

## INDUSTRY'S VOICE

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# An Open Letter to JESA

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I challenge *JESA* to create the next generation of system administrators (SAs) who can meet a wide range of ever-changing duties and responsibilities. As I will show, this is necessary for society as a whole to continue to grow and survive.

## The Forest

Two people attempt to walk across a large forest.

The first person has no maps, no training, no tools or equipment. However, this person is very smart. Very, very smart. It will be difficult to make it to their destination. They will need to quickly figure out how to find food and water or they will starve. They will need to navigate based on educated guesses and not be deterred by missteps and dead-ends. Learning how to defend oneself against bears by trial and error seems like a losing proposition, but I suppose it can be done.

The second person has a recent map, training in outdoor survival skills, a proper compass, sleeping equipment, and a backpack. They know what plants are edible and which aren't. They know how to find safe drinking water. Recent plant growth has made their map slightly outdated but it is sufficient for their needs. Their training has prepared them to avoid bears and, more importantly, how not to attract them in the first place.

The first person's journey was high-stress, high-risk, and difficult work. When they were done they said, "I'm glad I made it!"

The second person completed their journey and said, "I'm glad my teachers prepared me so well!"

## Society Depends on System Administration

We often lose sight of how important teaching system administration is. It isn't just important, it is scary-important.

When old systems are "computerized" this means "they now depend on sysadmins."

We are living in an era where society has become dependent on computers to sustain itself. It used to be that if the computer was down, we would temporarily "switch back to paper" until the computer came back up.

We can't do that anymore. It isn't that IT is a part of how food gets from the farm to our plate, but rather that we, as a society, no longer know how to provide food without IT. The supply chain from fertilizer to supermarket is planned, executed and monitored at such a scale that it cannot be done manually. We literally do not know how to feed a city without IT. Medicine isn't just billed and administered with the assistance of IT, we literally can't provide medical services without IT anymore. Our entertainment, education, government, and economics are unsustainable without IT.

Excellence in system administration is key to sustaining civilization as we know it.

## The Sad State of System Administration

Sadly, we're collectively doing a lousy job at system administration.

Very few IT organizations know and follow best practices. Many IT organizations know that they exist but don't follow them for political, budgetary, or competency reason. The rest, and I fear they are the majority, don't even know that best practices exist.

Students are graduating from four-year programs without understanding the internals of systems, nor how to manage large complex systems as they exist in the real world. This would be like auto mechanics not being taught how an

internal combustion engine works or doctors somehow graduating medical school without knowing that patients are alive between office visits.

In other words, the state of IT is horrible. It is so bad that our jobs are being legislated. You know you're doing a bad job when legislation is created to set absolute minimum standards and yet they seem like difficult burdens. Sarbanes-Oxley essentially says, "If you are going to be so unbelievably stupid as to do backups without testing them, create accounts without having a mechanism to make sure they are disabled when the employee leaves, and let developers have unrestricted raw access to live databases, then we're going to legislate how you have to do your job." HIPAA essentially says that our industry has proven itself too incompetent to be trusted with securing databases or WiFi networks in hospitals.

Even though these laws require such ludicrously minimal basic best practices, they strike fear in the heart of the average IT department. It reminds me of stories that surgeons initially balked at the idea that they should wash their hands before surgery. President James A. Garfield might have survived assassination in 1881 if doctors hadn't probed his wound with dirty, unsterilized fingers and instruments. If that story made you think "euuuu," then I hope you feel the same way about sites that don't encrypt credit card information. Security compliance is hygiene.

## **System Administration is Becoming DevOps**

In the 20th century, the Lean Manufacturing movement transformed manufacturing. It applied scientific operations management to manufacturing and revolutionized it, making it more cost-effective, faster, and more profitable. You may have heard it called Supply Chain Management, or Just-In-Time Manufacturing, or The Toyota Production System. It went from being a rare thing to the only way manufacturing is done at scale.

DevOps is the application of Lean Manufacturing to information services, and it is having the same transformational effect. To a system administrator it may feel like a new thing, but to the large companies that employ them, it feels like IT has finally woken up. DevOps is moving from a rare thing to the only way IT services will be delivered.

As I write this, a major retailer is in the process of laying off IT workers, yet it has 60 openings for people with DevOps skills. Another major company has 500 open positions for DevOps-related positions. DevOps is the way forward for web companies, startups, enterprises, retail, and all industries.

