ADDITIONAL MATERIAL

There is no DORA DevOps X-Ray Assessment included with the audio version of The DevOps Handbook

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THE DEVOPS HANDBOOK

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Preface
Aha!

The journey to complete *The DevOps Handbook* has been a long one—it started with weekly working Skype calls between the co-authors in February of 2011, with the vision of creating a prescriptive guide that would serve as a companion to the as-yet unfinished book *The Phoenix Project: A Novel About IT, DevOps, and Helping Your Business Win*.

More than five years later, with over two thousand hours of work, *The DevOps Handbook* is finally here. Completing this book has been an extremely long process, although one that has been highly rewarding and full of incredible learning, with a scope that is much broader than we originally envisioned. Throughout the project, all the co-authors shared a belief that DevOps is genuinely important, formed in a personal "aha" moment much earlier in each of our professional careers, which I suspect many of our readers will resonate with.

Gene Kim

I've had the privilege of studying high-performing technology organizations since 1999, and one of the earliest findings was that boundary-spanning between the different functional groups of IT Operations, Information Security, and Development was critical to success. But I still remember the first time I saw the magnitude of the downward spiral that would result when these functions worked toward opposing goals.

It was 2006, and I had the opportunity to spend a week with the group who managed the outsourced IT Operations of a large airline reservation service. They described the downstream consequences of their large, annual software releases: each release would cause immense chaos and disruption for the outsourcer, as well as customers; there would be SLA (service level agreement) penalties, because of the customer-impacting outages; there would be layoffs of the most talented and experienced staff, because of the resulting profit shortfalls; there would be much unplanned work and firefighting so that the remaining staff couldn't work on the ever-growing service request backlogs coming from customers; the contract would be held together by the heroics of middle management; and everyone felt that the contract would be doomed to be put out for re-bid in three years.

The sense of hopelessness and futility that resulted created for me the beginnings of a moral crusade. Development seemed to always be viewed as strategic, but IT Operations was viewed as tactical, often delegated away or outsourced entirely, only to return in five years in worse shape than it was first handed over.

For many years, many of us knew that there must be a better way. I remember seeing the talks coming out of the 2009 Velocity Conference, describing amazing outcomes enabled by architecture, technical practices, and cultural norms that we now know as DevOps. I was so excited, because it clearly pointed to the better way that we had all been searching for. And helping spread that word was one of my personal motivations to co-author *The Phoenix Project*. You can imagine how incredibly rewarding it was to see the broader community react to that book, describing how it helped them achieve their own "aha" moments.

Jez Humble

My DevOps "aha" moment was at a start-up in 2000—my first job after graduating. For some time, I was one of two technical staff. I did everything: networking, programming, support, systems administration. We deployed software to production by FTP directly from our workstations.

Then in 2004 I got a job at ThoughtWorks, a consultancy where my first gig was working on a project involving about seventy people. I was on a team of eight engineers whose full-time job was to deploy our software into a production-like environment. In the beginning, it was really stressful. But over a few months we went from manual deployments

that took two weeks to an automated deployment that took one hour, where we could roll forward and back in milliseconds using the blue-green deployment pattern during normal business hours.

That project inspired a lot of the ideas in both the *Continuous Delivery* (Addison-Wesley, 2000) book and this one. A lot of what drives me and others working in this space is the knowledge that, whatever your constraints, we can always do better, and the desire to help people on their journey.

Patrick Debois

For me, it was a collection of moments. In 2007 I was working on a data center migration project with some Agile teams. I was jealous that they had such high productivity—able to get so much done in so little time.

For my next assignment, I started experimenting with Kanban in Operations and saw how the dynamic of the team changed. Later, at the Agile Toronto 2008 conference I presented my IEEE paper on this, but I felt it didn't resonate widely in the Agile community. We started an Agile system administration group, but I overlooked the human side of things.

After seeing the 2009 Velocity Conference presentation "10 Deploys per Day" by John Allspaw and Paul Hammond, I was convinced others were thinking in a similar way. So I decided to organize the first DevOpsDays, accidently coining the term DevOps.

The energy at the event was unique and contagious. When people started to thank me because it changed their life for the better, I understood the impact. I haven't stopped promoting DevOps since.

John Willis

In 2008, I had just sold a consulting business that focused on large-scale, legacy IT operations practices around configuration management and monitoring (Tivoli) when I first met Luke Kanies (the founder of Puppet Labs). Luke was giving a presentation on Puppet at an O'Reilly open source conference on configuration management (CM).

At first I was just hanging out at the back of the room killing time and thinking, "What could this twenty-year-old tell me about configuration management?" After all, I had literally been working my entire life at some of the largest enterprises in the world, helping them architect CM and other operations management solutions. However, about five minutes into his session, I moved up to the first row and realized everything I had been doing for the last twenty years was wrong. Luke was describing what I now call second generation CM.

After his session I had an opportunity to sit down and have coffee with him. I was totally sold on what we now call infrastructure as code. However, while we met for coffee, Luke started going even further, explaining his ideas. He started telling me he believed that operations was going to have to start behaving like software developers. They were going to have to keep their configurations in source control and adopt CI/CD delivery patterns for their workflow. Being the old IT Operations person at the time, I think I replied to him with something like, "That idea is going to sink like Led Zeppelin with Ops folk." (I was clearly wrong.)

Then about a year later in 2009 at another O'Reilly conference, Velocity, I saw Andrew Clay Shafer give a presentation on Agile Infrastructure. In his presentation, Andrew showed this iconic picture of a wall between developers and operations with a metaphorical depiction of work being thrown over the wall. He coined this "the wall of confusion." The ideas he expressed in that presentation codified what Luke was trying to tell me a year earlier. That was the light bulb for me. Later that year, I was the only American invited to the original DevOpsDays in Ghent. By the time that event was over, this thing we call DevOps was clearly in my blood.

Clearly, the co-authors of this book all came to a similar epiphany, even if they came there from very different directions. But there is now an overwhelming weight of evidence that the problems described above happen almost everywhere, and that the solutions associated with DevOps are nearly universally applicable.

The goal of writing this book is to describe how to replicate the DevOps transformations we've been a part of or have observed, as well as dispel many of the myths of why DevOps won't work in certain situations. Below are some of the most common myths we hear about DevOps.

Myth—*DevOps is Only for Startups:* While DevOps practices have been pioneered by the web-scale, Internet "unicorn" companies such as Google, Amazon, Netflix, and Etsy, each of these organizations has, at some point in their history, risked going out of business because of the problems associated with more traditional "horse" organizations: highly dangerous code releases that were prone to catastrophic failure, inability to release features fast enough to beat the competition, compliance concerns, an inability to scale, high levels of distrust between Development and Operations, and so forth.

However, each of these organizations was able to transform their architecture, technical practices, and culture to create the amazing outcomes that we associate with DevOps. As Dr. Branden Williams, an information security executive, quipped, "Let there be no more talk of DevOps unicorns or horses but only thoroughbreds and horses heading to the glue factory."

Myth—*DevOps Replaces Agile:* DevOps principles and practices are compatible with Agile, with many observing that DevOps is a logical continuation of the Agile journey that started in 2001. Agile often serves as an effective enabler of DevOps, because of its focus on small teams continually delivering high quality code to customers.

Many DevOps practices emerge if we continue to manage our work beyond the goal of "potentially shippable code" at the end of each iteration, extending it to having our code always in a deployable state, with developers checking into trunk daily, and that we demonstrate our features in production-like environments.

Myth—*DevOps is incompatible with ITIL:* Many view DevOps as a backlash to ITIL or ITSM (IT Service Management), which was originally published in 1989. ITIL has broadly influenced multiple generations of Ops practitioners, including one of the co-authors, and is an ever-evolving library of practices intended to codify the processes and practices that underpin world-class IT Operations, spanning service strategy, design, and support.

DevOps practices can be made compatible with ITIL process. However, to support the shorter lead times and higher deployment frequencies associated with DevOps, many areas of the ITIL processes become fully automated, solving many problems associated with the configuration and release management processes (e.g., keeping the configuration management database and definitive software libraries up to date). And because DevOps requires fast detection and recovery when service incidents occur, the ITIL disciplines of service design, incident, and problem management remain as relevant as ever.

Myth—*DevOps is Incompatible with Information Security and Compliance:* The absence of traditional controls (e.g., segregation of duty, change approval processes, manual security reviews at the end of the project) may dismay information security and compliance professionals.

However, that doesn't mean that DevOps organizations don't have effective controls. Instead of security and compliance activities only being performed at the end of the project, controls are integrated into every stage of daily work in the software development life cycle, resulting in better quality, security, and compliance outcomes.

Myth—*DevOps Means Eliminating IT Operations, or "NoOps:"* Many misinterpret DevOps as the complete elimination of the IT Operations function. However, this is rarely the case. While the nature of IT Operations work may change, it remains as important as ever. IT Operations collaborates far earlier in the software life cycle with Development, who continues to work with IT Operations long after the code has been deployed into production.

Instead of IT Operations doing manual work that comes from work tickets, it enables developer productivity through APIs and self-serviced platforms that create environments, test and deploy code, monitor and display production telemetry, and so forth. By doing this, IT Operations become more like Development (as do QA and Infosec), engaged in product development, where the product is the platform that developers use to safely, quickly, and securely test, deploy, and run their IT services in production.

Myth—*DevOps is Just "Infrastructure as Code" or Automation:* While many of the DevOps patterns shown in this book require automation, DevOps also requires cultural norms and an architecture that allows for the shared goals to be achieved throughout the IT value stream. This goes far beyond just automation. As Christopher Little, a technology executive and one of the earliest chroniclers of DevOps, wrote, "DevOps isn't about automation, just as astronomy isn't about telescopes."

Myth—*DevOps is Only for Open Source Software:* Although many DevOps success stories take place in organizations using software such as the LAMP stack (Linux, Apache, MySQL, PHP), achieving DevOps outcomes is independent of the technology

being used. Successes have been achieved with applications written in Microsoft.NET, COBOL, and mainframe assembly code, as well as with SAP and even embedded systems (e.g., HP LaserJet firmware).

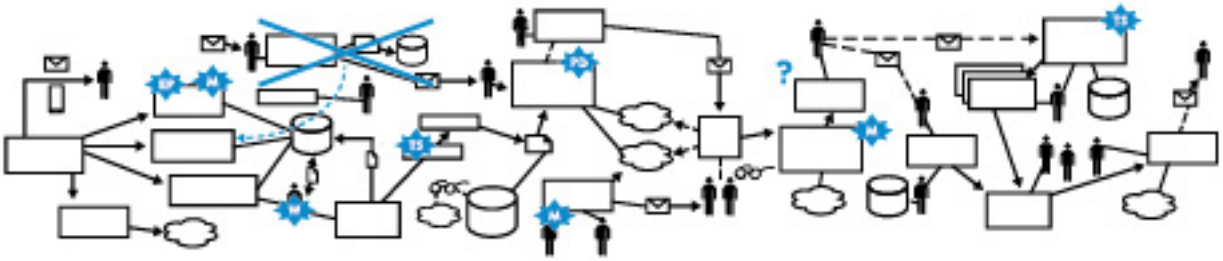
SPREADING THE AHA! MOMENT

Each of the authors has been inspired by the amazing innovations happening in the DevOps community and the outcomes they are creating: they are creating safe systems of work, and enabling small teams to quickly and independently develop and validate code that can be safely deployed to customers. Given our belief that DevOps is a manifestation of creating dynamic, learning organizations that continually reinforce high-trust cultural norms, it is inevitable that these organizations will continue to innovate and win in the marketplace.

It is our sincere hope that *The DevOps Handbook* will serve as a valuable resource for many people in different ways: a guide for planning and executing DevOps transformations, a set of case studies to research and learn from, a chronicle of the history of DevOps, a means to create a coalition that spans Product Owners, Architecture, Development, QA, IT Operations, and Information Security to achieve common goals, a way to get the highest levels of leadership support for DevOps initiatives, as well as a moral imperative to change the way we manage technology organizations to enable better effectiveness and efficiency, as well as enabling a happier and more humane work environment, helping everyone become lifelong learners—this

not only helps everyone achieve their highest goals as human beings, but also helps their organizations win.

Figures



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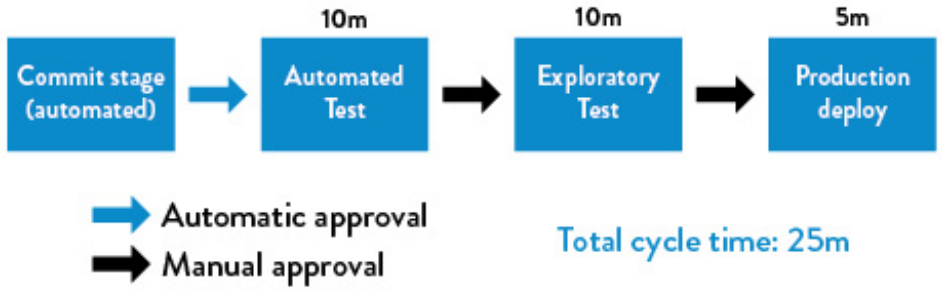

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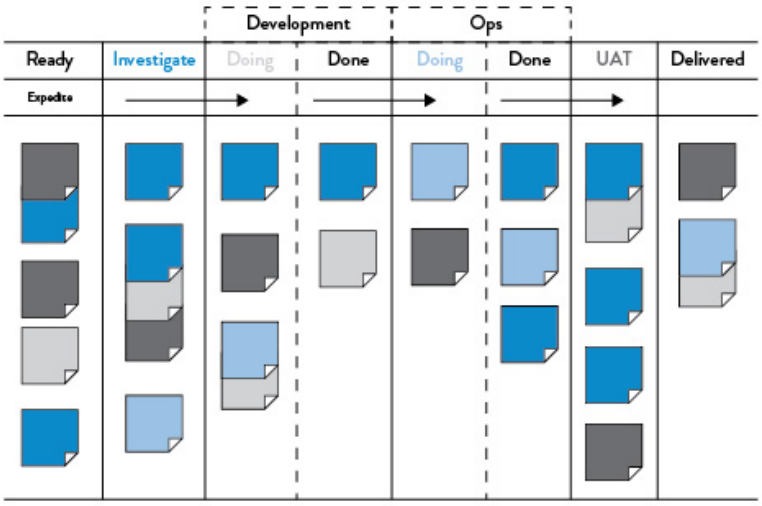

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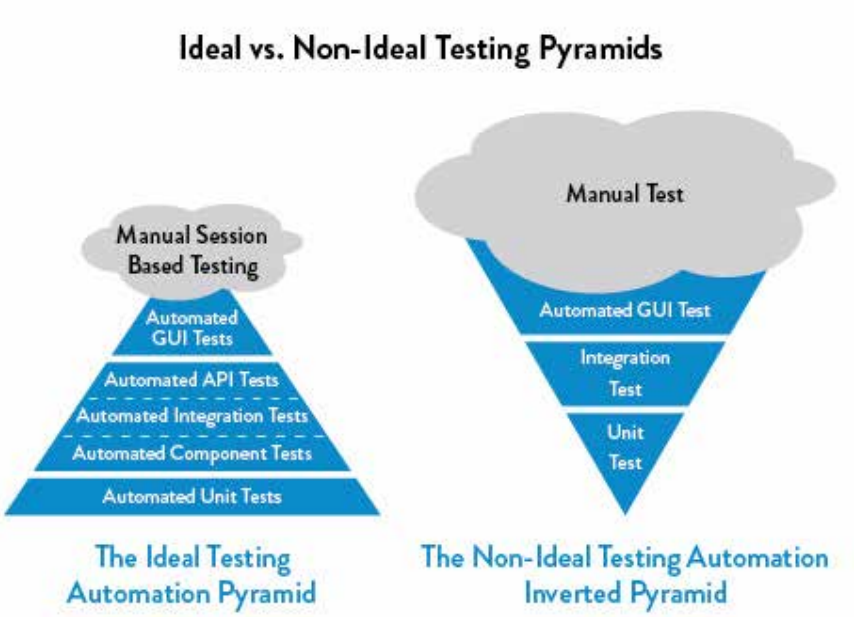

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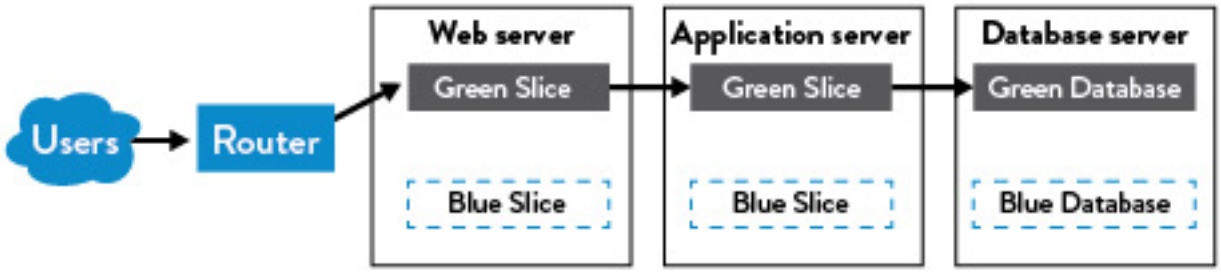

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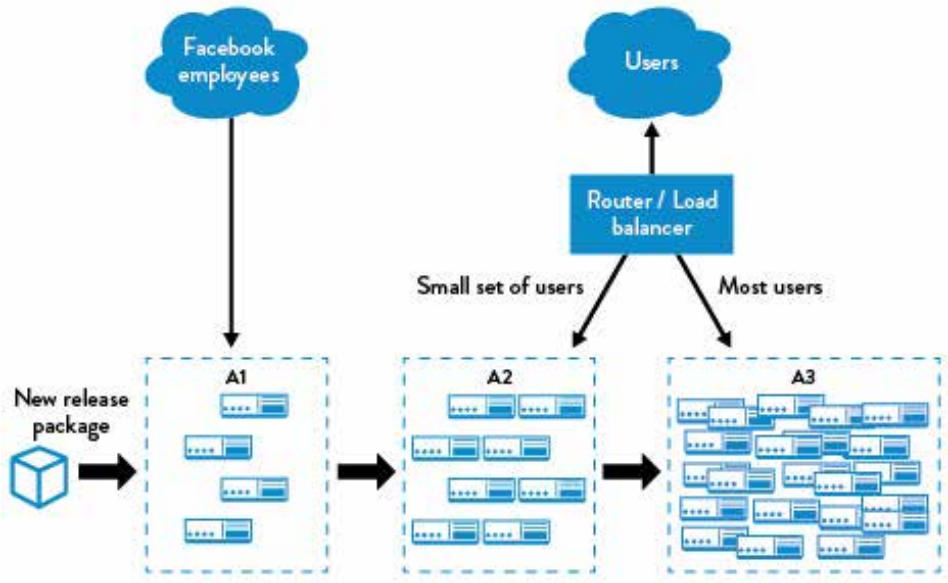

