Uptime Institute® | RESEARCH

Solving the Issue of Complex Systems Failure

FOCUS I JUNE 2018 | UII report 14
By Kevin Heslin, chief editor, Uptime Institute

While conventional wisdom blames human error for the majority of outages, as the Uptime Institute has long maintained, those failures are incorrectly attributed to front-line operator errors, rather than management mistakes.

Indeed, when John MacLean, author of numerous books, including *Fire on the Mountain* (Morrow 1999), appeared at an Uptime Institute Network meeting, it kicked off a broader discussion about rebranding high-reliability organizations (those that require high-availability IT operations) as high-risk organizations–one that is tasked with averting or minimizing impact and that gages success in a non-binary fashion (system is up/system is down).

A new book, *Meltdown* by Chris Clearfield and András Tilcsik, provides an alternative explanation for the source of systems errors. Like Uptime Institute, the authors attribute these errors to management mistakes, but they also offer a number of innovative solutions for addressing organizational flaws that ineluctably lead to management mistakes.

Some of these solutions, based on the social sciences rather than on business or engineering curricula, will be counterintuitive to IT operations and C-suite executives alike. Clearfield and Tilcsik make a convincing case that diverse leadership is essential to avoiding the groupthink that permeates many organizations and creates a layer of management risk.

Keep in mind that 70% of respondents to the 2018 Uptime Institute Data Center Survey believe that lack of women in the sector's workforce is not a threat to their businesses or the industry at large. Clearfield and Tilcsik believe that a lack of industry outsiders and overconcentration of experienced professionals leads executive management to become overconfident in its own abilities and more willing to take chances than groups with more diverse expertise.

In all instances, Clearfield and Tilcsik argue for the inclusion of the outsider: individuals who are not constrained by prior participation in a project and who can independently evaluate a project without regard for team loyalty, personal attachments, internal pressures, and even budget constraints. These factors can lead to compromises that can cause a project to fail. Some data center operators might recognize that Uptime Institute's Tier Certification and M&O Stamp of Approval as meeting the criteria for outside, independent validation of project plans and construction.

In creating its 2015 paper, "Complex Systems and How They Fail," (*The Uptime Institute Journal*, vol. 6, p. 12) Uptime Institute referenced a widely cited book written by Dr. Richard I. Cook, *How Complex*

