EPISODE 944

[INTRODUCTION]

[00:00:00] JM: Drone applications are easy to imagine. Drones will deliver food to us. Drones will be able to extinguish fires. Drones will be used to relay internet signal and make the world more connected. These all sound like great ideas. Why aren't there more drones in the sky today? There are many answers to that question some of which relate to engineering and some of which are about regulatory barriers.

Chris Anderson is the CEO of 3D Robotics, a drone company which he started seven years ago. Before 3DR, Chris worked for many years as a journalist writing about technology and science. He was the editor-in-chief at WIRED for 11 years, a writer for the Economist for 7 years and spent 3 years at both of the leading scientific journals; Nature & Science.

Chris is highly eloquent and has lots of interesting ideas. He also wrote *The Long Tail*, which is an influential 2004 book which described a set of emergent internet trends. I read that book back in 2009 and it was enlightening. Chris joins the show for a discussion about drones, journalism and his perspective on modern technology.

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I'm really happy to have Pager Duty as a sponsor. I first heard about them on a podcast probably more than five years ago. So it's quite satisfying to have them on Software Engineering Daily as a sponsor. I've been hearing about their product for many years, and I hope you check it out pagerduty.com.

[INTERVIEW]

[00:02:51] JM: Chris Anderson, welcome to Software Engineering Daily.

[00:02:53] CA: Thank you.

[00:02:54] JM: I first saw your name when I read *The Long Tail* in college. Excellent book. I followed your work since then. You did spend many years as a professional editor, writer, but your background is a scientist. In 2009 you started 3DR and no longer had as much time for writing or editing. If you were a fulltime writer or editor today, what area would you be covering?

[00:03:21] CA: Gosh! That's a good question. I backed into writing and editing simply because in science I've done physics and physics was kind of a dying profession for reasons that had to do with the cost of accelerators and things like that. My parents had been journalists and I swore I would never do journalism for exactly that reason. But I tried to find a middle ground which was, "Okay. I'm not going to be a journalist, but rather than doing science, I'll work for the science journals and write about or edit science." I still thought I was in science and academia, but it was technical media in nature and science with the two journals.

Again, I didn't think of writing as being my thing. That, I ended up writing in that context and doing journalism, although science journalism. Then I went from there to the Economist where I was starting science and technology. At the Economist, if you've read the Economist, it's got a very distinctive voice. What I learned there was I sort of picked up that voice. You can think of it as like the Oxford's Debating Society voice or Prime Minister's Question Time, but it's a voice

that has – It's confident, that's assured, that's quite opinionated, that's sort of assertion evidence, assertion evidence.

When you get to the Economist – The reason I'm telling you this story is because I think that that – Once you get that voice, it becomes very portable and that voice carries you on the books and beyond. I'll explain why that voice carries on. When you get to the Economist, there was a poster on the wall and the poster on the wall has the canonical economist sentence, and the canonical economist sentence is "Wrong." As a matter of fact, it's the canonical economist paragraph.

Now when you think about that, what does it take to be able to get away with wrong period as a paragraph? What that means is that you basically have – You set up an assertion. Somebody else's assertion, presumably. The Prime Minister of Indonesia has said that palm oil subsidies are the root to the country's prosperity. Wrong. How do you get away with that?

The answer is that you're not just a neutral observer. You're coming from an intellectual foundation. Basically the Anglo-Saxon philosophical foundation of free markets and free people and democracy and all these kind of stuff and you're sort of summoning all these kind of western philosophy to take down an argument using the power of the brand, 150 years of economy traditions. The worldview of the liberal British perspective. Then you sort of – Then the rest of it is just once you've internalized that voice and once you have the sort of the – You've internalized the Anglo-Saxon economic philosophy, then you can go around and see the world through that lens and say, "Wrong." and explain why. At the end of the day, people come away informed and perhaps enlightened by that perspective.

That confidence and that voice which you learn and the sitting on the editor's floor every Monday morning as the debates on what you're going to say come across, that voice. Then once you come out of there you realize, "Well, there's a lot of the world that you can apply that voice to." You could talk about technology. You could talk about the environment. You can talk about science, etc. Not that you necessarily need to be obnoxious and contrarian, but that gives you the confidence to move beyond sort of the failure of American journalism. Failure of American journalism is neutrality. What people call like the view from nowhere.