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	Pros	Cons
Monolithic v1 (All functionality in one application)	• Simple at first • Low inter-process latencies • Single codebase, one deployment unit • Resource-efficient at small scales	• Coordination overhead increases as team grows • Poor enforcement of modularity • Poor scaling • All-or-nothing deploy (downtime, failures) • Long build times
Monolithic v2 (Sets of monolithic tiers: "front end presentation," "application server," "database layer")	• Simple at first • Join queries are easy • Single schema, deployment • Resource-efficient at small scales	• Tendency for increased coupling over time • Poor scaling and redundancy (all or nothing, vertical only) • Difficult to tune properly • All-or-nothing schema management
Microservice (Modular, independent, graph relationship vs. tiers, isolated persistence)	• Each unit is simple • Independent scaling and performance • Independent testing and deployment • Can optimally tune performance (caching, replication, etc.)	• Many cooperating units • Many small repos • Requires more sophisticated tooling and dependency management • Network latencies

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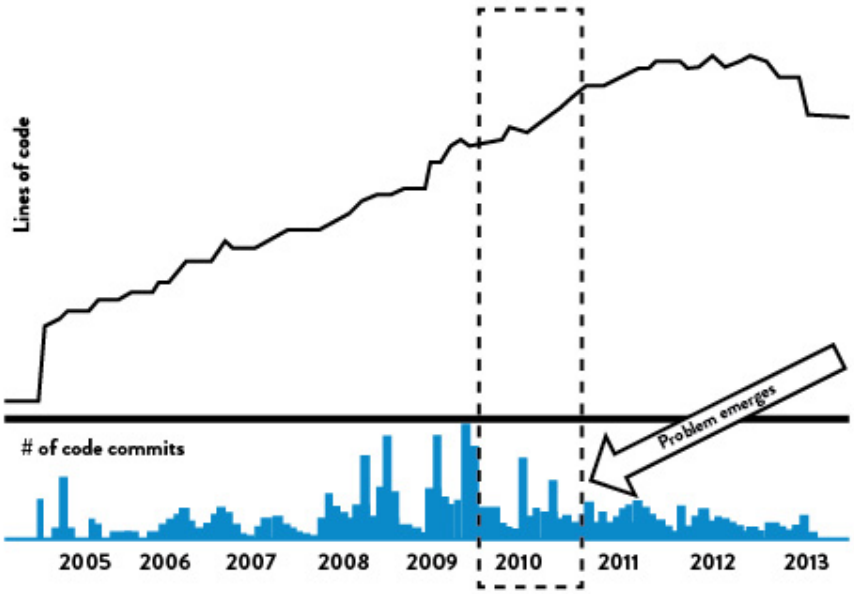

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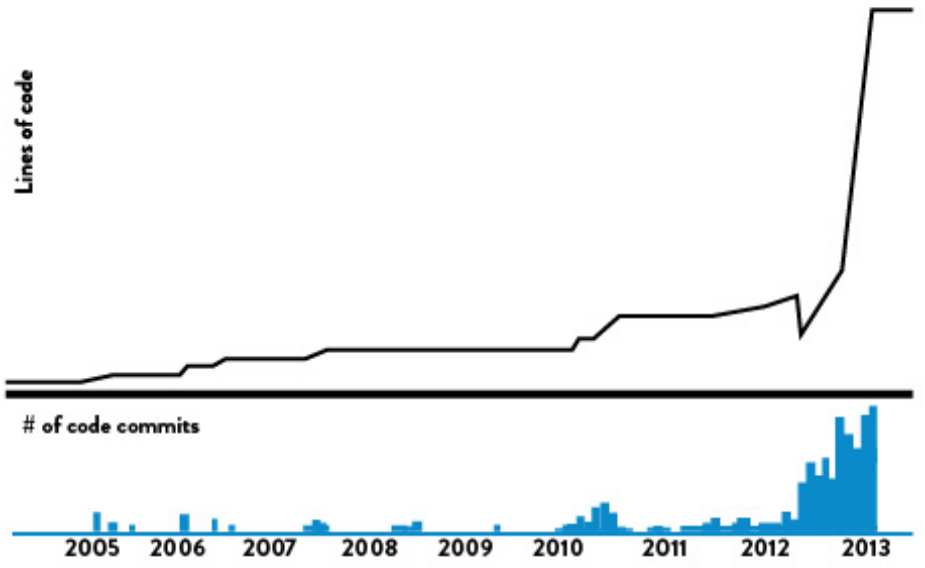

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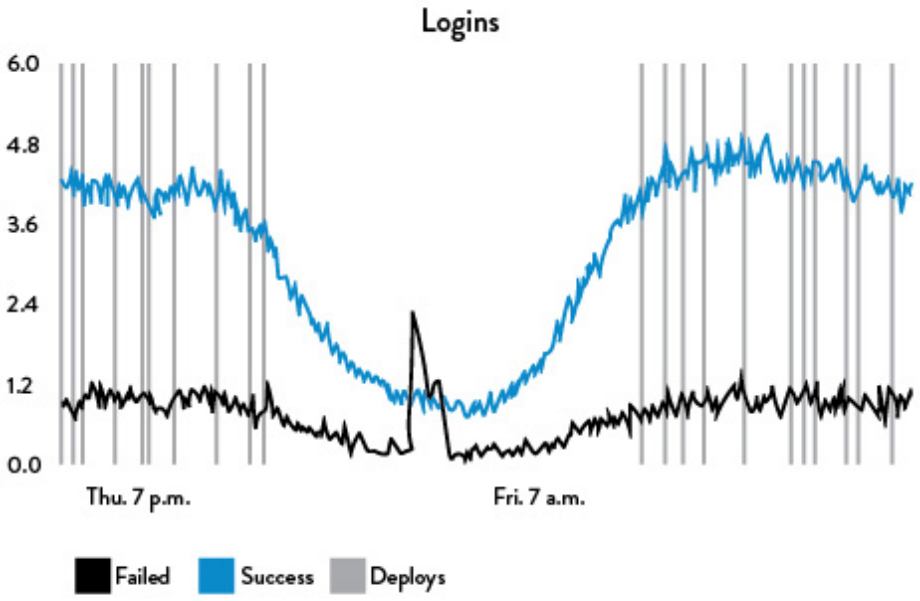

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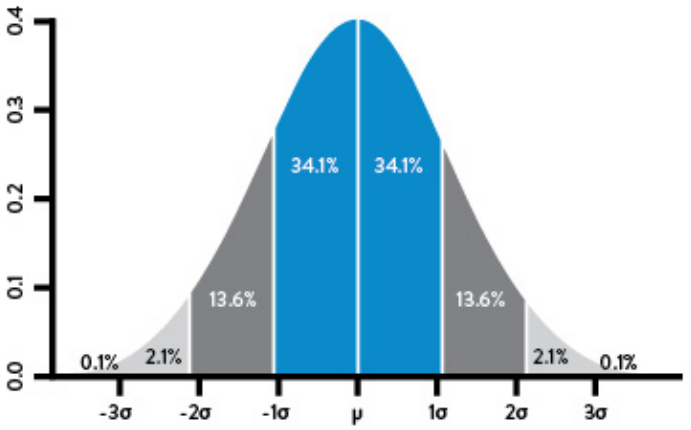

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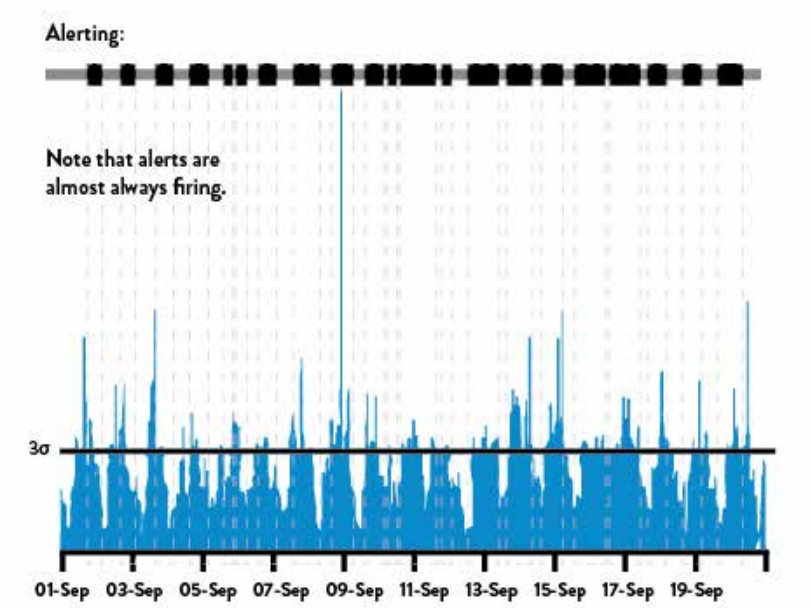

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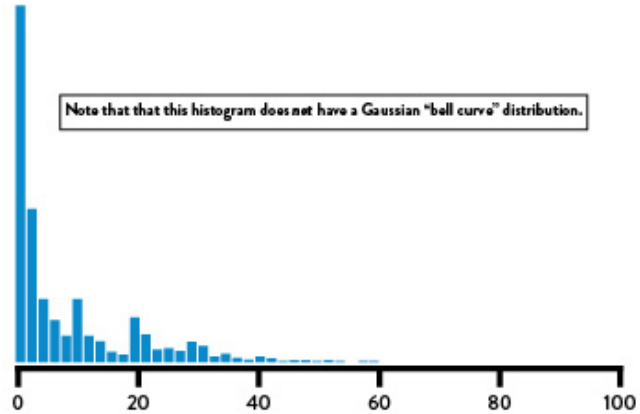

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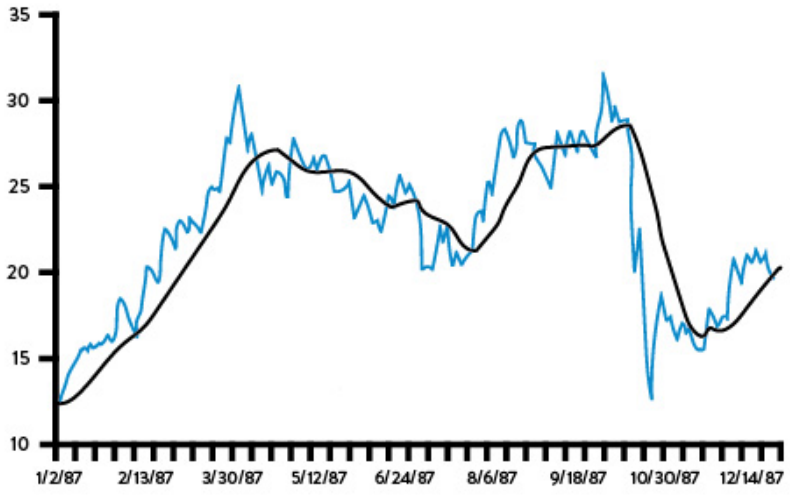

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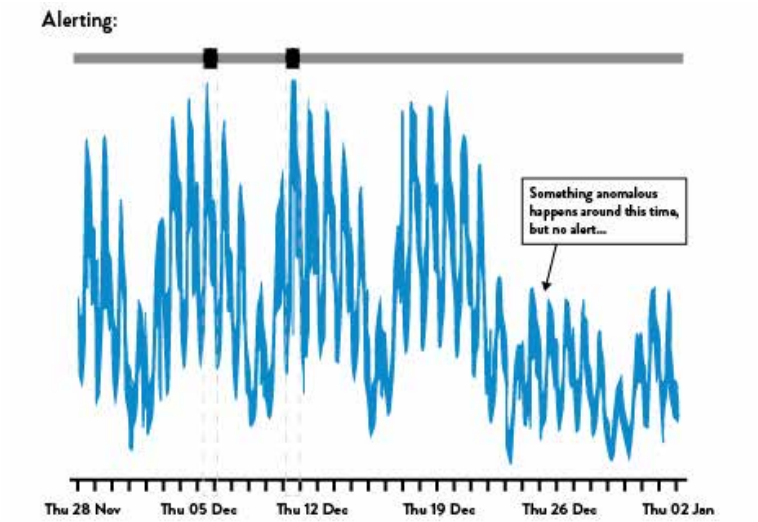

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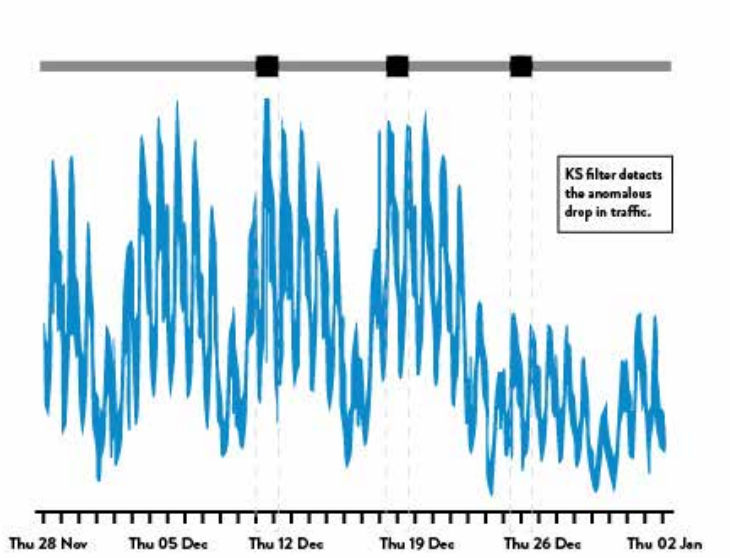

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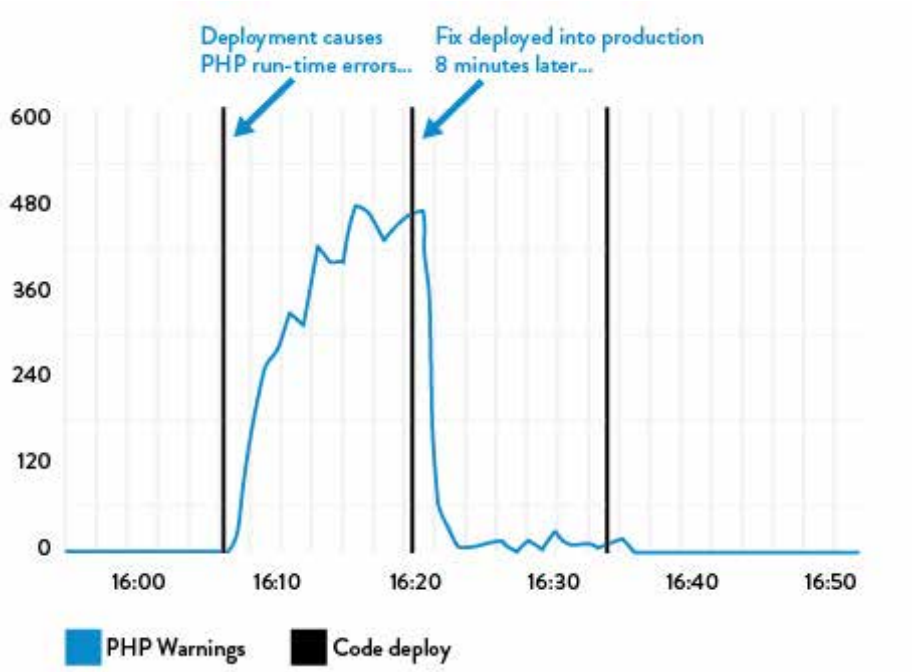

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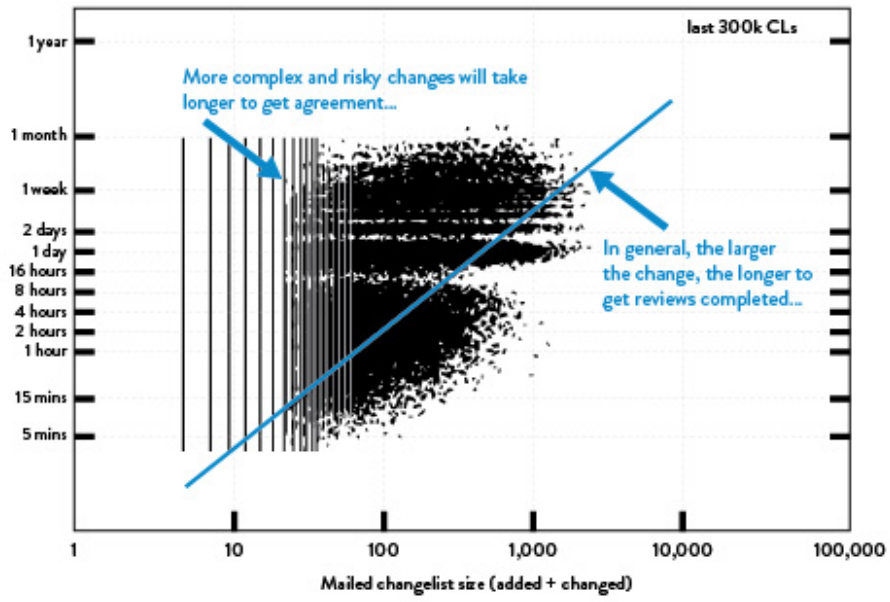

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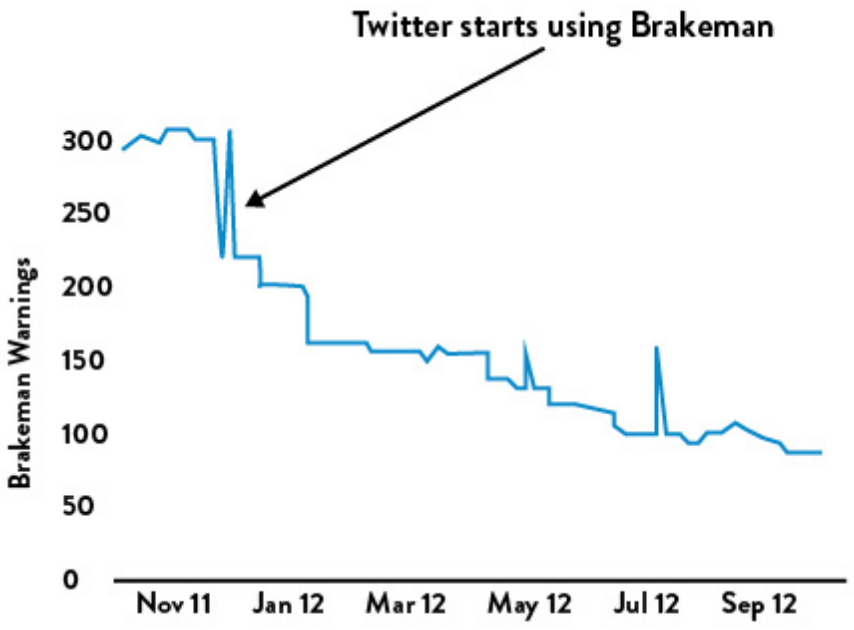

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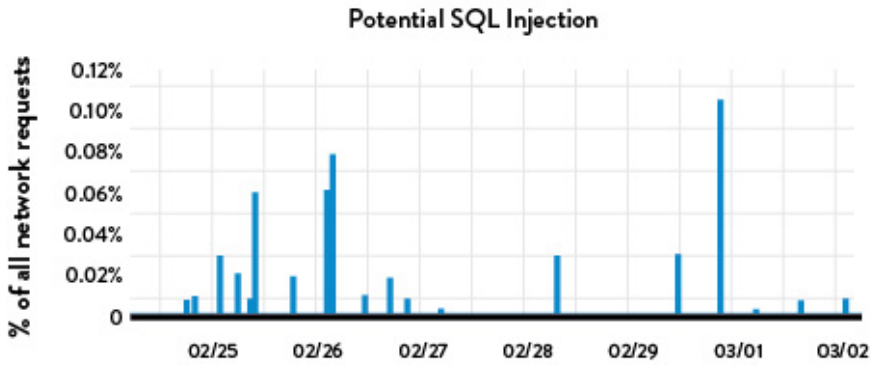

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Appendices

APPENDIX 1 THE CONVERGENCE OF DEVOPS

We believe that DevOps is benefiting from an incredible convergence of management movements, which are all mutually reinforcing and can help create a powerful coalition to transform how organizations develop and deliver IT products and services.