DevOps takes the risky, stressful nature of IT and replaces it with consistent, reliable results. People that work in a DevOps environment have less stress, higher job satisfaction, and feel more motivated. Sysadmins that have moved into DevOps environments do not want to go back to the old ways. This is why Gene Kim famously wrote, "The opposite of DevOps is despair."

We must not just teach the bits and bytes of system administration. Students must learn the high-level strategies of DevOps and the best practices and tactics that implement it.

## **What We Need**

We need a new generation of sysadmins that are prepared to face the challenges of today and the future. Sysadmins need:

- **Deep technical knowledge of systems:** How CPUs, memory, storage, networking, and crypto work.
- **Software development experience:** How to automate systems, create tools, and build robust applications in support of operations.
- **The scientific process as applied to IT:** Engineering new systems and debugging existing systems should be based on science and evidence, not folklore and myth.
- **Strategies over specific technologies:** Technology changes rapidly, but strategies are timeless.
- **DevOps and SRE principles:** End-to-end system analysis, rapid iterations, automation, introspection, and balancing the need for change and stability.

- **A sense of duty and ethics:** With great power comes great responsibility.
- **The ability to adopt new technology:** We should instill a love of new technology as well as the wisdom to avoid snake-oil.

A **deep technical knowledge** of systems is required to administer today's large, complex systems. One can not design a large system, evaluate vendor claims, or fix a performance issue without understanding how modern multi-core CPUs work, how packets route, and the proper use and limits of crypto.

System administrators must be fully capable **software developers**. System administrators need to transition from being the people that do work to the people that maintain the automation that does work. Don't be the auto manufacturer assembly-line worker, be the person that maintains the robotics that build cars. This kind of software development requires dual expertise in systems and software engineering.

System administrators must be able to create automation so as to work smarter, not harder. They must be able to solve problems by glueing systems together using APIs and protocols. They must be skilled at creating new tools on demand using scripting languages. They must be able to create applications and self-service portals that relieve them from being in the loop, thus creating applications that empower and enable customers to be self-sufficient.

System administrators must also have enough software development experience that they can converse with developers in their own language, reason effectively when submitting bugs, and collaboratively design systems. They must understand what a developer means when told an algorithm scales  $O(n \log n)$ , yet they must also be able to explain when a CPU's L1 cache size is far more important.

We must encourage the use of the **scientific process** in IT to fight the constant flood of misinformation, myth, and rumor. Science requires measurement, experimentation, and iteration. It saddens me to see large projects fail because nobody took the time to measure actual latency, properly estimate storage requirements, or validate assumptions via evidence gathered through prototypes. It worries me that "Googling an error message" has become a first line of defense instead of a last resort after rigorous scientific methods have been exhausted. I fear that every time we accept cosmic rays as the cause of failure we are digging ourselves deeper into a hole. I cringe when, as happened recently, a technician tells me they'll never buy a hard drive from a particular vendor because the one in his home PC failed. I asked him which brand guaranteed supernatural perfection. He didn't have an answer.

Students should **learn strategies and best practices**, not just solutions for specific technologies. Technology is constantly changing. By learning generalized strategies and best practices, we prepare students for a career of constant change. Learning your fourth language is easier than the previous three because you've started to observe the common patterns between them. Strategies and best practices are the patterns that help us do our jobs as new technologies appear and evolve. Universities should be forbidden from offering vendor certification classes. Passing them off as "system administration" is harmful, unethical, and verges on malpractice. Would you trust a medical school that taught how to prescribe only one manufacturer's medicines?

**DevOps and SRE principles** are, essentially, bringing all aspects of operations science to the practice of IT systems and services. They take an end-to-end view, encouraging vertical integration over silos, and process and people over technology. They enable confidence to make rapid change and to innovate.

Because society depends on system administrators, and because of the power we wield, students must learn a **sense of duty**. There is an inherent responsibility and therefore system of **ethics** that are part of the job. Whether our systems control nuclear weapons, hospital monitoring equipment, the WiFi at a coffee shop, or a question and answer forum for English language and usage, our services exist because people depend on them. We have a duty to serve these people. Because the job of a system administrator inherently requires privileged access to systems and information, we have a higher bar for ethics. Every action we take has an ethical component: from not revealing personal information discovered while debugging a user's mail account, to deciding where to store backup data, to deciding how far to go in reporting when we see our employer is breaking the law.