UII-14 v1.1 published June 19, 2018 last updated August 8, 2019

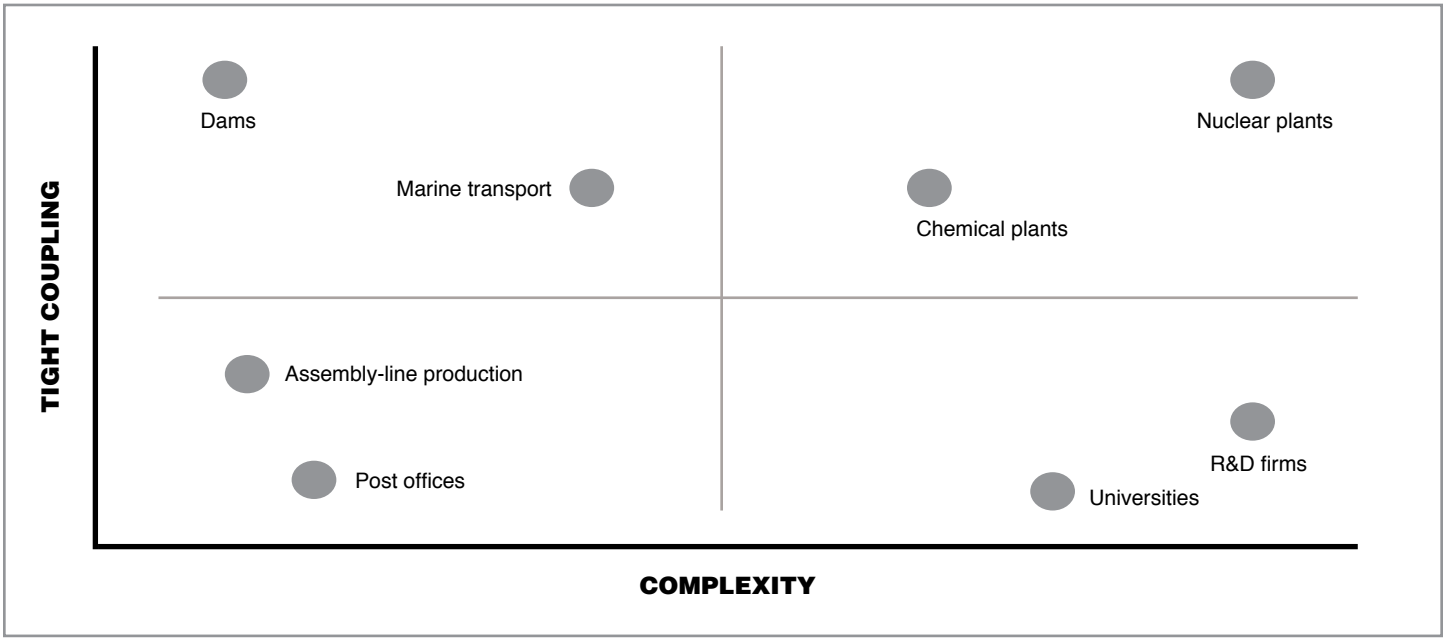
Uptime Institute® | RESEARCH

Solving the Issue of Complex Systems Failure

Systems Fail, first published in 1998. The Uptime Institute article examined the nature of complex systems and how the 18 characteristics described by Dr. Cook apply to data centers. Uptime Institute concluded that, "Human error is often cited as the root cause of many engineering system failures, yet it does not often cause a major disaster on its own. Leadership decisions and priorities that result in a lack of adequate staffing and training, an organizational culture that becomes dominated by a fire drill mentality, or budget cutting that reduces preventive/proactive maintenance could result in cascading failures that truly flow from the top down."

By contrast, Clearfield and Tilcsik rely on the scholarship of Charles "Chick" Perrow, a sociology professor who studied organizations. Perrow first became interested in catastrophes when he was appointed to a presidential committee investigating the nuclear disaster at Three Mile Island accident. He recognized, as did Uptime Institute, that accidents like the one at Three Mile Island could not be blamed on any individual, rather it was a management or organization problem.

The causes of the Three Mile Island accident, he concluded, were trivial: a combination of small failures—a plumbing problem, a stuck valve, and an ambiguous indicator light that caused the system to run amok in 13 seconds and damage the core in less than 10 minutes.



Uptime Institute® | RESEARCH

Solving the Issue of Complex Systems Failure

Critically, he concluded that nuclear facilities are complex, tightly coupled facilities (insert figure). These qualities combined means that no one individual has all the information needed to understand how a system is operating in a given moment and that the system cannot be "paused" while operators determine the state of system and the proper corrective action.

Perrow noted that automation and computerization can help manage operations, but they can also obscure what's really going on and lead to missteps during an emergency. In highly automated facilities, operators work in a "wicked" environment in which they take actions but have only indicator lights and readings to determine the outcome of the action. In many instances, operators can no longer visually confirm that an operation has taken place, rather they must rely on indicators that may be misleading.

Perrow observed that more and more systems can be described as complex and tightly coupled, adding banking, finance, and organizational reputations (because of social media) to a list that formerly encompassed only physical facilities such as nuclear plants, oil drilling platforms, jets, and space shuttles. Modern data centers certainly belong on the list. Interestingly, Uptime Institute and the authors of *Meltdown* reference some of the same accidents as examples.

Considered carefully, this means that some operators of mission critical IT must perform as though they have three complex, tightly coupled systems to manage: the data center, brand reputation, and the product or service offered by the company. Consider, for example, the effect of data center failure on airlines. After a data center failed, flights were grounded and the airline's brand suffered as a result.

Uptime Institute has convincingly made the case that data center failures could be more accurately attributed to management failures that to human error. Clearfield and Tilcsik break new ground in exploring the causes of management failures that lead to apparent human error. More importantly, they suggest solutions at the C-level or higher that many engineers and executives alike may find counterintuitive.

Clearfield and Tilcsik find evidence for their conclusions in many industries. A study of the financial industry in the aftermath of the 2008 financial crisis, for example, revealed that banks fared better when their leadership was drawn from a wide range of professions than those led by banking experts. They also note that a board (fall 2015) consisting solely of older men, including Henry Kissinger, Bill Perry, George Schultz, James Mattis, and Riley Bechtel, failed to sniff out the Theranos fraud that is still playing out in today's headlines.