John Willis named this "the Convergence of DevOps." The various elements of this convergence are described below in approximate chronological order. (Note that these descriptions are not intended to be an exhaustive description, but merely enough to show the progression of thinking and the rather improbable connections that led to DevOps.)

THE LEAN MOVEMENT

The Lean Movement started in the 1980s as an attempt to codify the Toyota Production System with the popularization of techniques such as Value Stream Mapping, kanban boards, and Total Productive Maintenance.

Two major tenets of Lean were the deeply held belief that lead time (i.e., the time required to convert raw materials into finished goods) was the best predictor of quality, customer satisfaction, and employee happiness; and that one of the best predictors of short lead times was small batch sizes, with the theoretical ideal being "single piece flow" (i.e., "1x1" flow: inventory of 1, batch size of 1).

Lean principles focus on creating value for the customer—thinking systematically, creating constancy of purpose, embracing scientific thinking, creating flow and pull (versus push), assuring quality at the source, leading with humility, and respecting every individual.

THE AGILE MOVEMENT

Started in 2001, the Agile Manifesto was created by seventeen of the leading thinkers in software development, with the goal of turning lightweight methods such as DP and DSDM into a wider movement that could take on heavyweight software development processes such as waterfall development and methodologies such as the Rational Unified Process.

A key principle was to "deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale." Two other principles focus on the need for small, self-motivated teams, working in a high-trust management model and an emphasis on small batch sizes. Agile is also associated with a set of tools and practices such as Scrum, Standups, and so on.

THE VELOCITY CONFERENCE MOVEMENT

Started in 2007, the Velocity Conference was created by Steve Souders, John Allspaw, and Jesse Robbins to provide a home for the IT Operations and Web Performance tribe. At the Velocity 2009 conference, John Allspaw and Paul Hammond gave the seminal "10 Deploys per Day: Dev and Ops Cooperation at Flickr."

THE AGILE INFRASTRUCTURE MOVEMENT

At the 2008 Agile Toronto conference, Patrick Dubois and Andrew Schafer held a "birds of a feather" session on applying Agile principles to infrastructure as opposed to application code. They rapidly gained a following of like-minded thinkers, including John Willis. Later, Dubois was so excited by Allspaw and Hammond's "10 Deploys per Day: Dev and Ops Cooperation at Flickr" presentation that he created the first DevOpsDays in Ghent, Belgium, in 2009, coining the word "DevOps."

THE CONTINUOUS DELIVERY MOVEMENT

Building upon the Development discipline of continuous build, test, and integration, Jez Humble and David Farley extended the concept of continuous delivery, which included a "deployment pipeline" to ensure that code and infrastructure are always in a deployable state and that all code checked in to truck is deployed into production.

This idea was first presented at Agile 2006 and was also independently developed by Tim Fitz in a blog post titled "Continuous Deployment."

THE TOYOTA KATA MOVEMENT

In 2009, Mike Rother wrote *Toyota Kata: Managing People for Improvement, Adaptiveness and Superior Results*, which described learnings over his twenty-year journey to understand and codify the causal mechanisms of the Toyota Production System. *Toyota Kata* describes the "unseen managerial routines and thinking that lie behind Toyota's success with continuous improvement and adaptation... and how other companies develop similar routines and thinking in their organizations."

His conclusion was that the Lean community missed the most important practice of all, which he described as the Improvement Kata. He explains that every organization has work routines, and the critical factor in Toyota was making improvement work habitual, and building it into the daily work of everyone in the organization. The Toyota Kata institutes an iterative, incremental, scientific approach to problem-solving in the pursuit of a shared organizational true north.

THE LEAN STARTUP MOVEMENT

In 2011, Eric Ries wrote *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*, codifying his lessons learned at IMVU, a Silicon Valley startup, which built upon the work of Steve Blank in *The Four Steps to the Epiphany* as well as continuous deployment techniques. Eric Ries also codified related practices and terms including Minimum Viable Product, the build-measure-learn cycle, and many continuous deployment technical patterns.

THE LEAN UX MOVEMENT

In 2013, Jeff Gothelf wrote *Lean UX: Applying Lean Principles to Improve User Experience*, which codified how to improve the "fuzzy front end" and explained how product owners can frame business hypotheses, experiment, and gain confidence in those business hypotheses before investing time and resources in the resulting features. By adding Lean UX, we now have the tools to fully optimize the flow between business hypotheses, feature development, testing, deployment, and service delivery to the customer.

THE RUGGED COMPUTING MOVEMENT

In 2011, Joshua Corman, David Rice, and Jeff Williams examined the apparent futility of securing applications and environments late in the life cycle. In response, they created a philosophy called "Rugged Computing," which attempts to frame the non-functional requirements of stability, scalability, availability, survivability, sustainability, security, supportability, manageability, and defensibility.

Because of the potential for high release rates, DevOps can put incredible pressure on QA and Infosec, because when deploy rates go from monthly or quarterly to hundreds or thousands daily, no longer are two week turnaround times from Infosec or QA tenable. The Rugged Computing movement posited that the current approach to fighting the vulnerable industrial complex being employed by most information security programs is hopeless.

APPENDIX 2 THEORY OF CONSTRAINTS AND CORE, CHRONIC CONFLICTS

The Theory of Constraints body of knowledge extensively discusses the use of creating core conflict clouds (often referred to as "C³"). Here is the conflict cloud for IT:

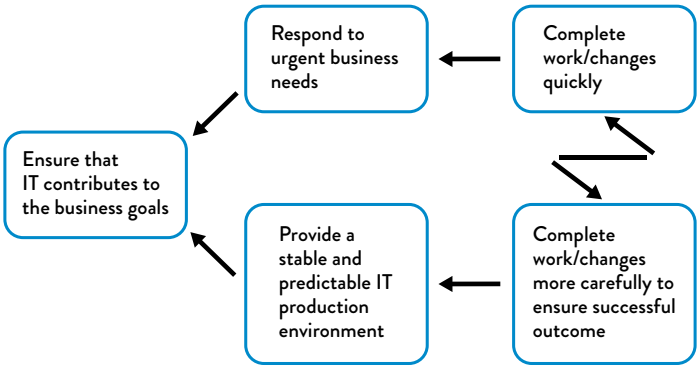

Figure 46: *The core, chronic conflict facing every IT organization*

During the 1980s, there was a very well-known core, chronic conflict in manufacturing. Every plant manager had two valid business goals: protect sales and reduce costs. The problem was that in order to protect sales, sales management was incentivized to increase inventory to ensure that it was always possible to fulfill customer demand.

On the other hand, in order to reduce cost, production management was incentivized to decrease inventory to ensure that money was not tied up in work in progress that wasn't immediately shippable to the customer in the form of fulfilled sales.

They were able to break the conflict by adopting Lean principles, such as reducing batch sizes, reducing work in process, and shortening and amplifying feedback loops. This resulted in dramatic increases in plant productivity, product quality, and customer satisfaction.

The principles behind DevOps work patterns are the same as those that transformed manufacturing, allowing us to optimize the IT value stream, converting business needs into capabilities and services that provide value for our customers.

APPENDIX 3 TABULAR FORM OF DOWNWARD SPIRAL

The columnar form of the downward spiral depicted in *The Phoenix Project* is shown below:

Table 4: *The Downward Spiral*

IT Operations sees...	Development sees...
Fragile applications are prone to failure	Fragile applications are prone to failure
Long time required to figure out which bit got flipped	More urgent, date-driven projects put into the queue
Detective control is a salesperson	Even more fragile code (less secure) put into production
Too much time required to restore service	More releases have increasingly turbulent installs
Too much firefighting and unplanned work	Release cycles lengthen to amortize cost of deployments
Urgent security rework and remediation	Failing bigger deployments more difficult to diagnose

Planned project work cannot be completed	Most senior and constrained IT Operations resources have less time to fix underlying process problems
Frustrated customers leave	Ever increasing backlog of work that could help the business win
Market share goes down	Ever increasing amount of tension between IT Operations, Development, Design
Business misses Wall Street commitments	
Business makes even larger promises to Wall Street	

APPENDIX 4 THE DANGERS OF HANDOFFS AND QUEUES

The problem with high amounts of queue time is exacerbated when there are many handoffs, because that is where queues are created. Figure 47 shows wait time as a function of how busy a resource at a work center is. The asymptotic curve shows why a "simple 30 minute change" often takes weeks to complete—specific engineers and work centers often become problematic bottlenecks when they operate at high utilization. As a work center approaches 100% utilization, any work required from it will languish in queues and won't be worked on without someone expediting/escalating.

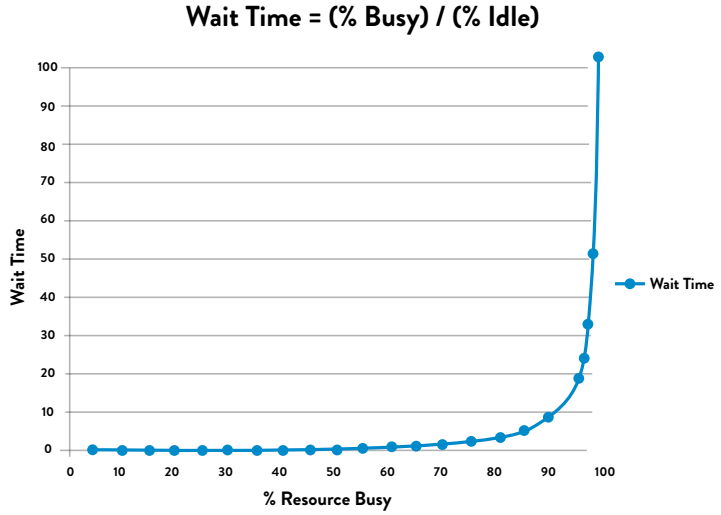

Figure 47: *Queue size and wait times as function of percent utilization (Source: Kim, Behr, and Spafford,* The Phoenix Project, *ePub edition, 557.)*

In figure 47, the x-axis is the percent busy for a given resource at a work center, and the y-axis is the approximate wait time (or, more precisely stated, the queue length). What the shape of the line shows is that as resource utilization goes past 80%, wait time goes through the roof.

In *The Phoenix Project*, here's how Bill and his team realized the devastating consequences of this property on lead times for the commitments they were making to the project management office:

> I tell them about what Erik told me at MRP-8, about how wait times depend upon resource utilization. "The wait time is the 'percentage of time busy' divided by the 'percentage of time idle.' In other words, if a resource is fifty percent busy, then it's fifty percent idle. The wait time is fifty percent divided by fifty percent, so one unit of time. Let's call it one hour.
>
> So, on average, our task would wait in the queue for one hour before it gets worked.

"On the other hand, if a resource is ninety percent busy, the wait time is "ninety percent divided by ten percent", or nine hours. In other words, our task would wait in queue nine times longer than if the resource were fifty percent idle."

I conclude, "So... For the Phoenix task, assuming we have seven handoffs, and that each of those resources is busy ninety percent of the time, the tasks would spend in queue a total of nine hours times the seven steps..."

"What? Sixty-three hours, just in queue time?" Wes says, incredulously. "That's impossible!"

Patty says with a smirk, "Oh, of course. Because it's only thirty seconds of typing, right?"

Bill and team realize that their "simple 30 minute task" actually requires seven handoffs (e.g., server team, networking team, database team, virtualization team, and, of course, Brent, the 'rockstar' engineer).

Assuming that all work centers were 90% busy, the figure shows us that the average wait time at each work center is nine hours—and because the work had to go through seven work centers, the total wait time is seven times that: sixty-three hours.

In other words, the total % of *value added time* (sometimes known as process time) was only 0.16% of the total lead time (thirty minutes divided by sixty-three hours). That means that for 99.8% of our total lead time, the work was simply sitting in queue, waiting to be worked on.

APPENDIX 5 MYTHS OF INDUSTRIAL SAFETY

Decades of research into complex systems shows that countermeasures are based on several myths. In "Some Myths about Industrial Safety," by Denis Besnard and Erik Hollnagel, they are summarized as such:

- **Myth 1:** "Human error is the largest single cause of accidents and incidents."
- **Myth 2:** "Systems will be safe if people comply with the procedures they have been given."
- **Myth 3:** "Safety can be improved by barriers and protection; more layers of protection results in higher safety."
- **Myth 4:** "Accident analysis can identify the root cause (the 'truth') of why the accident happened."
- **Myth 5:** "Accident investigation is the logical and rational identification of causes based on facts."
- **Myth 6:** "Safety always has the highest priority and will never be compromised."

The differences between what is myth and what is true are shown below:

Table 5: *Two Stories*

Myth	Reality
Human error is seen as the cause of failure.	Human error is seen as the effect of systemic vulnerabilities deeper inside the organization.
Saying what people should have done is a satisfying way to describe failure.	Saying what people should have done doesn't explain why it made sense for them to do what they did.
Telling people to be more careful will make the problem go away.	Only by constantly seeking out their vulnerabilities can organizations enhance safety.

APPENDIX 6 THE TOYOTA ANDON CORD

Many ask how can any work be completed if the Andon cord is being pulled over five thousand times per day? To be precise, not every Andon cord pull results in stopping the entire assembly line. Rather, when the Andon cord is pulled, the team leader overseeing the specified work center has fifty seconds to resolve the problem. If the problem has not been resolved by the time the fifty seconds is up, the partially assembled vehicle will cross a physically drawn line on the floor, and the assembly line will be stopped.

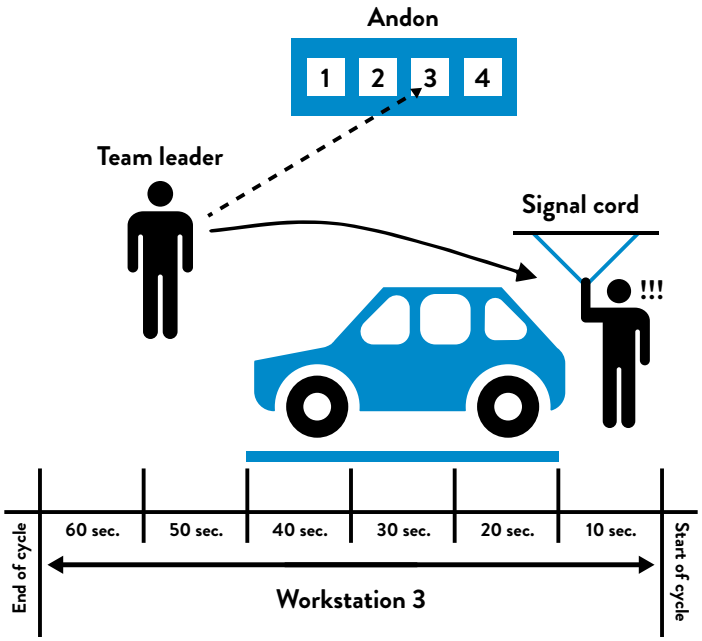

Figure 48: *The Toyota Andon cord*

APPENDIX 7 COTS SOFTWARE

Currently, in order to get complex COTS (commercial off-the-shelf) software (e.g., SAP, IBM WebSphere, Oracle WebLogic) into version control, we may have to eliminate the use of graphical point-and-click vendor installer tools. To do that, we need to discover what the vendor installer is doing, and we may need to do an install on a clean server image, diff the file system, and put those added files into version control. Files that don't vary by environment are put into one place ("base install"), while environment-specific files are put into their own directory ("test" or "production"). By doing this, software install operations become merely a version control operation, enabling better visibility, repeatability, and speed.

We may also have to transform any application configuration settings so that they are in version control. For instance, we may transform application configurations that are stored in a database into XML files and vice versa.

APPENDIX 8 POST-MORTEM MEETINGS

A sample agenda of the post-mortem meeting is shown below:

- An initial statement will be made by the meeting leader or facilitator to reinforce that this meeting is a blameless post-mortem and that we will not focus on past events or speculate on "would haves" or "could haves." Facilitators might read the "Retrospective Prime Directive" from the website Retrospective.com.

  Furthermore, the facilitator will remind everyone that any countermeasures must be assigned to someone, and

if the corrective action does not warrant being a top priority when the meeting is over, then it is not a corrective action. (This is to prevent the meeting from generating a list of good ideas that are never implemented.)

- Those at the meeting will reach an agreement on the complete timeline of the incident, including when and who detected the issue, how it was discovered (e.g., automated monitoring, manual detection, customer notified us), when service was satisfactorily restored, and so forth. We will also integrate into the timeline all external communications during the incident.

  When we use the word "timeline," it may evoke the image of a linear set of steps of how we gained an understanding of the problem and eventually fixed it. In reality, especially in complex systems, there will likely be many events that contributed to the accident, and many troubleshooting paths and actions will have been taken in an effort to fix it. In this activity, we seek to chronicle all of these events and the perspectives of the actors and establish hypotheses concerning cause and effect where possible.

- The team will create a list of all the factors which contributed to the incident, both human and technical. They may then sort them into categories, such as 'design decision,' 'remediation,' 'discovering there was a problem,' and so forth. The team will use techniques such as brainstorming and the 'infinite hows' to drill down on contributing factors they deem particularly important to discover deeper levels of contributing factors. All perspectives should be included and respected—nobody shod be permitted to argue with or deny the reality of a contributing factor somebody else has identified. It's important for the post-mortem facilitator to ensure that sufficient time is spent on this activity, and that the team doesn't try and engage in convergent behavior such as trying to identify one or more 'root causes.'