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Just like, well, on one hand people say this. On the other hand people say that. Then American journalists aren't allowed to have opinions. Whereas elsewhere in the world, especially in the UK, journalists are allowed to have opinions, especially informed opinions. So that power to have an opinion sort of carries over to writing. Then when you write a book like *The Long Tail* , or *Frey,* or *Makers,* etc., that book becomes a thesis. It's basically just a long informed opinion argued out. Now you have the ability to have opinions. You have the ability to inform those opinions and they have the skills to communicate that opinion. Now the world is your oyster.

So if I was writing today, I would not – I hasten to add. You basically go and you say, "What is the most interesting thing that's the most poorly understood?" Those are the best ones. I think AI probably right now is very interesting and poorly understood and there're lots of people writing good books about it. So I don't need to add to that.

I think autonomy in general is interesting and poorly understood. I'm tormented by headlines I see about AI ethics, which I think is a complete head scratcher. I don't even know what that means. That would be a reason not to write about it, because I don't want to get caught up in a straw man argument. In general, right now, technology has accelerated faster than society's ability to deal with it, and that strikes me as a good opportunity to bring clarity and persuasive argument to the case.

[00:08:30] JM: There are so many applications of consumer drones that could improve our world. Why don't we see drones in the sky every day?

[00:08:40] CA: Why is the sky not dark with drones? I ask myself that every morning. You are with me here in Berkley, at the headquarters of 3DR. Also, Berkeley was one of the birth places of the modern drone industry. Military drones started in the 1950s, but this is consumer drones that you describe and it was here with the University of California, Stanford, myself about 10 years ago. At the time it was obvious that, A, drones could be cheap and ubiquitous. I started something called DIY Drones, the notion that you could stick like literally the letters do it yourself in front of a military industrial thing and it could work.

It was clear that drones were going to be – Future drones were going to descend from smartphones, not from 777s. So that sort of told you something about if smartphones are

ubiquitous. I presume that drones could be as well. Economic reason they couldn't. Then the next question was only going to be what are they good for?

We've not answered the question what are they good for sufficiently, because there is a regulatory barrier between inventing a drone and being able to use a drone. The regulatory barrier – By the way, totally appropriate. It's true for autonomous cars as well. Silicon Valley is all about asking forgiveness. Not permission. I can tell you, the original drones, we did not look for permission. We just did it. San Francisco Bay out there has got – The floor of that bay is scattered with crashed drones. Nobody got hurt. I don't think they leaked bad things into – With the foam, etc., but lots of drones crashed in the course of doing this.

As we went from the DIY phase to the commercial phase and the consumer phase, we started to have to comply with the regulations, and the FAA regulations initially didn't allow commercial use at all. It was only recreational use. There's really like – You couldn't make money from drones until 2016. There's one answer why the sky is not dark with these things.

The next answer is that even once commercial use was allowed, it had certain restrictions. You had to say within visual line of sight. You had to stay below 400 feet. You couldn't fly over people. You couldn't fly at night. Also, there had to be one pilot per drone. Although they're autonomous, they don't need piloting. There actually has to be a person standing there.

Even today, our fully autonomous drones cannot be launched until a human being touches an iPad. That's it. There's nothing to do. They just have to touch an iPad. The act of touching the iPad validates that there is a human being present watching in case something happens, emergency services headquarters, helicopters, something like that.

We actually haven't achieved any real efficiencies yet because of these restrictions. Now, we're very, very close to being able to breakthrough, and there's an FAA process called type certification. Once a vehicle is certified as safe, then it will be allowed to fly beyond visualized sight over people maybe more than one-to-one pilot to human, pilot to drone, but could be one to 20, one to 50, one to 100. Then we're going to start to see the efficiencies that automation of robotics brings. I mean, our type certification is going to be the first and that's going to happen before the end of the year. Starting next year, we may actually start to see them flying. Initially,

we're going to be doing things like infrastructure inspection, pipeline, power line inspection, DAMs, you're going to state delivery, things like that.

I think the answer is we thought it was a technical problem and we saw the technical problem in 5 years. It was actually a technical and then a regulatory problem. The regulatory problem is going to take 10 years, and we're about 5 years into it. Give us another few years and we'll get there. What would they be doing? Anything satellites were doing in the 70s, and then airplanes were doing in the 90s. Drones can do better. Drones have higher resolution both spatial and temporal resolution. If you want to see something, millimeter resolution every hour, only a drone can do that.

If you want to see the globe once a week or whatever, that's a satellite. It's the long answer to your question, but I believe that we, in Silicon Valley, have a holy mission, which is that we were gifted the Internet. We're born with the most important technology of our ages, electricity of our time. Our mission is to extend this gift to the world. Extend the internet to our homes, to our arms, to our cars, to the air, to space, etc. Why would we do that? Well, if you extend the internet into the world, the world becomes smarter. All these devices connected to the Internet are smarter. Then the Internet becomes smarter from being able to kind of measure the planet.