Lastly we must teach the ability to adopt new technology. We should instill a love of new technology. To appreciate the value of change and innovation. The grandeur of how optimizing one part creates a cascade of changes. The way that each order of magnitude of reduced cost or size creates a new era of applications previously unimagined. Likewise, students must understand the Technology Adoption Lifecycle. They should appreciate how and why organizations are early adopters, technology laggards, and everything in between.

At the graduate level, students should go beyond the best practices and gain a deep knowledge of how they work. For every area of practice, they should know who originally created that area of practice, what the current accepted practice is in that area, and what the current cutting edge of that practice is.

### **Is System Administration about Failing to Fail?**

IT operations is often measured not by success, but by lack of failure. We don't notice a system that runs well, but a well-run system requires huge amounts of planning, skill, and effort.

I've been told that the most difficult part of being a salesperson is that you must hear many "nos" to get to a single "yes." Salespeople learn to not be discouraged by the "nos." They are what teaches them how to get to "yes."

System administration is not about failure. Students need to learn that system administration is about iterations and repetition. At the micro level, we try, try, try before we succeed. At the macro level, we learn to iterate quickly through many failures and learn our way to success.

### **The Challenges Ahead**

I see two major challenges for solving the problems and fulfilling the requirements I've listed above: creating a curriculum, and finding people to teach it.

One of the biggest challenges of creating a curriculum is fitting it all in two or four years. Just defining the minimum set of courses, to me, seems impossible. I'm a "yes/and" person.

It is tempting to focus the curriculum on building ideal systems from the ground up. However, the typical sysadmin's job is the opposite: they jump into an existing system which others have built, then slowly evolve it over time. Only once in my 25 years in system administration have I had the opportunity to start from a green field.

I think it would be useful to start students by giving them a completely working service and teaching them to maintain it and evolve it over time. Maybe each student receives a cluster of virtual machines that implement a web server, database, and load balancer. They would also be provided with a wiki of operational procedures which they would have to maintain. Assignments would be graded on completeness plus an evaluation of their updates to the wiki. Every so often the instructor would switch who was maintaining which cluster. Important lessons would be learned from inheriting their fellow student's messy systems and incomplete wiki documentation.

Another challenge is finding people to teach system administration. I hope *JESA* will be a forum to discuss successful ways to train, recruit, and retain excellent instructors.

To teach system administration, you must be a system administrator. In order to be able to teach relevant information, you will need to be an active systems or network administrator. Do real projects on campus or in industry. This is the only way to provide up-to-date, relevant, and applicable information.

Salaries in industry drain good people from academia. We are eating the seed corn.

### **Call to Action**

System administrators are the architects, engineers, and stewards of the interface between the digital world and the real world. Creating the next generation of system administrators is a moral imperative. Society depends on it.

I am excited to see USENIX creating the *Journal of Education in System Administration (JESA)*. USENIX is in the unique position of being the center of system administration innovation for three decades and still being on the cutting edge of systems, security, and network research.

I challenge educators to create future generations of system administrators that can meet all of these challenges I've listed and new ones yet undiscovered.

Education is one of the top predictors of health and wealth. We are not in the business of making system administrators: we are in the business of producing a path to a healthy, wealthy, life for millions of people.

If your institution has a successful program, use *JESA* to give it the visibility it deserves and let others learn from your experience. When you try something new, share your experiences, both positive and negative. Use this forum to propose new curriculum standards, ontologies, teaching methods, and formats. Invent. Disrupt the old ways. Set a new standard and raise the bar. Have a sense of urgency: Passion builds momentum!

Solving all the problems I've listed above is a long, difficult journey. It is a journey without end. It is a journey whose importance cannot be understated. Society depends on system administrators in ways that even we ourselves barely appreciate. This dependence will only grow over time. The forest is deep and wide and full of unexpected challenges, beautiful vistas, and a lot of scary bears.

An old African proverb states: "If you want to travel fast, travel alone. If you want to travel far, travel together."

Now we can travel this forest together.

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*The author wishes to thank the following for their feedback and review of drafts: Kyle Brandt, Katherine Daniels, Jason Punyon, Bart Silverstrim, and Sam Torno.*