- Those at the meeting will reach an agreement on the list of corrective actions that will be made top priorities after the meeting. Assembling this list will require brainstorming and choosing the best potential actions to either prevent the issue from occurring or enable faster detection or recovery. Other ways to improve the systems may also be included.

  Our goal is to identify the smallest number of incremental steps to achieve the desired outcomes, as opposed to "big bang" changes, which not only take longer to implement, but delay the improvements we need.

  We will also generate a separate list of lower priority ideas and assign an owner. If similar problems occur in the future, these ideas may serve as the foundation for crafting future countermeasures.

- Those at the meeting will reach an agreement on the incident metrics and their organizational impact. For example, we may choose to measure our incidents by the following metrics:

  - **Event severity:** How severe was this issue? This directly relates to the impact on the service and our customers.

  - **Total downtime:** How long were customers unable to use the service to any degree?

  - **Time to detect:** How long did it take for us or our systems to know there was a problem?

  - **Time to resolve:** How long after we knew there was a problem did it take for us to restore service?

Bethany Macri from Etsy observed, "Blamelessness in a post-mortem does not mean that no one takes responsibility. It means that we want to find out what the circumstances were that allowed the person making the change or who introduced the problem to do this. What was the larger environment....The idea is that by removing blame, you remove fear, and by removing fear, you get honesty."

APPENDIX 9 THE SIMIAN ARMY

After the 2011 AWS EAST Outage, Netflix had numerous discussions about engineering their systems to automatically deal with failure. These discussions have evolved into a service called "Chaos Monkey."

Since then, Chaos Monkey has evolved into a whole family of tools, known internally as the "Netflix Simian Army," to simulate increasingly catastrophic levels of failures:

- **Chaos Gorilla:** simulates the failure of an entire AWS availability zone
- **Chaos Kong:** simulates failure of entire AWS regions, such as North America or Europe

Other member of the Simian Army now include:

- **Latency Monkey:** induces artificial delays or downtime in their RESTful client-server communication layer to simulate service degradation and ensure that dependent services respond appropriately
- **Conformity Monkey:** finds and shuts down AWS instances that don't adhere to best-practices (e.g., when instances don't belong to an auto-scaling group or when there is no escalation engineer email address listed in the service catalog)
- **Doctor Monkey:** taps into health checks that run on each instance and finds unhealthy instances and proactively shuts them down if owners don't fix the root cause in time
- **Janitor Monkey:** ensures that their cloud environment is running free of clutter and waste; searches for unused resources and disposes of them
- **Security Monkey:** an extension of Conformity Monkey; finds and terminates instances with security violations or vulnerabilities, such as improperly configured AWS security groups

APPENDIX 10 TRANSPARENT UPTIME

Lenny Rachitsky wrote about the benefits of what he called "transparent uptime:"

1. Your support costs go down as your users are able to self-identify system wide problems without calling or emailing your support department. Users will no longer have to guess whether their issues are local or global, and can more quickly get to the root of the problem before complaining to you.
2. You are better able to communicate with your users during downtime events, taking advantage of the broadcast nature of the Internet versus the one-to-one nature of email and the phone. You spend less time communicating the same thing over and over and more time resolving the issue.
3. You create a single and obvious place for your users to come to when they are experiencing downtime. You save your users' time currently spent searching forums, Twitter, or your blog.
4. Trust is the cornerstone of any successful SaaS adoption. Your customers are betting their business and their livelihoods on your service or platform. Both current and prospective customers require confidence in your service. Both need to know they won't be left in the dark, alone and uninformed, when you run into trouble. Real time insight into unexpected events is the best way to build this trust. Keeping them in the dark and alone is no longer an option.
5. It's only a matter of time before every serious SaaS provider will be offering a public health dashboard. Your users will demand it.

Additional Resources

- Many of the common problems faced by IT organizations are discussed in the first half of the book *The Phoenix Project: A Novel about IT, DevOps, and Helping Your Business Win* by Gene Kim, Kevin Behr, and George Spafford.
- This video shows a speech Paul O'Neill gave on his tenure as CEO of Alcoa, including the investigation he took part in after a teenage worker was killed at one of Alcoa's plants: https://www.youtube.com/watch?v=tC2ucDs_XJY.
- For more on value stream mapping, see *Value Stream Mapping: How to Visualize Work and Align Leadership for Organizational Transformation* by Karen Martin and Mike Osterling.
- For more on ORMs, visit Stack Overflow: http://stackoverflow.com/questions/1279613/what-is-an-orm-and-where-can-i-learn-more-about-it.
- An excellent primer on many agile development rituals and how to use them in IT Operations work can be found in a series of posts written on the Agile Admin blog: http://theagileadmin.com/2011/02/21/scrum-for-operations-what-is-scrum/.
- For more information on architecting for fast builds, see Daniel Worthington-Bodart's blog post "Crazy Fast Build Times (or When 10 Seconds Starts to Make You Nervous):" http://dan.bodar.com/2012/02/28/crazy-fast-build-times-or-when-10-seconds-starts-to-make-you-nervous/.
- For more details on performance testing at Facebook, along with some detailed information on Facebook's release process, check out Chuck Rossi's presentation "The Facebook Release Process:" http://www.infoq.com/presentations/Facebook-Release-Process.
- Many more variants of dark launching can be found in chapter 8 of *The Practice of Cloud System Administration: Designing and Operating Large Distributed Systems, Volume 2* by Thomas A. Limoncelli, Strata R. Chalup, and Christina J. Hogan.
- There is an excellent technical discussion of feature toggles here: http://martinfowler.com/articles/feature-toggles.html.
- Releases are discussed in more detail in *The Practice of Cloud System Administration: Designing and Operating Large Distributed Systems, Volume 2* by Thomas A. Limoncelli, Strata R. Chalup, and Christina J. Hogan; *Continuous Delivery: Reliable Software Releases Through Build, Test, and Deployment Automation* by Jez Humble and David Farley; and *Release It! Design and Deploy Production-Ready Software* by Michael T. Nygard.
- A description of the circuit breaker pattern can be found here: http://martinfowler.com/bliki/CircuitBreaker.html.
- For more on the cost of delay see *The Principles of Product Development Flow: Second Generation Lean Product Development* by Donald G. Reinertsen.

- A further discussion on staying ahead of failures for the Amazon S3 service can be found here: https://qconsf.com/sf2010/dl/qcon-sanfran-2009/slides/JasonMcHugh_AmazonS3ArchitectingForResiliencyInTheFaceOfFailures.pdf.

- For an excellent guide on conducting user research, see *Lean UX: Applying Lean Principles to Improve User Experience* by Jeff Gothelf and Josh Seiden.

- Which Test Won? is a site that displays hundreds of real-life A/B tests and asks the viewer to guess which variant performed better, reinforcing the key that unless we actually test, we're merely guessing. Visit it here: http://whichtestwon.com/.

- A list of architectural patterns can be found in *Release It! Design and Deploy Production-Ready Software* by Michael T. Nygard.

- An example of published Chef post-mortem meeting notes can be found here: https://www.chef.io/blog/2014/08/14/cookbook-dependency-api-postmortem/. A video of the meeting can be found here: https://www.youtube.com/watch?v=Rmi1Tn50WfI.

- A current schedule of upcoming DevOpsDays can be found on the DevOpsDays website: http://www.devopsdays.org/. Instructions on organizing a new DevOpsDays can be found on the DevOpsDay Organizing Guide page: http://www.devopsdays.org/pages/organizing/.

- More on using tools to manage secrets can be found in Noah Kantrowitz's post "Secrets Management and Chef" on his blog: https://coderanger.net/chef-secrets/.

- James Wickett and Gareth Rushgrove have put all their examples of secure pipelines on the GitHub website: https://github.com/secure-pipeline.

- The National Vulnerability Database website and XML data feeds can be found at: https://nvd.nist.gov/.

- A concrete scenario involving integration between Puppet and ThoughtWorks' Go and Mingle (a project management application) can be found in a Puppet Labs blog post by Andrew Cunningham and Andrew Myers and edited by Jez Humble: https://puppetlabs.com/blog/a-deployment-pipeline-for-infrastructure.

- Preparing and passing compliance audits is further explored in Jason Chan's 2015 presentation "SEC310: Splitting the Check on Compliance and Security: Keeping Developers and Auditors Happy in the Cloud:" https://www.youtube.com/watch?v=I000_K4v12Y&feature=youtu.be.

- The story of how application configuration settings were transformed by Jez Humble and David Farley for Oracle WebLogic was described in the book *Continuous Delivery: Reliable Software Releases Through Build, Test, and Deployment Automation*. Mirco Hering described a more generic approach to this process here: http://notafactory-anymore.com/2015/10/19/devops-for-systems-of-record-a-new-hope-preview-of-does-talk/.

- A sample list of DevOps operational requirements can be found here: http://blog.devopsguys.com/2013/12/19/the-top-ten-devops-operational-requirements/.

Endnotes

INTRODUCTION

xxii *Before the revolution…* Eliyahu M. Goldratt, *Beyond the Goal: Eliyahu Goldratt Speaks on the Theory of Constraints (Your Coach in a Box)* (Prince Frederick, Maryland: Gildan Media, 2005), Audiobook.

xxiv *Put even more…* Jeff Immelt, "GE CEO Jeff Immelt: Let's Finally End the Debate over Whether We Are in a Tech Bubble," *Business Insider*, December 9, 2015, http://www.businessinsider.com/ceo-of-ge-lets-finally-end-the-debate-over-whether-we-are-in-a-tech-bubble-2015-12.

Or as Jeffrey… "Weekly Top 10: Your DevOps Flavor," *Electric Cloud*, April 1, 2016, http://electric-cloud.com/blog/2016/04/weekly-top-10-devops-flavor/.

xxv *Dr. Eliyahu M. Goldratt…* Goldratt, *Beyond the Goal*.

xvi *As Christopher Little…* Christopher Little, personal correspondence with Gene Kim, 2010.

xxvii *As Steven J. Spear…* Steven J. Spear, *The High-Velocity Edge: How Market Leaders Leverage Operational Excellence to Beat the Competition* (New York, NY: McGraw Hill Education), Kindle edition, chap. 3.

In 2013, the… Chris Skinner, "Banks have bigger development shops than Microsoft," Chris Skinner's Blog, accessed July 28, 2016, http://thefinanser.com/2011/09/banks-have-bigger-development-shops-than-microsoft.html/.

xxviii *Projects are typically…* Nico Stehr and Reiner Grundmann, *Knowledge: Critical Concepts, Volume 3* (London: Routledge, 2005), 139.

Dr. Vernon Richardson… A. Masli, V. Richardson, M. Widenmier, and R. Zmud, "Senior Executive's IT Management Responsibilities: Serious IT Deficiencies and CEO-CFO Turnover," *MIS Quaterly* (published electronically June 21, 2016).

xxix *Consider the following…* "IDC Forecasts Worldwide IT Spending to Grow 6% in 2012, Despite Economic Uncertainty," *Business Wire*, September 10, 2012, http://www.businesswire.com/news/home/20120910005280/en/IDC-Forecasts-Worldwide-Spending-Grow-6-2012.

xxxii *The first surprise…* Nigel Kersten, IT Revolution, and PwC, *2015 State of DevOps Report* (Portland, OR: Puppet Labs, 2015), https://puppet.com/resources/white-paper/2015-state-of-devops-report?_ga=1.6612658.168869.1464412647&link=blog.

xxxiii *This is highlighted…* Frederick P. Brooks, Jr., *The Mythical Man-Month: Essays on Software Engineering, Anniversary Edition* (Upper Saddle River, NJ: Addison-Wesley, 1995).

xxxiv *As Randy Shoup…* Gene Kim, Gary Gruver, Randy Shoup, and Andrew Phillips, "Exploring the Uncharted Territory of Microservices," XebiaLabs.com, webinar, February 20, 2015, https://xebialabs.com/community/webinars/exploring-the-uncharted-territory-of-microservices/.

The 2015 State… Kersten, IT Revolution, and PwC, *2015 State of DevOps Report*.

Another more extreme… "Velocity 2011: Jon Jenkins, 'Velocity Culture'," YouTube video, 15:13, posted by O'Reilly, June 20, 2011, https://www.youtube.com/watch?v=dxk8b9rSKOo; "Transforming Software Development," YouTube video, 40:57, posted by Amazon Web Service, April 10, 2015, https://www.youtube.com/watch?v=YCrhemssYuI&feature=youtu.be.

xxxv *Later in his…* Eliyahu M. Goldratt, *Beyond the Goal*.

As with The… JGFLL, review of *The Phoenix Project: A Novel About IT, DevOps, and Helping Your Business Win*, by Gene Kim, Kevin Behr, and George Spafford, Amazon.com review, March 4, 2013, http://www.amazon.com/review/R1KSSPTEGLWJ23; Mark L Townsend, review of *The Phoenix Project: A Novel About IT, DevOps, and Helping Your Business Win*, by Gene Kim, Kevin Behr, and George Spafford, Amazon.com review, March 2, 2013, http://uedata.amazon.com/gp/customer-reviews/R1097DFODM12VD/ref=cm_cr_getr_d_rvw_ttl?ie=UTF8&ASIN=B00VATFAMI; Scott Van Den Elzen, review of *The Phoenix Project: A Novel About IT, DevOps, and Helping Your Business Win*, by Gene Kim, Kevin Behr, and George Spafford, Amazon.com review, March 13, 2013, http://uedata.amazon.com/gp/customer-reviews/R2K95XEH5OL3Q5/ref=cm_cr_getr_d_rvw_ttl?ie=UTF8&ASIN=B00VATFAMI.

PART I INTRODUCTION

5 *One key principle*… Kent Beck, et al., "Twelve Principles of Agile Software," AgileManifesto.org, 2001, http://agilemanifesto.org/principles.html.

6 *He concluded that*… Mike Rother, *Toyota Kata: Managing People for Improvement, Adaptiveness and Superior Results* (New York: McGraw Hill, 2010), Kindle edition, Part III.

CHAPTER 1

7 *Karen Martin and*… Karen Martin and Mike Osterling, *Value Stream Mapping: How to Visualize Work and Align Leadership for Organizational Transformation* (New York: McGraw Hill, 2013), Kindle edition, chap 1.

9 *In this book*… Ibid., chap. 3.

11 *Karen Martin and*… Ibid.

CHAPTER 2

17 *Studies have shown*… Joshua S. Rubinstein, David E. Meyer, and Jeffrey E. Evans, "Executive Control of Cognitive Processes in Task Switching," *Journal of Experimental Psychology: Human Perception and Performance* 27, no. 4 (2001): 763-797, doi: 10.1037//0096-1523.27.4.763, http://www.umich.edu/~bcalab/documents/RubinsteinMeyerEvans2001.pdf.

18 *Dominica DeGrandis, one*… "DOES15—Dominica DeGrandis—The Shape of Uncertainty," YouTube video, 22:54, posted by DevOps Enterprise Summit, November 5, 2015, https://www.youtube.com/watch?v=Gp05i0d34gg.

Taiichi Ohno compared… Sami Bahri, "Few Patients-In-Process and Less Safety Scheduling; Incoming Supplies are Secondary," The Deming Institute Blog, August 22, 2013, https://blog.deming.org/2013/08/fewer-patients-in-process-and-less-safety-scheduling-incoming-supplies-are-secondary/.

In other words… Meeting between David J. Andersen and team at Motorola with Daniel S. Vacanti, February 24, 2004; story retold at USC CSSE Research Review with Barry Boehm in March 2004.

19 *The dramatic differences*… James P. Womack and Daniel T. Jones, *Lean Thinking: Banish Waste and Create Wealth in Your Corporation* (New York: Free Press, 2010), Kindle edition, chap. 1.

20 *There are many*… Eric Ries, "Work in small batches," StartupLessonsLearned.com, February 20, 2009, http://www.startuplessonslearned.com/2009/02/work-in-small-batches.html.

21 *In* Beyond the… Goldratt, *Beyond the Goal*.

22 *As a solution*… Eliyahu M. Goldratt, *The Goal: A Process of Ongoing Improvement* (Great Barrington, MA: North River Press, 2014), Kindle edition, "Five Focusing Steps."

23 *Shigeo Shingo, one*… Shigeo Shingo, *A Study of the Toyota Production System: From an Industrial Engineering Viewpoint* (London: Productivity Press, 1989); "The 7 Wastes (Seven forms of Muda)," BeyondLean.com, accessed July 28, 2016, http://www.beyondlean.com/7-wastes.html.

24 *In the book*… Mary Poppendieck and Tom Poppendieck, *Implementing Lean Software: From Concept to Cash*, (Upper Saddle River, NJ: Addison-Wesley, 2007), 74.

The following categories... Adapted from Damon Edwards, "DevOps Kaizen: Find and Fix What Is Really Behind Your Problems," Slideshare.net, posted by dev2ops, May 4, 2015, http://www.slideshare.net/dev2ops/dev-ops-kaizen-damon-edwards.

CHAPTER 3

28 *Dr. Charles Perrow*... Charles Perrow, *Normal Accidents: Living with High Risk Technologies* (Princeton, NJ: Princeton University Press, 1999).

Dr. Sidney Dekker... Dr. Sidney Dekker, *The Field Guide to Understanding Human Error* (Lund University, Sweden: Ashgate, 2006).

After he decoded... Spear, *The High-Velocity Edge*, chap. 8.

Dr. Spear extended... Ibid.

29 *Dr. Peter Senge*... Peter M. Senge, *The Fifth Discipline: The Art & Practice of the Learning Organization* (New York: Doubleday, 2006), Kindle edition, chap. 5.

In one well-documented... "NUMMI," *This American Life*, March 26, 2010, http://www.thisamericanlife.org/radio-archives/episode/403/transcript.

30 *As Elisabeth Hendrickson*... "DOES15 - Elisabeth Hendrickson - Its All About Feedback," YouTube video, 34:47, posted by DevOps Enterprise Summit, November 5, 2015, https://www.youtube.com/watch?v=r2BFTXBundQ.

"In doings so... Spear, *The High-Velocity Edge*, chap. 1.

31 *As Dr. Spear*... Ibid., chap. 4.

33 *Examples of ineffective*... Jez Humble, Joanne Molesky, and Barry O'Reilly, *Lean Enterprise: How High Performance Organizations Innovate at Scale* (Sebastopol, CA: O'Reilly Media, 2015), Kindle edition, Part IV.

In the 1700s... Dr. Thomas Sowell, *Knowledge and Decisions* (New York: Basic Books, 1980), 222.

34 *As Gary Gruver*... Gary Gruver, personal correspondence with Gene Kim, 2014.