More diverse boards also tend to get post better results. According to McKinsey (2015), "Companies in the top quartile for gender diversity are 15 percent more likely to have financial returns above their

Solving the Issue of Complex Systems Failure

respective national industry medians." http://www.mckinsey.com/business-functions/organization/our-insights/why-diversity-matters.

In both examples, it is argued that the 'sameness' within the leadership team led to a lack of productive conflict, which is needed to unearth genuine problems. People, it seems, no matter their station in life, tend to defer to experts and trust those they most identify with. The authors suggest that people of different backgrounds and experience levels are more likely to challenge each other's assumptions, so issues are aired most thoroughly.

Counterintuitively, the airline industry found that most crashes take place when the most experienced officer has the controls. A less experienced officer is less likely to challenge the captain at the helm, which reduces the effectiveness of the doublecheck system. The captain, however, is less likely to hesitate to question the less-experienced officer, so that both officers wind up thinking out the better course of action.

Clearfield and Tilcsik also site studies in which non-diverse panels provide the benefit of the doubt to colleagues who share the same backgrounds, in what could be considered a show of collegiality. They write, "Diversity is helpful not so much because of a unique perspective that minorities or amateurs bring to the table but because diversity makes the whole group more skeptical."

The anonymous suggestion box may be a sign that speaking up in an organization is dangerous. People must be allowed to make mistakes. Clearfield and Tilcsik warn that a danger of expert environments is the temptation to write more rules and procedures, adding unnecessary complexity to simple tasks and binding them ever closer together.

They note that leadership styles matter too. The leader who offers his or her own ideas first may foreclose genuine discussion of issues. Consensus may be achieved but only because the expert has steered the conversation and foreclosed all but a few dissenting views.

Greater diversity is just one solution to a hard-to-see problem. Without sufficient numbers, the outsider–be it the woman, the racial minority, the non-engineer or the non-banker, or the newcomer–may be overlooked or disregarded. Leadership must be expanded to include these perspectives. But it is equally important how these individuals are deployed.

Clearfield and Tilscik advocate for independent review of project decisions. Ideally, these reviewers would be drawn from outside the organization. Most importantly, they would be free of organizational biases, the need to please the project manager, or a project budget or deadline. They would include

Solving the Issue of Complex Systems Failure

a variety of perspectives, as well. In the data center industry, an Uptime Institute Tier Certification of Operational Sustainability may most closely fit the bill.

Of course, some organizations may prefer to deploy internal reviewers or ombudsmen. Generally, however, this is a difficult challenge because at some level even the most independent personalities will be drawn to please, to trust those most like themselves, and to have a financial stake in an organization or project, even if it is just through a bonus plan or stock options.

Meltdown is full of ideas for improving project management and decision making. The airline industry, for example, introduced a concept call Crew Resource Management that addressed the disparity between captain and co-captain.

The authors also discuss the concept of the pre-mortem as a way to anticipate and address failure as well as taking risk, rewarding mistakes, empowering staff, and changing leadership styles. These steps, they note, can be taken at almost any level of an organization.

Traditionalists may chafe at some of the suggestions in *Meltdown*, but the authors' assessment of traditional diversity efforts might cause some human resources officers to frown as well. While continuing to call for the additional productive conflict that diversity brings, Clearfield and Tilcsik call for organizations to re-examine their efforts to achieve greater diversity at all levels. They suggest formal mentoring programs, tracking, but not mandating, hiring diversity, and role rotation. These, and other short-term steps, can open the door to better project management and organizational decision making.

These short-term steps may be a prelude to broader measures that reduce system complexity where possible but also introduce slack (reduce tight coupling) into some systems, so operators have some ability to pause automated systems like mission-critical IT before disaster occurs.

Uptime Institute has identified the tendency to attribute failures to "human error," as an industry-wide shortcoming. In "Complex Systems and How They Fail," Uptime Institute accurately noted that data centers share many characteristics with a wide variety of complex systems, including jets, nuclear facilities, space shuttles, and deep-sea drilling platforms. Today, Clearfield and Tilcsik help the industry recognize that behaviors identified by 2018 Uptime Institute's Data Center Survey are corporate failings that prevent the industry from resolving its most important issues.