adaptations become existing patterns** of our system as we gain the ability to react, the system grows around us (new customers, differing business environments), which means our **mental models rapidly deteriorate**.

Only practitioners in the system, at the edge, can do this, it can't be done elsewhere

How do we keep up?

- Let someone **less experienced** take the helm during an incident, shifting technical lead in discussions or project planning, who may:
 - be **slower** to respond, **decisions that end in failure** or too risky, or use **unorthodox bands of communications**
- Outwardly **talking about how you determine risk**, a shared negotiation as we each wrestle with our differing experience
- Knowing what it's like when you're destroying your **institutionalized knowledge**, such as **mass layoffs** which force employees into **indecisiveness or face firing for not making the safest decision possible**
- Look at **high risk, repetitive work** (such as a db schema change)

Graceful Extensibility

Systems displaying resilience don't break immediately. Understanding the approach to edges of success lets us "stretch" our adaptive capacity to continue to tolerate increased disturbances without collapse. Dr. David Woods coined this as **Graceful Extensibility**. **Boundary is not fixed either, so we must continue to monitor and adjust - making GE dynamic.**

Extension people give can plaster over failures in the system (Woods' **law of fluency**). **Expertise hides effort.** How do we manage?

Story: Engineer responds very quickly to customer requests, goes on PTO, requests go unfulfilled. Failure mode!

What **coordination is being handled regularly** - and how do we introspect on that?

"**Coordination** often involves **conflicting interests, goals, and risks**"

"For this reason, coordination often has well-defined criteria (the rules) that constrain decision making"

Keeping capacity for folks. When do you tell people not to join an incident, to not work late, to not join a project already past due?



When do we come to an agreement that we've **put too much work** into researching this?

We can't prepare for everything, we can't share everything. What should we focus on?

- What **scares you the most**?
- What do you have the **most confidence in**?

We work on building adaptation in our system as a response to handling risk. **Risk and Safety are subjective negotiations, shared and individually, based on our interpretation of the system.** We'll often pull back on this uncertain investment when we feel "safe enough"

Efficiency vs. Thoroughness

We limit ourselves, especially over time, because **inherent pressures in our system (produce more/faster/better) pull us away** from this thoroughness. **Anomalous events (incidents, near misses, notable wins, inefficiencies)** are how we continue this dynamic motion of trending between Efficiency and Thoroughness. We develop patterns, heuristics, and shortcuts until they no longer work, then reevaluate.

A fantastic book on this, the ETTO Principle, goes into much more detail.

What's your short hand, your communication paths that in a small bandwidth convey a lot of info?

General ones like eyes when reviewing or a check mark completing a task. What subtle, more nuanced reactions do you have for your organizations as you develop new patterns?

Here's a tough trade off - I'm asking you all to think about RE topics, which will get lodged in your brain (hopefully) and have you look at your work in new ways. But, in doing so, there are tasks that require your focus that will have to fight for this. We don't know if this is worth it

(The same can be said about conferences...)



We can't list all the places, they're **for all practical purposes infinite**. And what we've talked about **so far feels reactive**. That's because it is - we won't know for sure where resilience is manifesting until after. **Adaptation is a response to surprise**.

But there are common threads to these places and one way is to **understand common structure between them**.



Desire Path

What's the ordinary work that crosses boundaries? Where do the boundaries guide and where do we find *new* paths?

Need to have a conversation with Marketing for the upcoming launch

Types: **Spatial** (in person/remote/hybrid or even where in floor plan), **Temporal** (timezones, oncall), **Professional/Organizational** (title, team structure)



Signs and Portents

Language and communication we're using can also highlight

"I can keep going", failure modes that lead to burn out (a brittle system) vs. giving yourself an exit strategy that allows for flexibility

Asking experts to walk you through their strategies, **on particular uses of tooling and introspection of systems (shortcuts/patterns)**

Giving folks a chance to communicate and then act on **where in the system they keep checking** (Slack channels, particular teams)



I've got an eye for where to look, but which ones are worthy, how do I build confidence in that work? We should be looking for expressions of resilience (where people adapted) and work back from sources, which is why incidents are so prevalent. But it's not just the incident, it's everything leading up to it.



I won't talk about many areas of AI - ethics, conservation of resources, etc. but I will focus on AI within Resilience, notably in your retrospectives. Gen AI can't generate insights and it can't adapt.

- LLMs have no concept of socio-technical graphs and can't understand relationships between people.
- Hallucinating facts with data will give you only the responses that *sound* like answers, because they're designed to be "truth-like"
- AI can only take what exists and remix it. It doesn't generate a new point of view, lacking experience
- Computers can never be held accountable, so you can't have a blame aware retrospective



So we've looked at a whole bunch of ways to view Resilience and hopefully given folks some things to consider how you might approach seeking out new forms of it. But it's challenging - for experts as well as neophytes, when so much of the system is constantly changing from underneath us. I want to emphasize it's ok to fail, even in this work about failure - that's how we get better after all. And don't worry, I've gotten up on stage and gotten things wrong, in recorded talks, but they still invite me back.



As we close, taking time to observe. Vonnegut, one of my favorite authors, suggested we frequently stop and think to ourselves “If this isn’t nice, I don’t know what is.” I’d like us to do the same with Resilience, to know we can’t see it all but when we do to actively point it out. So, to steal from a talk he gave 20 years ago, pause and think to an incident where you were frazzled, at your end, and someone shared a bit of their extra capacity or expertise to help you out. Now, I’d like you all to think “
(Alternate Title: “If this isn’t nice...”)

Video

[REdeploy 2019: A Few Observations on the Marvelous Resilience of Bone & Resilience Engineering, Dr. Richard Cook](#)

[Velocity 2012: How Complex Systems Fail, Dr. Richard Cook](#)

[Velocity NY 2013: Resilience In Complex Adaptive Systems, Dr. Richard Cook](#)

[DevOpsDays DC 2021: Resilience Engineering Panel, Dr. David Woods, Dr. Laura Maguire, John Allspaw](#)

[QCon NY, 2024: Resilience Hides in Plain Sight, John Allspaw](#)

Papers

[Four concepts for resilience and the implications for the future of resilience engineering, Dr. David Woods](#)

[The theory of graceful extensibility: basic rules that govern adaptive systems, Dr. David Woods](#)

[Four concepts for resilience and the implications for the future of resilience engineering, Dr. David Woods](#)

Books

[The ETTO Principle: Efficiency-Thoroughness Trade-Off, Dr. Erik Hollnagel](#)
[Seeing What Others Don't, Gary Klein](#)

Misty Mountains - <https://www.pexels.com/photo/fog-covering-the-mountains-and-hills-6874983/>
Poker chips - <https://www.pexels.com/photo/blue-green-and-purple-poker-chips-39856/>
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