CHAPTER 4

37 *For instance, in*... Paul Adler, "Time-and-Motion Regained," *Harvard Business Review*, January-February 1993, https://hbr.org/1993/01/time-and-motion-regained.

38 *The "name, blame*... Dekker, *The Field Guide to Understanding Human Error,* chap. 1.

Dr. Sidney Dekker... "Just Culture: Balancing Safety and Accountability," Lund University, Human Factors & System Safety website, November 6, 2015, http://www.humanfactors.lth.se/sidney-dekker/books/just-culture/.

39 *He observed that*... Ron Westrum, "The study of information flow: A personal journey," *Proceedings of Safety Science* 67 (August 2014): 58-63, https://www.researchgate.net/publication/261186680_The_study_of_information_flow_A_personal_journey.

40 *Just as Dr. Westrum*... Nicole Forsgren Velasquez, Gene Kim, Nigel Kersten, and Jez Humble, *2014 State of DevOps Report* (Portland, OR: Puppet Labs, IT Revolution Press, and ThoughtWorks, 2014), http://puppetlabs.com/2014-devops-report.

As Bethany Macri... Bethany Macri, "Morgue: Helping Better Understand Events by Building a Post Mortem Tool - Bethany Macri," Vimeo video, 33:34, posted by info@devopsdays.org, October 18, 2013, http://vimeo.com/77206751.

Dr. Spear observes... Spear, *The High-Velocity Edge*, chap. 1.

In The Fifth... Senge, *The Fifth Discipline*, chap. 1.

Mike Rother observed... Mike Rother, *Toyota Kata*, 12.

This is why... Mike Orzen, personal correspondence with Gene Kim, 2012.

41 *Consider the following*... "Paul O'Neill," *Forbes*, October 11, 2001, http://www.forbes.com/2001/10/16/poneill.html.

In 1987, Alcoa... Spear, *The High-Velocity Edge*, chap. 4.

As Dr. Spear... Ibid.

42 *A remarkable example*... Ibid., chap. 5.

44 *This process of*... Nassim Nicholas Taleb, *Antifragile: Things That Gain from Disorder* (Incerto), (New York: Random House, 2012).

According to Womack... Jim Womack, *Gemba Walks* (Cambridge, MA: Lean Enterprise Institute, 2011), Kindle edition, location 4113.

45 *Mike Rother formalized*... Rother, *Toyota Kata*, Part IV.

Mike Rother observes... Ibid., Conclusion.

CHAPTER 5

51 *Therefore, we must*... Michael Rembetsy and Patrick McDonnell, "Continuously Deploying Culture [at Etsy]," Slideshare.net, October 4, 2012, posted by Patrick McDonnel.bl, http://www.slideshare.net/mcdonnps/continuously-deploying-culture-scaling-culture-at-etsy-14588485.

In 2015, Nordstrom... "Nordstrom, Inc.," company profile on Vault.com, http://www.vault.com/company-profiles/retail/nordstrom,-inc/company-overview.aspx.

The stage for... Courtney Kissler, "DOES14 - Courtney Kissler - Nordstrom - Transforming to a Culture of Continuous Improvement," YouTube video, 29:59, posted by DevOps Enterprise Summit 2014, October 29, 2014, https://www.youtube.com/watch?v=0ZAcsrZBSlo.

These organizations were... Tom Gardner, "Barnes & Noble, Blockbuster, Borders: The Killer B's Are Dying," *The Motley Fool*, July 21, 2010, http://www.fool.com/investing/general/2010/07/21/barnes-noble-blockbuster-borders-the-killer-bs-are.aspx.

52 *As Kissler described*... Kissler, "DOES14 - Courtney Kissler - Nordstrom."

As Kissler said... Ibid; Alterations to quote made by Courtney Kissler via personal correspondence with Gene Kim, 2016.

53 *As Kissler stated*... Ibid; Alterations to quote made by Courtney Kissler via personal correspondence with Gene Kim, 2016.

In 2015, Kissler... Ibid.

She continued, "This... Ibid.

54 *Kissler concluded, "From*... Ibid.

An example of... Ernest Mueller, "Business model driven cloud adoption: what NI Is doing in the cloud," Slideshare.net, June 28, 2011, posted by Ernest Mueller, http://www.slideshare.net/mxyzplk/business-model-driven-cloud-adoption-what-ni-is-doing-in-the-cloud.

55 *Although many believe*... Unpublished calculation by Gene Kim after the 2014 DevOps Enterprise Summit.

Indeed, one of... Kersten, IT Revolution, and PwC, *2015 State of DevOps Report*.

56 *CSG (2013): In*... Prugh, "DOES14: Scott Prugh, CSG - DevOps and Lean in Legacy Environments," Slideshare.net, November 14, 2014, posted by DevOps Enterprise Summit, http://www.slideshare.net/DevOpsEnterpriseSummit/scott-prugh.

Etsy (2009): In... Rembetsy and McDonnell, "Continuously Deploying Culture [at Etsy]."

56 *The Gartner research*... Bernard Golden, "What Gartner's Bimodal IT Model Means to Enterprise CIOs," *CIO Magazine*, January 27, 2015, http://www.cio.com/article/2875803/cio-role/what-gartner-s-bimodal-it-model-means-to-enterprise-cios.html.

Systems of record... Ibid.

Systems of engagement... Ibid.

57 *The data from*... Kersten, IT Revolution, and PwC, *2015 State of DevOps Report*.

Scott Prugh, VP... Scott Prugh, personal correspondence with Gene Kim, 2014.

Geoffrey A. Moore... Geoffrey A. Moore and Regis McKenna, *Crossing the Chasm: Marketing and Selling High-Tech Products to Mainstream Customers* (New York: HarperCollins, 2009), 11.

58 *Big bang, top-down*… Linda Tucci, "Four Pillars of PayPal's 'Big Bang' Agile Transformation," *TechTarget*, August 2014, http://searchcio
.techtarget.com/feature/Four-pillars-of-PayPals-big-bang-Agile
-transformation.

59 *The following list*… "Creating High Velocity Organizations," description of course by Roberto Fernandez and Steve Spear, MIT Sloan Executive Education website, accessed May 30, 2016, http://executive.mit.edu/openenrollment/program/organizational
-development-high-velocity-organizations.

But as Ron van Kemenade… Ron Van Kemande, "Nothing Beats Engineering Talent: The Agile Transformation at ING," presentation at the DevOps Enterprise Summit, London, UK, June 30-July 1, 2016.

60 *Peter Drucker, a*… Leigh Buchanan, "The Wisdom of Peter Drucker from A to Z," *Inc*., November 19, 2009, http://www.inc.com/articles
/2009/11/drucker.html.

CHAPTER 6

61 *Over the years*… Kissler, "DOES14 - Courtney Kissler - Nordstrom."

Kissler explained:… Ross Clanton and Michael Ducy, interview of Courtney Kissler and Jason Josephy, "Continuous Improvement at Nordstrom," *The Goat Farm*, podcast audio, June 25, 2015, http://goatcan.do/2015/06/25/the-goat-farm-episode-7-continuous
-improvement-at-nordstrom/.

62 *She said proudly*… Ibid.

63 *Technology executives or*… Brian Maskell, "What Does This Guy Do? Role of Value Stream Manager," *Maskell*, July 3, 2015, http://blog
.maskell.com/?p=2106http://www.lean.org/common/display
/?0=221.

64 *Damon Edwards observed*… Damon Edwards, "DevOps Kaizen: Find and Fix What Is Really Behind Your Problems," Slideshare.net, posted by dev2ops, May 4, 2015, http://www.slideshare.net/dev2ops
/dev-ops-kaizen-damon-edwards.

66 *In their book* …Vijay Govindarajan and Chris Trimble, *The Other Side of Innovation: Solving the Execution Challenge* (Boston, MA: Harvard Business Review, 2010) Kindle edition.

67 *Based on their*…Ibid., Part I.

70 *After the near-death*… Marty Cagan, *Inspired: How to Create Products Customers Love* (Saratoga, CA: SVPG Press, 2008), 12.

Cagan notes that… Ibid.

71 *Six months after*… Ashlee Vance, "LinkedIn: A Story About Silicon Valley's Possibly Unhealthy Need for Speed," *Bloomberg*, April 30, 2013, http://www.bloomberg.com/bw/articles/2013-04-29/linkedin
-a-story-about-silicon-valleys-possibly-unhealthy-need-for-speed.

LinkedIn was created… "LinkedIn started back in 2003 — Scaling LinkedIn - A Brief History," Slideshare.net, posted by Josh Clemm, November 9, 2015, http://www.slideshare.net/joshclemm/how
-linkedin-scaled-a-brief-history/3-LinkedIn_started_back_in_2003.

One year later… Jonas Klit Nielsen, "8 Years with LinkedIn – Looking at the Growth [Infographic]," MindJumpers.com, May 10, 2011, http://www.mindjumpers.com/blog/2011/05/linkedin-growth
-infographic/.

By November 2015… "LinkedIn started back in 2003," Slideshare.net.

The problem was… "From a Monolith to Microservices + REST: The Evolution of LinkedIn's Architecture," Slideshare.net, posted by Karan Parikh, November 6, 2014, http://www.slideshare.net
/parikhk/restli-and-deco.

Josh Clemm, a… "LinkedIn started back in 2003," Slideshare.net.

72 *In 2013, journalist*… Vance, "LinkedIn: A Story About," *Bloomberg*.

Scott launched Operation... "How I Structured Engineering Teams at LinkedIn and AdMob for Success," *First Round Review*, 2015, http://firstround.com/review/how-i-structured-engineering-teams-at-linkedin-and-admob-for-success/.

Scott described one... Ashlee Vance, "Inside Operation InVersion, the Code Freeze that Saved LinkedIn," *Bloomberg*, April 11, 2013, http://www.bloomberg.com/news/articles/2013-04-10/inside-operation-inversion-the-code-freeze-that-saved-linkedin.

However, Vance described... Vance, "LinkedIn: A Story About," *Bloomberg*.

As Josh Clemm... "LinkedIn started back in 2003," Slideshare.net.

Kevin Scott stated... "How I Structured Engineering Teams," *First Round Review*.

73 *As Christopher Little*... Christopher Little, personal correspondence with Gene Kim, 2011.

74 *As Ryan Martens*... Ryan Martens, personal correspondence with Gene Kim, 2013.

CHAPTER 7

77 *He observed, "After*...Dr. Melvin E. Conway, "How Do Committees Invent?" MelConway.com, http://www.melconway.com/research/committees.html, previously published in *Datamation*, April 1968.

These observations led... Ibid.

77 *Eric S. Raymond, author*... Eric S. Raymond, "Conway's Law," catb.org, accessed May 31, 2016, http://catb.org/~esr/jargon/.

78 *Etsy's DevOps journey*... Sarah Buhr, "Etsy Closes Up 86 Percent on First Day of Trading," *Tech Crunch*, April 16, 2015, http://techcrunch.com/2015/04/16/etsy-stock-surges-86-percent-at-close-of-first-day-of-trading-to-30-per-share/.

As Ross Snyder... "Scaling Etsy: What Went Wrong, What Went Right," Slideshare.net, posted by Ross Snyder, October 5, 2011, http://www.slideshare.net/beamrider9/scaling-etsy-what-went-wrong-what-went-right.

As Snyder observed... Ibid.

In other words... Sean Gallagher, "When 'Clever' Goes Wrong: How Etsy Overcame Poor Architectural Choices," *Arstechnica*, October 3, 2011, http://arstechnica.com/business/2011/10/when-clever-goes-wrong-how-etsy-overcame-poor-architectural-choices/.

Snyder explained that... "Scaling Etsy" Slideshare.net.

79 *Etsy initially had*... Ibid.

In the spring... Ibid.

As Snyder described... Ross Snyder, "Surge 2011—Scaling Etsy: What Went Wrong, What Went Right," YouTube video, posted by Surge Conference, December 23, 2011, https://www.youtube.com/watch?v=eenrfm50mXw.

80 *As Snyder said*... Ibid.

Sprouter was one... "Continuously Deploying Culture: Scaling Culture at Etsy - Velocity Europe 2012," Slideshare.net, posted by Patrick McDonnell, October 4, 2012, http://www.slideshare.net/mcdonnps/continuously-deploying-culture-scaling-culture-at-etsy-14588485.

They are defined... "Creating High Velocity Organizations," description of course by Roberto Fernandez and Steven Spear.

82 *Adrian Cockcroft remarked*... Adrian Cockcroft, personal correspondence with Gene Kim, 2014.

84 *In the Lean*... Spear, *The High-Velocity Edge*, chap. 8.

As Mike Rother... Rother, *Toyota Kata*, 250.

Reflecting on shared... "DOES15 - Jody Mulkey - DevOps in the Enterprise: A Transformation Journey," YouTube video, 28:22, posted by DevOps Enterprise Summit, November 5, 2015, https://www.youtube.com/watch?v=USYrDaPEFtM.

85 *He continued, "The*... Ibid.

Pedro Canahuati, their... Pedro Canahuati, "Growing from the Few to the Many: Scaling the Operations Organization at Facebook," *InfoQ*, December 16, 2013, http://www.infoq.com/presentations/scaling-operations-facebook.

When departments over-specialize... Spear, *The High-Velocity Edge*, chap. 1.

86 *Scott Prugh writes*... Scott Prugh, "Continuous Delivery," Scaled Agile Framework, updated February 14, 2013, http://www
.scaledagileframework.com/continuous-delivery/.

"*By cross-training*... Ibid.

"*Traditional managers will*... Ibid.

87 *Furthermore, as Prugh*... Ibid.

When we value... Dr. Carol Dweck, "Carol Dweck Revisits the 'Growth Mindset,'" *Education Week*, September 22, 2015, http://www.edweek.org/ew
/articles/2015/09/23/carol-dweck-revisits-the-growth-mindset
.html.

As Jason Cox... Jason Cox, "Disney DevOps: To Infinity and Beyond," presentation at DevOps Enterprise Summit 2014, San Francisco, CA, October 2014.

88 *As John Lauderbach*... John Lauderbach, personal conversation with Gene Kim, 2001.

89 *These properties are*... Tony Mauro, "Adopting Microservices at Netflix: Lessons for Architectural Design," *NGINX*, February 19, 2015, https://www.nginx.com/blog/microservices-at-netflix
-architectural-best-practices/.; Adam Wiggins, "The Twelve-Factor App," 12Factor.net, January 30, 2012, http://12factor.net/.

90 *Randy Shoup, former*... "Exploring the Uncharted Territory of Microservices," YouTube video, 56:50, posted by XebiaLabs, Inc., February 20, 2015, https://www.youtube.com/watch?v
=MRa21icSIQk.

As part of... Humble, O'Reilly, and Molesky, *Lean Enterprise*, Part III.

In the Netflix... Reed Hastings, "Netflix Culture: Freedom and Responsibility," Slideshare.net, August 1, 2009, http://www
.slideshare.net/reed2001/culture-1798664.

91 *Amazon CTO Werner*... Larry Dignan, "Little Things Add Up," *Baseline*, October 19, 2005, http://www.baselinemag.com/c/a/Projects-Management/Profiles-Lessons-From-the-Leaders-in-the-iBaselinei500/3.

Target is the... Heather Mickman and Ross Clanton, "DOES15 - Heather Mickman & Ross Clanton - (Re)building an Engineering Culture: DevOps at Target," YouTube video, 33:39, posted by DevOps Enterprise Summit, November 5, 2015, https://www.youtube.com
/watch?v=7s-VbB1fG5o.

As Mickman described... Ibid.

92 *In an attempt*... Ibid.

Because our team... Ibid.

In the following... Ibid.

93 *These changes have*... Ibid.

The API Enablement... Ibid.

CHAPTER 8

95 *At Big Fish*... "Big Fish Celebrates 11th Consecutive Year of Record Growth," BigFishGames.com, January 28, 2014, http://pressroom
.bigfishgames.com/2014-01-28-Big-Fish-Celebrates-11th
-Consecutive-Year-of-Record-Growth.

96 *He observed that*...Paul Farrall, personal correspondence with Gene Kim, January 2015.

Farrall defined two... Ibid., 2014.

He concludes, "The... Ibid.

97 *Ernest Mueller observed*... Ernest Mueller, personal correspondence with Gene Kim, 2014.

As Damon Edwards... Edwards, "DevOps Kaizen."

98 *Dianne Marsh, Director*... "Dianne Marsh 'Introducing Change while Preserving Engineering Velocity," YouTube video, 17:37, posted by Flowcon, November 11, 2014, https://www.youtube.com/watch?v =eW3ZxY67fnc.

99 *Jason Cox said*... Jason Cox, "Disney DevOps."

100 *At Etsy*, this... "devopsdays Minneapolis 2015 - Katherine Daniels - DevOps: The Missing Pieces," YouTube video, 33:26, posted by DevOps Minneapolis, July 13, 2015, https://www.youtube.com /watch?v=LNJkVw93yTU.

102 *As Ernest Mueller*... Ernest Mueller, personal correspondence with Gene Kim, 2015.

Scrum is an agile... Hirotaka Takeuchi and Ikujiro Nonaka, "New Product Development Game," *Harvard Business Review* (January 1986): 137-146.

CHAPTER 9

111 *In her presentation*... Em Campbell-Pretty, "DOES14 - Em Campbell-Pretty - How a Business Exec Led Agile, Lead, CI/ CD," YouTube video, 29:47, posted by DevOps Enterprise Summit, April 20, 2014, https://www.youtube.com/ watch?v=-4pIMMTbtwE.

Campbell-Pretty became... Ibid.

112 *They created a*... Ibid.

Campbell-Pretty observed... Ibid.

Camplbell-Pretty described... Ibid.

115 *The first version*... "Version Control History," PlasticSCM.com, accessed May 31, 2016, https://www.plasticscm.com/ version -control-history.html.

A version control... Jennifer Davis and Katherine Daniels, Effective DevOps: Building a Culture of Collaboration, Affinity, and Tooling at Scale (Sebastopol, CA: O'Reilly Media, 2016), 37.

118 *Bill Baker, a*... Simon Sharwood, "Are Your Servers PETS or CATTLE?," *The Register*, March 18 2013, http://www. theregister.co .uk/2013/03/18/servers_pets_or_cattle_cern/.

118 *At Netflix, the*... Jason Chan, "OWASP AppSecUSA 2012: Real World Cloud Application Security," YouTube video, 37:45, posted by Christiaan008, December 10, 2012, https://www.youtube.com /watch?v=daNA0jXDvYk.

119 *The latter pattern*... Chad Fowler, "Trash Your Servers and Burn Your Code: Immutable Infrastructure and Disposable Components," ChadFowler.com, June 23, 2013, http://chadfowler.com/2013/06 /23/immutable-deployments.html.

The entire application... John Willis, "Docker and the Three Ways of DevOps Part 1: The First Way—Systems Thinking," *Docker*, May 26, 2015, https://blog.docker.com/2015/05/docker-three-ways-devops/.

CHAPTER 10

123 *Gary Gruver, former*... Gary Gruver, personal correspondence with Gene Kim, 2014.

They had problems... "DOES15 - Mike Bland - Pain Is Over, If You Want It," Slideshare.net, posted by Gene Kim, November 18, 2015, http://www.slideshare.net/ITRevolution/does15-mike-bland-pain-is-over-if-you-want-it-55236521.

124 *Bland describes how*... Ibid.

Bland described that... Ibid.

As Bland describes... Ibid.

As Bland notes... Ibid.

125 *Over the next*... Ibid.

Eran Messeri, an... Eran Messeri, "What Goes Wrong When Thousands of Engineers Share the Same Continuous Build?," presentation at the GOTO Conference, Aarhus, Denmark, October 2, 2013.

Messeri explains, "There... Ibid.

All their code... Ibid.

126 *Some of the*...Ibid.

In Development, continuous... Jez Humble and David Farley, personal correspondence with Gene Kim, 2012.

The deployment pipeline... Jez Humble and David Farley, *Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation* (Upper Saddle River, NJ: Addison-Wesly, 2011), 3.

131 *Humble and Farley*... Ibid., 188.

As Humble and... Ibid., 258.

132 *Martin Fowler observes*... Martin Fowler, "Continuous Integration," MartinFowler.com, May 1, 2006, http://www.martinfowler.com
/articles/continuousIntegration.html.

132 *Martin Fowler described*... Martin Fowler, "TestPyramid," MartinFowler.com, May 1, 2012, http://martinfowler.com/bliki
/TestPyramid.html.

134 *This technique was*.. Martin Fowler, "Test Driven Development," MartinFowler.com, March 5, 2005, http://martinfowler.com/bliki
/TestDrivenDevelopment.html.

135 *Nachi Nagappan, E. Michael*... Nachiappan Nagappan, E. Michael Maximilien, Thirumalesh Bhat, and Laurie Williams, "Realizing quality improvement through test driven development: results and experiences of four industrial teams," *Empir Software Engineering*, 13, (2008): 289-302, http://research.microsoft.com/en-us/groups/ese/nagappan_tdd.pdf.

In her 2013... Elisabeth Hendrickson, "On the Care and Feeding of Feedback Cycles," Slideshare.net, posted by Elisabeth Hendrickson, November 1, 2013, http://www.slideshare.net/ehendrickson/care-and-feeding-of-feedback-cycles.

However, merely automating... "Decreasing false positives in automated testing," Slideshare.net, posted by Sauce Labs, March 24, 2015, http://www.slideshare.net/saucelabs/decreasing-false-positives-in-automated-testing.; Martin Fowler, "Eradicating Non-determinism in Tests," MartinFowler.com, April 14, 2011, http://martinfowler.com/articles/nonDeterminism.html.

136 *As Gary Gruver*... Gary Gruver, "DOES14 - Gary Gruver - Macy's - Transforming Traditional Enterprise Software Development Processes," YouTube video, 27:24, posted by DevOps Enterprise Summit 2014, October 29, 2014, https://www.youtube.com/watch?v=-HSSGiYXA7U.

139 *Randy Shoup, former*... Randy Shoup, "The Virtuous Cycle of Velocity: What I Learned About Going Fast at eBay and Google by Randy Shoup," YouTube video, 30:05, posted by Flowcon, December 26, 2013, https://www.youtube.com/watch?v=EwLBoRyXTOI.

This is sometimes... David West, "Water scrum-fall is-reality_of_agile_for_most," Slideshare.net, posted by harsoft, April 22, 2013, http://www.slideshare.net/harsoft/water-scrumfall-isrealityofagileformost.

CHAPTER 11

144 *The surprising breadth*... Gene Kim, "The Amazing DevOps Transformation of the HP LaserJet Firmware Team (Gary Gruver)," ITRevolution.com, 2013, http://itrevolution.com/the-amazing-devops-transformation-of-the-hp-laserjet-firmware-team-gary-gruver/.

Gruvery described this... Ibid.

145 *Compile flags (#define*... Ibid.

Gruver admits trunk-based...Gary Gruver and Tommy Mouser, *Leading the Transformation: Applying Agile and DevOps Principles at Scale* (Portland, OR: IT Revolution Press), 60.

Gruver observed, "Without... Kim, "The Amazing DevOps Transformation " ITRevolution.com.

147 *Jeff Atwood, founder*...Jeff Atwood, "Software Branching and Parallel Universes," CodingHorror.com, October 2, 2007, http://blog.codinghorror.com/software-branching-and-parallel-universes/.

148 *This is how*... Ward Cunningham, "Ward Explains Debt Metaphor," c2.com, 2011, http://c2.com/cgi/wiki?WardExplainsDebtMetaphor.

149 *Ernest Mueller, who*... Ernest Mueller, "2012: A Release Odyssey," Slideshare.net, posted by Ernest Mueller, March 12, 2014, http://www.slideshare.net/mxyzplk/2012-a-release-odyssey.

At that time... "Bazaarvoice, Inc. Announces Its Financial Results for the Fourth Fiscal Quarter and Fiscal Year Ended April 30, 2012," BasaarVoice.com, June 6, 2012, http://investors.bazaarvoice.com/releasedetail.cfm?ReleaseID=680964.

150 *Mueller observed, "It*... Ernest Mueller, "DOES15 - Ernest Mueller - DevOps Transformations At National Instruments and...," YouTube video, 34:14, posted by DevOps Enterprise Summit, November 5, 2015, https://www.youtube.com/watch?v=6Ry40h1UAyE.

"By running these... Ibid.

151 *Mueller further described*... Ibid.

However, the data...Kersten, IT Revolution, and PwC, *2015 State of DevOps Report*.

CHAPTER 12

153 *In 2012, Rossi*... Chuck Rossi, "Release engineering and push karma: Chuck Rossi," post on Chuck Rossi's Facebook page, April 5, 2012, https://www.facebook.com/notes/facebook-engineering/release-engineering-and-push-karma-chuck-rossi/10150660826788920.

Just prior to... Ryan Paul, "Exclusive: a behind-the-scenes look at Facebook release engineering," *Ars Technica*, April 5, 2012, http://arstechnica.com/business/2012/04/exclusive-a-behind-the-scenes-look-at-facebook-release-engineering/1/.

Rossi continued, "If... Chuck Rossi, "Release engineering and push karma."

The Facebook frontend... Paul, "Exclusive: a behind-the-scenes look at Facebook release engineering," *Ars Technica*.

He explained that... Chuck Rossi, "Ship early and ship twice as often," post on Chuck Rossi's Facebook page, August 3, 2012, https://www.facebook.com/notes/facebook-engineering/ship-early-and-ship-twice-as-often/10150985860363920.

154 *Kent Beck, the*.. Kent Beck, "Slow Deployment Causes Meetings," post on Kent Beck's Facebook page, November 19, 2015), https://www.facebook.com/notes/kent-beck/slow-deployment-causes-meetings/1055427371156793?_rdr=p.

157 *Scott Prugh, their*... Prugh, "DOES14: Scott Prugh, CSG - DevOps and Lean in Legacy Environments."

Prugh observed, "It... Ibid.

158 *Prugh writes, "We*... Ibid.

Prugh also observes:... Ibid.

In their experiments... Puppet Labs and IT Revolution Press, *2013 State of DevOps Report* (Portland, OR: Puppet Labs, 2013), http://www.exin-library.com/Player/eKnowledge/2013-state-of-devops-report.pdf.

Prugh reported that... Scott Prugh and Erica Morrison, "DOES15 - Scott Prugh & Erica Morrison - Conway & Taylor Meet the Strangler (v2.0)," YouTube video, 29:39, posted by DevOps Enterprise Summit, November 5, 2015, https://www.youtube.com/watch?v=tKdIHCLoDUg.

159 *Consider the following*... Tim Tischler, personal conversation with Gene Kim, FlowCon 2013.

In practice, the... Puppet Labs and IT Revolution Press, *2013 State of DevOps Report*.

161 *In Puppet Lab's*... Velasquez, Kim, Kersten, and Humble, *2014 State of DevOps Report*.

162 *The deployment process*... Chad Dickerson, "Optimizing for developer happiness," CodeAsCraft.com, June 6, 2011, https://codeascraft.com/2011/06/06/optimizing-for-developer-happiness/.

As Noah Sussman... Noah Sussman and Laura Beth Denker, "Divide and Conquer," CodeAsCraft.com, April 20, 2011, https://codeascraft
.com/2011/04/20/divide-and-concur/.

Sussman writes, "Through... Ibid.

163 *If all the tests*... Ibid.

Once it is an.. Erik Kastner, "Quantum of Deployment," CodeAsCraft.com, May 20, 2010, https://codeascraft.com/2010/05
/20/quantum-of-deployment/.

168 *This technique was*... Timothy Fitz, "Continuous Deployment at IMVU: Doing the impossible fifty times a day," TimothyFitz.com, February 10, 2009, http://timothyfitz.com/2009/02/10/continuous
-deployment-at-imvu-doing-the-impossible-fifty-times-a-day/.

This pattern is... Fitz, "Continuous Deployment," TimothyFitz.com.; Michael Hrenko, "DOES15 - Michael Hrenko - DevOps Insured By Blue Shield of California," YouTube video, 42:24, posted by DevOps Enterprise Summit, November 5, 2015, https://www.youtube.com
/watch?v=NlgrOT24UDw.

Dan North and Dave... Humble and Farley, *Continuous Delivery*, 265.

171 *The cluster immune*... Eric Ries, *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses* (New York: Random House, 2011), Audiobook.

172 *One sophisticated example*... Andrew 'Boz' Bosworth, "Building and testing at Facebook," post on Boz Facebook page, August 8, 2012, https://www.facebook.com/notes/facebook-engineering/building
-and-testing-at-facebook/10151004157328920; "Etsy's Feature flagging API used for operational rampups and A/B testing," GitHub.com, https://github.com/etsy/feature; "Library for configuration management API," GitHub.com, https://github.com
/Netflix/archaius.

173 *In 2009, when*... John Allspaw, "Convincing management that cooperation and collaboration was worth it," KitchenSoap.com, January 5, 2012, http://www.kitchensoap.com/2012/01/05/convincing-management-that-cooperation-and-collaboration-was
-worth-it/.

174 *Similarly, as Chuck*... Rossi, "Release engineering and push karma."

For nearly a decade... Emil Protalinski, "Facebook passes 1.55B monthly active users and 1.01B daily active users," *Venture Beat*, November 4, 2015, http://venturebeat.com/2015/11/04/facebook
-passes-1-55b-monthly-active-users-and-1-01-billion-daily-active
-users/.

174 *By 2015, Facebook*... Ibid.

Eugene Letuchy, an...Eugene Letuchy, "Facebook Chat," post on Eugene Letuchy's Facebook page, May 3, 2008, http://www
.facebook.com/note.php?note_id=14218138919&id=944554719.

Implementing this computationally-intensive... Ibid.

175 *As Letuchy wrote*... Ibid.

However, in 2015...Jez Humble, personal correspondence with Gene Kim, 2014.

176 *His updated definitions*...Ibid.

At Amazon and...Ibid.

CHAPTER 13

179 *This is the*...Jez Humble, "What is Continuous Delivery," ContinuousDelivery.com, accessed May 28, 2016, https://continuousdelivery.com/.

He observes that... Kim, Gruver, Shoup, and Phillips, "Exploring the Uncharted Territory of Microservices."

He reflects, "Looking... Ibid.

eBay's architecture went... Shoup, "From Monolith to Micro-services."

180 *Charles Betz, author*... Charles Betz, *Architecture and Patterns for IT Service Management, Resource Planning, and Governance: Making Shoes for the Cobbler's Children* (Witham, MA: Morgan Kaufmann, 2011), 300.

182 *As Randy Shoup*... Randy Shoup, "From the Monolith to Micro-services," Slideshare.net, posted by Randy Shoup, October 8, 2014, http://www.slideshare.net/RandyShoup/goto-aarhus2014-enterprisearchitecturemicroservices.

Shoup notes, "Organizations... Ibid.

As Randy Shoup observes... Ibid.

184 *One of the most*... Werner Vogels, "A Conversation with Werner Vogels," *acmqueque* 4, no. 4 (2006): 14-22, http://queue.acm.org/detail.cfm?id=1142065.

Vogel tells Gray... Ibid.

Describing the thought... Ibid.

Vogel notes, "The... Ibid.

185 *In 2011, Amazon*... John Jenkins, "Velocity 2011: Jon Jenkins, "Velocity Culture,"" YouTube video, 15:13, posted by O'Reilly, June 20, 2011, {https://www.youtube.com/watch?v=dxk8b9rSKOo.

185 *By 2015, they*... Ken Exner, "Transforming Software Development," YouTube video, 40:57, posted by Amazon Web Services, April 10, 2015, https://www.youtube.com/watch?v=YCrhemssYuI&feature=youtu.be.

The term strangler... Martin Fowler, "StranglerApplication," MartinFowler.com, June 29, 2004, http://www.martinfowler.com/bliki/StranglerApplication.html.

When we implement... Boris Lublinsky, "Versioning in SOA," *The Architecture Journal*, April 2007, https://msdn.microsoft.com/en-us/library/bb491124.aspx.

186 *The strangler application*... Paul Hammant, "Introducing Branch by Abstraction," PaulHammant.com, April 26, 2007, http://paulhammant.com/blog/branch_by_abstraction.html.

An observation from... Martin Fowler, "StranglerApplication," MartinFowler.com, June 29, 2004, http://www.martinfowler.com/bliki/StranglerApplication.html.

Blackboard Inc., is... Gregory T. Huang, "Blackboard CEO Jay Bhatt on the Global Future of Edtech," *Xconomy,* June 2, 2014, http://www.xconomy.com/boston/2014/06/02/blackboard-ceo-jay-bhatt-on-the-global-future-of-edtech/.

187 *As David Ashman*... David Ashman, "DOES14 - David Ashman - Blackboard Learn - Keep Your Head in the Clouds," YouTube video, 30:43, posted by DevOps Enterprise Summit 2014, October 28, 2014, https://www.youtube.com/watch?v=SSmixnMpsI4.

In 2010, Ashman... Ibid.

How this started...David Ashman, personal correspondence with Gene Kim, 2014.

Ashman noted. "To... Ibid.

188 *"In fact," Ashman*... Ibid.

189 *Ashman concluded, "Having*... Ibid.

CHAPTER 14

195 *In Operations, we*... Kim, Behr, and Spafford, *The Visible Ops Handbook: Implementing ITIL in 4 Practical and Auditable Steps* (Eugene, OR: IT Process Institute, 2004), Kindle edition, Introduction.

In contrast, the... Ibid.

In other words...Ibid.

196 *To enable this*... "Telemetry," *Wikipedia*, last modified May 5, 2016, https://en.wikipedia.org/wiki/Telemetry.

McDonnell described how... Michael Rembetsy and Patrick McDonnell, "Continuously Deploying Culture: Scaling Culture at Etsy - Velocity Europe 2012," Slideshare.net, posted by Patrick McDonnell, October 4, 2012, http://www.slideshare.net/mcdonnps
/continuously-deploying-culture-scaling-culture-at-etsy-14588485.

McDonnell explained further... Ibid.

By 2011, Etsy... John Allspaw, personal conversation with Gene Kim, 2014.

197 *As Ian Malpass*... Ian Malpass, "Measure Anything, Measure Everything," CodeAsCraft.com, February 15, 2011, http://codeascraft
.com/2011/02/15/measure-anything-measure-everything/.

197 *One of the findings*... Kersten, IT Revolution, and PwC, *2015 State of DevOps Report*.

The top two... "2014 State Of DevOps Findings! Velocity Conference," Slideshare.net, posted by Gene Kim, June 30, 2014, http://www
.slideshare.net/realgenekim/2014-state-of-devops-findings
-velocity-conference.

198 *In* The Art... James Turnbull, *The Art of Monitoring* (Seattle, WA: Amazon Digital Services, 2016), Kindle edition, Introduction.

200 *The resulting capability...* "Monitorama - Please, no more Minutes, Milliseconds, Monoliths or Monitoring Tools," Slideshare.net, posted by Adrian Cockcroft, May 5, 2014, http://www.slideshare
.net/adriancockcroft/monitorama-please-no-more.

201 *Scott Prugh, Chief*... Prugh, "DOES14: Scott Prugh, CSG - DevOps and Lean in Legacy Environments."

To support these... Brice Figureau, "The 10 Commandments of Logging," Mastersen's Blog, January 13, 2013, http://www.masterzen.fr/2013/01/13/the-10-commandments-of-logging/.

202 *Choosing the right*... Dan North, personal correspondence with Gene Kim, 2016.

To help ensure... Anton Chuvakin, "LogLogic/Chuvakin Log Checklist," republished with permission, 2008, http://juliusdavies
.ca/logging/llclc.html.

203 *In 2004, Kim...* Kim, Behr, and Spafford, *The Visible Ops Handbook*, Introduction.

204 *This was the*... Dan North, "Ops and Operability," SpeakerDeck.com, February 25, 2016, https://speakerdeck.com/tastapod/ops-and
-operability.

As John Allspaw... John Allspaw, personal correspondence with Gene Kim, 2011.

206 *This is often*... "Information Radiators," AgileAlliance.com, accessed May 31, 2016, https://www.agilealliance.org/glossary/incremental
-radiators/.

207 *Although there may*.. Ernest Mueller, personal correspondence with Gene Kim, 2014.

Prachi Gupta, Director... Prachi Gupta, "Visualizing LinkedIn's Site Performance," LinkedIn Engineering blog, June 13, 2011, https://engineering.linkedin.com/25/visualizing-linkedins-site
-performance.

208 *Thus began Eric*... Eric Wong, "Eric the Intern: the Origin of InGraphs," LinkedIn, June 30, 2011, http://engineering.linkedin
.com/32/eric-intern-origin-ingraphs.

Wong wrote, "To... Ibid.

At the time... Ibid.

In writing about... Gupta, "Visualizing LinkedIn's Site Performance."

210 *Ed Blankenship, Senior*... Ed Blankenship, personal correspondence with Gene Kim, 2016.

212 *However, increasingly these*... Mike Burrows, "The Chubby lock service for loosely-coupled distributed systems," *OSDI'06: Seventh Symposium on Operating System Design and Implementation*, November 2006, http://static.googleusercontent.com
/media/research.google.com/en//archive/chubby-osdi06.pdf.

212 *Consul may be…* Jeff Lindsay, "Consul Service Discovery with Docker," Progrium.com, August 20, 2014, http://progrium.com
/blog/2014/08/20/consul-service-discovery-with-docker.

213 *As Jody Mulkey…* Jody Mulkey, "DOES15 - Jody Mulkey - DevOps in the Enterprise: A Transformation Journey," YouTube video, 28:22, posted by DevOps Enterprise Summit, November 5, 2015, https://www.youtube.com/watch?v=USYrDaPEFtM.

CHAPTER 15

215 *In 2015, Netflix…* Netflix Letter to Shareholders, January 19, 2016, http://files.shareholder.com/downloads/NFLX/2432188684
x0x870685/C6213FF9-5498-4084-A0FF-74363CEE35A1/Q4_15
_Letter_to_Shareholders_-_COMBINED.pdf.

Roy Rapoport describes… Roy Rapoport, personal correspondence with Gene Kim, 2014.

One of the statistical… Victoria Hodge and Jim Austin, "A Survey of Outlier Detection Methodologies," *Artificial Intelligence Review* 22, no. 2 (October 2004): 85-126, http://www.geo.upm.es/postgrado/CarlosLopez/papers/Hodge+Austin_OutlierDetection_AIRE381
.pdf.

Rapoport explains that.. Roy Rapoport, personal correspondence with Gene Kim, 2014.

216 *Rapoport continues, "We…* Ibid.

Rapoport states that… Ibid.

*As John Vincent…*Toufic Boubez, "Simple math for anomaly detection toufic boubez - metafor software - monitorama pdx 2014-05-05," Slideshare.net, posted by tboubez, May 6, 2014, http://www.slideshare.net/tboubez/simple-math-for-anomaly
-detection-toufic-boubez-metafor-software-monitorama-pdx
-20140505.

218 *Tom Limoncelli, co-author…* Tom Limoncelli, "Stop monitoring whether or not your service is up!," EverythingSysAdmin.com, November 27, 2013, http://everythingsysadmin.com/2013/11/stop
-monitoring-if-service-is-up.html.

219 *As Dr. Toufic…* Toufic Boubez, "Simple math for anomaly detection toufic boubez - metafor software - monitorama pdx 2014-05-05," Slideshare.net, posted by tboubez, May 6, 2014, http://www.slideshare.net/tboubez/simple-math-for-anomaly-detection
-toufic-boubez-metafor-software-monitorama-pdx
-20140505.

220 *Dr. Nicole Forsgren…*Dr. Nicole Forsgren, personal correspondence with Gene Kim, 2015.

221 *Scryer works by…* Daniel Jacobson, Danny Yuan, and Neeraj Joshi, "Scryer: Netflix's Predictive Auto Scaling Engine," *The Netflix Tech Blog*, November 5, 2013, http://techblog.netflix.com/2013/11
/scryer-netflixs-predictive-auto-scaling.html.

222 *These techniques are…* Varun Chandola, Arindam Banerjee, and Vipin Kumar, "Anomaly detection: A survey," *ACM Computing Surveys* 41, no. 3 (July 2009): article no. 15, http://doi.acm.org/10
.1145/1541880.1541882.

Tarun Reddy, VP… Tarun Reddy, personal interview with Gene Kim, Rally headquarters, Boulder, CO, 2014.

224 *At Monitorama in* 2014… "Kolmogorov-Smirnov Test," *Wikipedia*, last modified May 19, 2016, http://en.wikipedia.org/wiki
/Kolmogorov%E2%80%93Smirnov_test.

225 *Even saying Kilmogorov-Smirnov…*"Simple math for anomaly detection toufic boubez - metafor software - monitorama pdx 2014-05-05," Slideshare.net, posted by tboubez, May 6, 2014, http://www.slideshare.net/tboubez/simple-math-for-anomaly-detection
-toufic-boubez-metafor-software-monitorama-pdx-20140505.

CHAPTER 16

227 *In 2006, Nick*... Mark Walsh, "Ad Firms Right Media, AdInterax Sell To Yahoo," *MediaPost,* October 18, 2006, http://www.mediapost.com
/publications/article/49779/ad-firms-right-media-adinterax-sell-to-yahoo.html?edition=.

Galbreath described the... Nick Galbreath, personal conversation with Gene, 2013.

However, Galbreath observed... Nick Galbreath, "Continuous Deployment - The New #1 Security Feature, from BSildesLA 2012," Slideshare.net, posted by Nick Galbreath, Aug 16, 2012, http://www.slideshare.net/nickgsuperstar/continuous-deployment-the-new-1
-security-feature.

After observing many... Ibid.

228 *Galbreath observes that*... Ibid.

231 *As Patrick Lightbody*... "Volocity 2011: Patrick Lightbody, 'From Inception to Acquisition,'" YouTube video, 15:28, posted by O'Reilly, June 17, 2011, https://www.youtube.com/watch?v=ShmPod8JecQ.

232 *As Arup Chakrabarti*... Arup Chakrabarti, "Common Ops Mistakes," presentation at Heavy Bit Industries, June 3, 2014, http://www
.heavybit.com/library/video/common-ops-mistakes/

233 *More recently, Jeff*... "From Design Thinking to DevOps and Back Again: Unifying Design & Operations," Vimeo video, 21:19, posted by William Evans, June 5, 2015, https://vimeo.com/129939230.

234 *As an anonymous*... Anonymous, personal conversation with Gene Kim, 2005.

Launch guidance and.. Tom Limoncelli, "SRE@Google: Thousands Of DevOps Since 2004," YouTube video of USENIX Association Talk, NYC, posted by USENIX, 45:57, posted January 12, 2012, http://www.youtube.com/watch?v=iIuTnhdTzK0.

238 *As Treynor Sloss has*... Ben Treynor, "Keys to SRE" (presentation, Usenix SREcon14, Santa Clara, CA, May 30, 2014), https://www
.usenix.org/conference/srecon14/technical-sessions/presentation
/keys-sre.

Treynor Sloss has resisted... Ibid.

Even when new... Limoncelli, "SRE@Google."

Tom Limoncelli noted... Ibid.

239 *Limoncelli noted, "In*... Ibid.

Furthemore, Limoncelli observed... Tom Limoncelli, personal correspondence with Gene Kim, 2016.

239 *Limoncelli explained, "Helping*...Ibid., 2015.

CHAPTER 17

241 *In general, Jez*... Humble, O'Reilly and Molesky, *Lean Enterprise*, Part II.

In 2012, they... Intuit, Inc., "2012 Annual Report: Form 10-K," July 31, 2012, http://s1.q4cdn.com/018592547/files/doc_financials/2012/INTU_2012_7_31_10K_r230_at_09_13_12_FINAL_and_Camera_Ready.pdf.

242 *Cook explained that*... Scott Cook, "Leadership in an Agile Age: An Interview with Scott Cook," Intuit.com, April 20, 2011, https://web
.archive.org/web/20160205050418/http://network.intuit.com/2011
/04/20/leadership-in-the-agile-age/

He continued, "By... Ibid.

243 *In previous eras*... "Direct Marketing," Wikipedia, last modified May 28, 2016, https://en.wikipedia.org/wiki/Direct_marketing.

Interestingly, it has... Freakonomics, "Fighting Poverty With Actual Evidence: Full Transcript," Freakonomics.com, November 27, 2013, http://freakonomics.com/2013/11/27/fighting-poverty-with-actual
-evidence-full-transcript/.

244 *Ronny Kohavi, Distinguished*... Ron Kohavi, Thomas Crook, and Roger Longbotham, "Online Experimentation at Microsoft," (paper presented at the Fifteenth ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, Paris, France, 2009), http://www.exp-platform.com/documents/exp_dmcasestudies.pdf.

Kohavi goes on...Ibid.

Jez Humble joked... Jez Humble, personal correspondence with Gene Kim, 2015.

245 *In a 2014*... Wang, Kendrick, "Etsy's Culture Of Continuous Experimentation and A/B Testing Spurs Mobile Innovation," Apptimize.com, January 30, 2014, http://apptimize.com/blog/2014/01/etsy-continuous-innovation-ab-testing/.

246 *Barry O'Reilly, co-author*... Barry O'Reilly, "How to Implement Hypothesis-Driven Development," BarryOReilly.com, October 21, 2013, http://barryoreilly.com/2013/10/21/how-to-implement-hypothesis-driven-development/.

In 2009, Jim... Gene Kim, "Organizational Learning and Competitiveness: Revisiting the "Allspaw/Hammond 10 Deploys Per Day at Flickr" Story," ITRevolution.com, 2015, http://itrevolution.com/organizational-learning-and-competitiveness-a-different-view-of-the-allspawhammond-10-deploys-per-day-at-flickr-story/.

247 *Stoneham observes that*... Ibid.

He continues, "These...Ibid.

Their astounding achievements... Ibid.

248 *Stoneham concluded, "This*... Ibid.

CHAPTER 18

249 *Once a pull*... Scott Chacon, "Github Flow," ScottChacon.com, August 31, 2011, http://scottchacon.com/2011/08/31/github-flow.html.

251 *For example, in*... Jake Douglas, "Deploying at Github," GitHub.com, August 29, 2012, https://github.com/blog/1241-deploying-at-github.

A fifteen minute... John Allspaw, "Counterfactual Thinking, Rules, and the Knight Capital Accident," KitchenSoap.com, October 29, 2013, http://www.kitchensoap.com/2013/10/29/counterfactuals-knight-capital/.

253 *One of the core*... Bradley Staats and David M. Upton, "Lean Knowledge Work," *Harvard Business Review*, October 2011, https://hbr.org/2011/10/lean-knowledge-work.

In the 2014... Velasquez, Kim, Kersten, and Humble, *2014 State of DevOps Report*.

255 *As Randy Shoup*... Randy Shoup, personal interview with Gene Kim, 2015.

256 *As Giary Özil*... Giray Özil, Twitter post, February 27, 2013, 10:42 a.m., https://twitter.com/girayozil/status/306836785739210752.

257 *As noted earlier...* Eran Messeri, "What Goes Wrong When Thousands of Engineers Share the Same Continuous Build?," (2013), http://scribes.tweetscriber.com/realgenekim/206.

In 2010, there... John Thomas and Ashish Kumar, "Welcome to the Google Engineering Tools Blog," Google Engineering Tools blog, posted May 3, 2011, http://google-engtools.blogspot.com/2011/05/welcome-to-google-engineering-tools.html.

This requires considerable... Ashish Kumar, "Development at the Speed and Scale of Google," (presentation at QCon, San Francisco, CA, 2010), https://qconsf.com/sf2010/dl/qcon-sanfran-2010/slides/AshishKumar_DevelopingProductsattheSpeedandScaleofGoogle.pdf.

258 *He said, "I*... Randy Shoup, personal correspondence with Gene Kim, 2014.

259 *Jeff Atwood, one*... Jeff Atwood, "Pair Programming vs. Code Reviews," CodingHorror.com, November 18, 2013, http://blog.codinghorror.com/pair-programming-vs-code-reviews/.

260 *He continued, "Most*... Ibid.

Dr. Laurie Williams performed... "Pair Programming," ALICE Wiki page, last modified April 4, 2014, http://euler.math.uga.edu/wiki/index.php?title=Pair_programming.

She argues that... Elisabeth Hendrickson, "DOES15 - Elisabeth Hendrickson - Its All About Feedback," YouTube video, 34:47, posted by DevOps Enterprise Summit, November 5, 2015, https://www.youtube.com/watch?v=r2BFTXBundQ.

261 *In her 2015*... Ibid.

The problem Hendrickson... Ibid.

Worse, skilled developers… Ibid.

Hendrickson lamented that… Ibid.

262 *That was an actual*… Ryan Tomayko and Shawn Davenport, personal interview with Gene Kim, 2013.

It is many… Ibid.

Reading through the… Ibid.

263 *Adrian Cockcroft observed*… Adrian Cockcroft, interview by Michael Ducy and Ross Clanton, "Adrian Cockcroft of Battery Ventures – the Goat Farm – Episode 8," *The Goat Farm*, podcast audio, July 31, 2015, http://goatcan.do/2015/07/31/adrian-cockcroft-of-battery-ventures-the-goat-farm-episode-8/.

Similarly, Dr. Tapabrata Pal… Tapabrata Pal, "DOES15 - Tapabrata Pal - Banking on Innovation & DevOps," YouTube video, 32:57, posted by DevOps Enterprise Summit, January 4, 2016, https://www.youtube.com/watch?v=bbWFCKGhxOs.

Jason Cox, Senior… Jason Cox, "Disney DevOps."

At Target in… Ross Clanton and Heather Mickman, 'DOES14 - Ross Clanton and Heather Mickman - DevOps at Target," YouTube video, 29:20, posted by DevOps Enterprise Summit 2014, October 29, 2014, https://www.youtube.com/watch?v=exrjV9V9vhY.

264 *"As we went*… Ibid.

She added, "I… Ibid.

Consider a story… John Allspaw and Jez Humble, personal correspondence with Gene Kim, 2014.

CHAPTER 19

271 *The result is*… Spear, *The High-Velocity Edge*, chap. 1.

"For such an… Ibid., chap. 10.

A striking example… Julianne Pepitone, "Amazon EC2 Outage Downs Reddit, Quora," *CNN Money*, April 22, 2011, http://money.cnn.com/2011/04/21/technology/amazon_server_outage.

In January 2013… Timothy Prickett Morgan, "A Rare Peek Into The Massive Scale of AWS," *Enterprise Tech*, November 14, 2014, http://www.enterprisetech.com/2014/11/14/rare-peek-massive-scale-aws/.

272 However, a *Netflix*… Adrian Cockcroft, Cory Hicks, and Greg Orzell, "Lessons Netflix Learned from the AWS Outage," *The Netflix Tech Blog*, April 29, 2011, http://techblog.netflix.com/2011/04/lessons-netflix-learned-from-aws-outage.html.

They did so… Ibid.

273 *Dr. Sidney Dekker*… Sidney Dekker, *Just Culture: Balancing Safety and Accountability* (Lund University, Sweden: Ashgate Publishing Company, 2007), 152.

He asserts that… "DevOpsDays Brisbane 2014 - Sidney Decker - System Failure, Human Error: Who's to Blame?" Vimeo video, 1:07:38, posted by info@devopsdays.org, 2014, https://vimeo.com/102167635.

273 *As John Allspaw*… Jenn Webb, interview with John Allspaw, "Post-Mortems, Sans Finger-Pointing," *The O'Reilly Radar Postcast*, podcast audio, August 21, 2014, http://radar.oreilly.com/2014/08/postmortems-sans-finger-pointing-the-oreilly-radar-podcast.html.

274 *Blameless post-mortems, a*… John Allspaw, "Blameless PostMortems and a Just Culture," CodeAsCraft.com, May 22, 2012, http://codeascraft.com/2012/05/22/blameless-postmortems/.

276 *Ian Malpass, an*… Ian Malpass, "DevOpsDays Minneapolis 2014 -- Ian Malpass, Fallible humans," YouTube video, 35:48, posted by DevOps Minneapolis, July 20, 2014, https://www.youtube.com/watch?v=5NY-SrQFrBU.

Dan Milstein, one… Dan Milstein, "Post-Mortems at HubSpot: What I Learned from 250 Whys," *HubSpot*, June 1, 2011, http://product.hubspot.com/blog/bid/64771/Post-Mortems-at-HubSpot-What-I-Learned-From-250-Whys.

277 *Randy Shoup, former*… Randy Shoup, personal correspondence with Gene Kim, 2014.

We may also… "Post-Mortem for February 24, 2010 Outage," Google App Engine website, March 4, 2010, https://groups.google.com/forum/#!topic/google-appengine/p2QKJ0OSLc8; "Summary of the Amazon DynamoDB Service Disruption and Related Impacts in the US-East Region," Amazon Web Services website, accessed May 28, 2016, https://aws.amazon.com/message/5467D2/.

This desire to... Bethany Macri, "Morgue: Helping Better Understand Events by Building a Post Mortem Tool - Bethany Macri," Vimeo video, 33:34, posted by info@devopsdays.org, October 18, 2013, http://vimeo.com/77206751.

For example, as... Spear, *The High-Velocity Edge*, chap. 4.

278 *Dr. Amy C. Edmondson*... Amy C. Edmondson, "Strategies for Learning from Failure," *Harvard Business Review*, April 2011, https://hbr.org/2011/04/strategies-for-learning-from-failure.

279 *Dr. Spear summarizes*... Ibid.

We now know... Ibid., chap. 3.

However, *prior to*... Michael Roberto, Richard M.J. Bohmer, and Amy C. Edmondson, "Facing Ambiguous Threats," *Harvard Business Review*, November 2006, https://hbr.org/2006/11/facing-ambiguous-threats/ar/1.

They describe how... Ibid.

280 *They observe, "Firms*... Ibid.

The authors conclude... Ibid.

On failures, Roy... Roy Rapoport, personal correspondence with Gene Kim, 2012.

He continues, "I... Ibid.

281 *He concludes, "DevOps*... Ibid.

As Michael Nygard... Michael T. Nygard, *Release It!: Design and Deploy Production-Ready Software* (Pragmatic Bookshelf: Raleigh, NC, 2007), Kindle edition, Part I.

281 *An even more*... Jeff Barr, "EC2 Maintenance Update," *AWS Blog*, September 25, 2014, https://aws.amazon.com/blogs/aws/ec2-maintenance-update/.

As Christos Kalantzis... Bruce Wong and Christos Kalantzis, "A State of Xen - Chaos Monkey & Cassandra," *The Netflix Tech Blog*, October 2, 2014, http://techblog.netflix.com/2014/10/a-state-of-xen-chaos-monkey-cassandra.html.

282 *But, Kalantzis continues*... Ibid.

As Kalantzis and... Ibid.

Even more surprising... Roy Rapoport, personal correspondence with Gene Kim, 2015.

Specific architectural patterns... Adrian Cockcroft, personal correspondence with Gene Kim, 2012.

In this section... Jesse Robbins, "GameDay: Creating Resiliency Through Destruction - LISA11," Slideshare.net, posted by Jesse Robbins, December 7, 2011, http://www.slideshare.net/jesserobbins/ameday-creating-resiliency-through-destruction.

Robbins defines resilience... Ibid.

283 *Jesse Robbins observes*... Jesse Robbins, Kripa Krishnan, John Allspaw, and Tom Limoncelli, "Resilience Engineering: Learning to Embrace Failure," *amcqueue* 10, no. 9 (September 13, 2012): https://queue.acm.org/detail.cfm?id=2371297.

As Robbins quips... Ibid.

As Robbins describes... Ibid.

Robbins explains, "You... Ibid.

284 *During that time*... "Kripa Krishnan: 'Learning Continuously From Failures' at Google," YouTube video, 21:35, posted by Flowcon, November 11, 2014, https://www.youtube.com/watch?v=KqqS3wgQum0.

Krishnan wrote, "An... Kripa Krishnan, "Weathering the Unexpected," *Communications of the ACM* 55, no. 11 (November 2012): 48-52, http://cacm.acm.org/magazines/2012/11/156583-weathering-the-unexpected/abstract.

Some of the learnings... Ibid.

285 *As Peter Senge*... Widely attributed to Peter Senge.

CHAPTER 20

287 *As Jesse Newland*... Jesse Newland, "ChatOps at GitHub," SpeakerDeck.com, February 7, 2013, https://speakerdeck.com/jnewland/chatops-at-github.

288 *As Mark Imbriaco*... Mark Imbriaco, personal correspondence with Gene Kim, 2015.

They enabled Hubot... Newland, "ChatOps at GitHub."

289 *Hubot often performed*... Ibid.

289 *Newland observes that*...Ibid.

290 *Instead of putting*... Leon Osterweil, "Software processes are software too," paper presented at International Conference on Software Engineering, Monterey, CA, 1987, http://www.cs.unibo.it/cianca/wwwpages/ids/letture/Osterweil.pdf.

Justin Arbuckle was... Justin Arbuckle, "What Is ArchOps: Chef Executive Roundtable" (2013).

What resulted was... Ibid.

Arbuckle's conclusion was... Ibid.

291 *By 2015, Google*... Cade Metz, "Google Is 2 Billion Lines of Code—and It's All in One Place," *Wired*, September 16, 2015, http://www.wired.com/2015/09/google-2-billion-lines-codeand-one-place/.

The Chrome and... Ibid.

Rachel Potvin, a... Ibid.

Furthermore, as Eran... Eran Messeri, "What Goes Wrong When Thousands of Engineers Share the Same Continuous Build?" (2013), http://scribes.tweetscriber.com/realgenekim/206.

As Randy Shoup... Randy Shoup, personal correspondence with Gene Kim, 2014.

292 *Tom Limoncelli, co-author*... Tom Limoncelli, "Yes, you can really work from HEAD," EverythingSysAdmin.com, March 15, 2014, http://everythingsysadmin.com/2014/03/yes-you-really-can-work-from-head.html.

296 *Tom Limoncelli describes*... Tom Limoncelli, "Python is better than Perl6," EverythingSysAdmin.com, January 10, 2011, http://everythingsysadmin.com/2011/01/python-is-better-than-perl6.html.

297 *Google used C++*... "Which programming languages does Google use internally?," Quora.com forum, accessed May 29, 2016, https://www.quora.com/Which-programming-languages-does-Google-use-internally.; "When will Google permit languages other than Python, C++, Java and Go to be used for internal projects?," Quora.com forum, accessed May 29, 2016, https://www.quora.com/When-will-Google-permit-languages-other-than-Python-C-Java-and-Go-to-be-used-for-internal-projects/answer/Neil-Kandalgaonkar.

In a presentation... Ralph Loura, Olivier Jacques, and Rafael Garcia, "DOES15 - Ralph Loura, Olivier Jacques, & Rafael Garcia - Breaking Traditional IT Paradigms to...," YouTube video, 31:07, posted by DevOps Enterprise Summit, November 16, 2015, https://www.youtube.com/watch?v=q9nNqqie_sM.

In many organizations... Michael Rembetsy and Patrick McDonnell, "Continuously Deploying Culture: Scaling Culture at Etsy - Velocity Europe 2012," Slideshare.net, posted by Patrick McDonnell, October 4, 2012, http://www.slideshare.net/mcdonnps/continuously-deploying-culture-scaling-culture-at-etsy-14588485.

At that time, Etsy... Ibid.

298 *Over the next*... Ibid.

Similarly, Dan McKinley... Dan McKinley, "Why MongoDB Never Worked Out at Etsy," McFunley.com, December 26, 2012, http://mcfunley.com/why-mongodb-never-worked-out-at-etsy.

CHAPTER 21

299 *One of the*... "Kaizen," *Wikipedia*, last modified May 12, 2016, https://en.wikipedia.org/wiki/Kaizen.

Dr. Spear explains... Spear, *The High-Velocity Edge*, chap. 8.

Spear observes that... Ibid.

300 *Clanton describes, "We*... Mickman and Clanton, "(Re)building an Engineering Culture."

Ravi Pandey, a... Ravi Pandey, personal correspondence with Gene Kim, 2015.

Clanton expands on... Mickman and Clanton, "(Re)building an Engineering Culture."

301 *In addition to*... Hal Pomeranz, "Queue Inversion Week," *Righteous IT*, February 12, 2009, https://righteousit.wordpress.com/2009/02/12/queue-inversion-week/.

302 *As Dr. Spear*... Spear, *The High-Velocity Edge*, chap. 3.

In an interview with Jessica... Jessica Stillman, "Hack Days: Not Just for Facebookers," *Inc.*, February 3, 2012, http://www.inc.com/jessica-stillman/hack-days-not-just-for-facebookers.html.

In 2008, Facebook... AP, "Number of active users at Facebook over the years," *Yahoo! News*, May 1, 2013, https://www.yahoo.com/news/number-active-users-facebook-over-230449748.html?ref=gs.

During a hack… Haiping Zhao, "HipHop for PHP: Move Fast," post on Haiping Zhao's Facebook page, February 2, 2010, https://www.facebook.com/notes/facebook-engineering/hiphop-for-php-move-fast/280583813919.

In an interview with Cade… Cade Metz, "How Three Guys Rebuilt the Foundation of Facebook," *Wired*, June 10, 2013, http://www.wired.com/wiredenterprise/2013/06/facebook-hhvm-saga/all/.

303 *Steve Farley, VP*… Steve Farley, personal correspondence with Gene Kim, January 5, 2016.

Karthik Gaekwad, who… "Agile 2013 Talk: How DevOps Change Everything," Slideshare.net, posted by Karthik Gaekwad, August 7, 2013, http://www.slideshare.net/karthequian/howdevopschangeseverythingagile2013karthikgaekwad/.

304 *As Glenn O'Donnell*… Glenn O'Donnell, "DOES14 - Glenn O'Donnell - Forrester - Modern Services Demand a DevOps Culture Beyond Apps," YouTube video, 12:20, posted by DevOps Enterprise Summit 2014, November 5, 2014, https://www.youtube.com/watch?v=pvPWKuO4_48.

305 *As of 2014*… Nationwide, *2014 Annual Report,* https://www.nationwide.com/about-us/nationwide-annual-report-2014.jsp.

Steve Farley, VP… Steve Farley, personal correspondence with Gene Kim, 2016.

305 *Capital One, one*… "DOES15 - Tapabrata Pal - Banking on Innovation & DevOps," YouTube video, 32:57, posted by DevOps Enterprise Summit, January 4, 2016, https://www.youtube.com/watch?v=bbWFCKGhxOs.

Dr. Tapabrata Pal… Tapabrata Pal, personal correspondence with Gene Kim, 2015.

Target is the… "Corporate Fact Sheet," Target company website, accessed June 9, 2016, https://corporate.target.com/press/corporate.

Incidentally, the first… Evelijn Van Leeuwen and Kris Buytaert, "DOES15 - Evelijn Van Leeuwen and Kris Buytaert - Turning Around the Containership," YouTube video, 30:28, posted by DevOps Enterprise Summit, December 21, 2015, https://www.youtube.com/watch?v=0GId4AMKvPc.

306 *Clanton describes, "2015*… Mickman and Clanton, "(Re)building an Engineering Culture."

At Capital One… "DOES15 - Tapabrata Pal - Banking on Innovation & DevOps," YouTube video, 32:57, posted by DevOps Enterprise Summit, January 4, 2016, https://www.youtube.com/watch?v=bbWFCKGhxOs.

Bland explains that…Bland, "DOES15 - Mike Bland - Pain Is Over, If You Want It."

Even though they… Ibid.

They used several… Ibid.

Bland described, "The… Ibid.

Bland continues, "One … Ibid.

307 *As Bland describes* … Ibid.

Bland continues, "It … Ibid.

He continues, "The … Ibid.

Bland describes fixits… Mike Bland, "Fixits, or I Am the Walrus," Mike-Bland.com, October 4, 2011, https://mike-bland.com/2011/10/04/fixits.html.

This Fixits, as… Ibid.

CHAPTER 22

313 *One of the top*… James Wickett, "Attacking Pipelines--Security meets Continuous Delivery," Slideshare.net, posted by James Wickett, June 11, 2014, http://www.slideshare.net/wickett/attacking-pipelinessecurity-meets-continuous-delivery.

James Wickett, one… Ibid.

Similar ideas were… Tapabrata Pal, "DOES15 - Tapabrata Pal - Banking on Innovation & DevOps," YouTube video, 32:57, posted by DevOps Enterprise Summit, January 4, 2016, https://www.youtube.com/watch?v=bbWFCKGhxOs.

314 *Justin Arbuckle, former*… Justin Arbuckle, personal interview with Gene Kim, 2015.

He continues, "*By*… Ibid.

314 *This helped the*… Snehal Antani, "IBM Innovate DevOps Keynote," YouTube video, 47:57, posted by IBM DevOps, June 12, 2014, https://www.youtube.com/watch?v=s0M1P05-6Io.

315 *In a presentation*... Nick Galbreath, "DevOpsSec: Appling DevOps Principles to Security, DevOpsDays Austin 2012," Slideshare, posted by Nick Galbreath, April 12, 2012, http://www.slideshare.net/nickgsuperstar/devopssec-apply-devops-principles-to-security.

Furthermore, he states... Ibid.

320 *Furthermore, we should*... "OWASP Cheat Sheet Series," OWASP.org, last modified March 2, 2016, https://www.owasp.org/index.php/OWASP_Cheat_Sheet_Series.

The scale of... Justin Collins, Alex Smolen, and Neil Matatall, "Putting to your Robots to Work V1.1," Slideshare.net, posted by Neil Matatall, April 24, 2012, http://www.slideshare.net/xplodersuv/sf-2013-robots/.

In early 2009... "What Happens to Companies That Get Hacked? FTC Cases," Giant Bomb forum, posted by SuicidalSnowman, July 2012, http://www.giantbomb.com/forums/off-topic-31/what-happens-to-companies-that-get-hacked-ftc-case-540466/.

321 *In their previously*... Collins, Smolen, and Matatall, "Putting to your Robots to Work V1.1."

322 *The first big*... Twitter Engineering, "Hack Week @ Twitter," Twitter blog, January 25, 2012, https://blog.twitter.com/2012/hack-week-twitter.

323 *Josh Corman observed*... Josh Corman and John Willis, "Immutable Awesomeness - Josh Corman and John Willis at DevOps Enterprise Summit 2015," YouTube video, 34:25, posted by Sonatype, October 21, 2015, https://www.youtube.com/watch?v=-S8-lrm3iV4.

In the 2014...Verizon, "2014 Data Breach Investigations Report," (Verizon Enterprise Solutions, 2014), https://dti.delaware.gov/pdfs/rp_Verizon-DBIR-2014_en_xg.pdf.

324 *In 2015, this*... "2015 State of the Software Supply Chain Report: Hidden Speed Bumps on the Way to 'Continuous,'" (Fulton, MD: Sonatype, Inc, 2015), http://cdn2.hubspot.net/hubfs/1958393/White_Papers/2015_State_of_the_Software_Supply_Chain_Report-.pdf?t=1466775053631.

The last statistic... Dan Geer and Joshua Corman, "Almost Too Big to Fail," *;login:: The Usenix Magazine*, 39, no. 4 (August 2014): 66-68, https://www.usenix.org/system/files/login/articles/15_geer_0.pdf.

325 *US Federal Government*... Wyatt Kash, "New details released on proposed 2016 IT spending," *FedScoop,* February 4, 2015, http://fedscoop.com/what-top-agencies-would-spend-on-it-projects-in-2016.

As Mike Bland... Bland, "DOES15 - Mike Bland - Pain Is Over, If You Want It."

326 *Furthermore, the Cloud.gov*... Mossadeq Zia, Gabriel Ramírez, Noah Kunin, "Compliance Masonry: Bulding a risk management platform, brick by brick," *18F*, April 15, 2016, https://18f.gsa.gov/2016/04/15/compliance-masonry-buildling-a-risk-management-platform/.

Marcus Sachs, one... Marcus Sachs, personal correspondence with Gene Kim, 2010.

328 *We need to*... "VPC Best Configuration Practices," Flux7 blog, January 23, 2014, http://blog.flux7.com/blogs/aws/vpc-best-configuration-practices.

In 2010, Nick... Nick Galbreath, "Fraud Engineering, from Merchant Risk Council Annual Meeting 2012," Slideshare.net, posted by Nick Galbreath, May 3, 2012, http://www.slideshare.net/nickgsuperstar/fraud-engineering.

329 *Of particular concern*... Nick Galbreath, "DevOpsSec: Appling DevOps Principles to Security, DevOpsDays Austin 2012," Slideshare.net, posted by Nick Galbreath, April 12, 2013, http://www.slideshare.net/nickgsuperstar/devopssec-apply-devops-principles-to-security.

We were always... Ibid.

This was a ridiculously... Ibid.

As Galbreath observed... Ibid.

330 *Galbreath observed, "One*... Ibid.

As Jonathan Claudius... Jonathan Claudius, "Attacking Cloud Services with Source Code," Speakerdeck.com, posted by Jonathan Claudius, April 16, 2013, https://speakerdeck.com/claudijd/attacking-cloud-services-with-source-code.

CHAPTER 23

334 *ITIL defines utility... Axelos, ITIL Service Transition* (ITIL Lifecycle Suite) (Belfast, Ireland: TSO, 2011), 48.

337 *Salesforce was founded*... Reena Matthew and Dave Mangot, "DOES14 - Reena Mathew and Dave Mangot - Salesforce," Slideshare.net, posted by ITRevolution, October 29, 2014, http://www.slideshare.net/ITRevolution/does14-reena-matthew-and-dave-mangot-salesforce.

By 2007, the... Dave Mangot and Karthik Rajan, "Agile.2013.effecting.a.dev ops.transformation.at.salesforce," Slideshare.net, posted by Dave Mangot, August 12, 2013, http://www.slideshare.net/dmangot/agile2013effectingadev-opstransformationatsalesforce.

Karthik Rajan, then... Ibid.

At the 2014... Matthew and Mangot, "DOES14 - Salesforce."

338 *For Mangot and* ... Ibid.

Furthermore, they noted ... Ibid.

339 *Bill Massie is*... Bill Massie, personal correspondence with Gene Kim, 2014.

340 *Because the scope*... "Glossary," PCI Security Standards Council website, accessed May 30, 2016, https://www.pcisecuritystandards.org/pci_security/glossary.

Are code review... PCI Security Standards Council, *Payment Card Industry (PCI) Data Security Stands: Requirements and Security Assessment Procedures, Version* 3.1 (PCI Security Standards Council, 2015), Section 6.3.2. https://webcache.googleusercontent.com/search?q=cache:hpRe2COzzdAJ:https://www.cisecuritystandards.org/documents/PCI_DSS_v3-1_SAQ_D_Merchant_rev1-1.docx+&cd=2&hl=en&ct=clnk&gl=us.

341 *To fulfill this*... Bill Massie, personal correspondence with Gene Kim, 2014.

Massie observes that... Ibid.

As a result... Ibid.

342 *As Bill Shinn*... Bill Shinn, "DOES15 - Bill Shinn - Prove it! The Last Mile for DevOps in Regulated Organizations," Slideshare.net, posted by ITRevolution, November 20, 2015, http://www.slideshare.net/ITRevolution/does15-bill-shinn-prove-it-the-last-mile-for-devops-in-regulated-organizations.

Helping large enterprise... Ibid.

Shinn notes, "One ... Ibid.

"That was fine ... Ibid.

He explains, "In ... Ibid.

343 *Shinn states that* ... Ibid.

Shinn continues, "With... Ibid.

That requires deriving ... Ibid.

Shinn continues, "How ... Ibid.

Shinn gives an... Ibid.

To helps solve... James DeLuccia, Jeff Gallimore, Gene Kim, and Byron Miller, *DevOps Audit Defense Toolkit* (Portland, OR: IT Revolution, 2015), http://itrevolution.com/devops-and-auditors-the-devops-audit-defense-toolkit.

344 *She made the*... Mary Smith (a pseudonym), personal correspondence with Gene Kim, 2013

She observed: ... Ibid., 2014.

CONCLUSION

349 *As Jesse Robbins*... "Hacking Culture at VelocityConf," Slideshare.net, posted by Jesse Robbins, June 28, 2012, http://www.slideshare.net/jesserobbins/hacking-culture-at-velocityconf.

APPENDIX

353 *The Lean movement started*... Ries, *The Lean Startup.*

354 *A key principal*... Kent Beck et al., "Twelve Principles of Agile Software," AgileManifesto.org, 2001, http://agilemanifesto.org/principles.html.

Building upon the... Humble and Farley, *Continuous Delivery*.

This idea was... Fitz, "Continuous Deployment at IMVU."

355 *Toyota Kata describes*... Rother, *Toyota Kata,* Introduction.

His conclusion was... Ibid..

355 *In 2011, Eric…* Ries, *The Lean Startup.*

358 *In the Phoenix…* Kim, Behr, and Spafford, *The Phoenix Project,* 365.

360 *Myth 1: "Human…* Denis Besnard and Erik Hollnagel, *Some Myths about Industrial Safety*(Paris, Centre De Recherche Sur Les Risques Et Les Crises Mines, 2012), 3, http://gswong.com/?wpfb_dl=31.

Myth 2: "Systems… Ibid., 4.

Myth 3: "Safety… Ibid., 6.

Myth 4: "Accident… Ibid., 8.

Myth 5: "Accident… Ibid., 9.

Myth 6: Safety… Ibid., 11.

Rather, when the… John Shook, "Five Missing Pieces in Your Standardized Work (Part 3 of 3)," Lean.org, October 27, 2009, http://www.lean.org/shook/DisplayObject.cfm?o=1321.

363 *Time to resolve…* "Post Event Retrospective - Part 1," Rally Blogs, accessed May 31, 2016, https://www.rallydev.com/blog/engineering/post-event-retrospective-part-i.

Bethany Macri, from… "Morgue: Helping Better Understand events by Building a Post Mortem Tool - Bethany Macri," Vimeo video, 33:34, posted by info@devopsdays.org, October 18, 2013, http://vimeo.com/77206751.

364 *These discussions have…* Cockcroft, Hicks, and Orzell, "Lessons Netflix Learned."

*Since then, Chaos…*Ibid.

365 *Lenny Rachitsky wrote…* Lenny Rachitsky, "7 Keys to a Successful Public Health Dashboard," *Transparent Uptime*, December 1, 2008, http://www.transparentuptime.com/2008/11/rules-for-successful-public-health.html.

Note: Figures are indicated with *f*; footnotes are indicated with *n*

SYMBOLS

NUMBERS

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