Our fundamental principles that you can only manage what you can measure, and we've been doing kind of bad job of managing the planet from environmental and economic perspectives. The better we can measure the planet with drones and satellites and everything else and fee it into the internet, the better we will be at managing it.

Right now we're just picking the ones where the value is the highest. We're in wildfire season in California. Our drones are being used to fight wildfires. How do they do that? The thermo cameras can see through the smoke and see where the fires are. Before the fire, the drones can spot the fuel, the needles and the leaves that will create those fire. Then after the fire, we can spot the hotspots. They're still there. So they don't turn into fires again.

Climate change. Our drones are right now – All the water infrastructure, the dams and levees of America are built assuming one amount of rainfall or sea level rise and they're all being challenged by climate change. Now we're seeing floods. We're seeing sea level rise, etc. All that

infrastructure needs to be rescanned. Impossibly expensive on the ground and trivially easy for drones. You're using the U.S. Army carve engineers using our drones to look at all those levees there to figure out what needs to be reinforced and what doesn't and so on.

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[00:14:33] JM: Looking for a job is painful, and if you are in software and you have the skillset needed to get a job in technology, it can sometimes seem very strange that it takes so long to find a job that's a good fit for you.

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[INTERVIEW CONTINUED]

[00:16:23] JM: Over the remaining 5 years of that regulatory timeline and then in the successive years after that, how will your business strategy unfold?

[00:16:33] CA: We at 3DR started by building the components for drones autopilots and such. Then we built the drones themselves and become America's largest manufacturer of drones. Then once the Chinese got really good at it, we got out of that and we moved over to the software. So we're essentially a software company and we just look at the data from drones, not the drones itself. That's not entirely true. We do actually have one drone of ourselves for people who can't or not allowed to buy Chinese drones, which is like the U.S. government. By and large, we're on the data side.

So it used to be that it was quite hard to use a drown and gather data. Now it's trivially easy. You just touch a button and just magic happens. The question is where is the return on investment on that data highest? We started with construction. Then we went to like the geospatial industries, like the earth work inspection that we talked about before. You're seeing public safety, fire police picking up as well.

We have just scratched the surface of what's possible here. I think that what the regulation allows us to do is to go beyond that sort of visual line of sight perspective. We're looking at bigger areas. Although we started with Autodesk and construction, we're now actually working even more with geospatial stuff with Esri, a geospatial giant, and that's our main partner in this. Whatever they were doing with satellites a few years ago, they're increasingly doing with drones.

The nice thing about these regulations is that now we can fly tens of kilometers beyond visualized site. So linear infrastructure, power lines, gas pipelines, roads, bridges, tunnels, airports. All that kind of stuff. Now, that's now within the reach of what we can scan with drones. I think you're going to see more of the world fall within the scope of drones. The battery life is already there. The flight time is already there. Soon, the regulations will be there. Now, think of it, we've been looking at pixels. Now we're going to start looking at screens.

[00:18:22] JM: What are the remaining technical barriers that feel the most acute right now?

[00:18:30] CA: Almost none. I sort of feel like all the technical problems were solved years ago. That's not entirely true. But fully autonomous operations including sense and avoid. There's a company, Skydio, right now doing amazing work. But that's computer vision basically. Navigating through forests and through leaves, etc., just using cameras. That's flying low.

When you fly higher, you want to be able to avoid other aircraft, and that's a harder computer vision problem, but there's a company called Iris Automation that's doing that again with cameras. The vehicles can fly almost any distance. Drones have flown across the Atlantic. Just use different fuel. Gas engines or hybrids or whatever. The radio links can go tens or hundreds of miles. The computer vision is amazing. The GPS gets better and better. The software is kind of done on all these. There's almost nothing I can think of. The drone delivery precision landing, all that stuff, we basically benefit from the advances in AI and computer vision out there already. I literally cannot think of any technical problems right now that haven't at least been solved at the kind of university level.

[00:19:41] JM: What about security?

[00:19:42] CA: Well, define security. I mean, the military has secure drones and has for many years. It's just do you want to have it like going through satellites encrypted stuff? Sure. Can be done. Right now, the security is kind of whatever people want on the commercial space, it standard Wi-Fi, 256bit encryption. You can pay more for other security even on the cloud side. We use FedRAMP. It's kind of what do you want to pay? It all exists.

[00:20:10] JM: Let's imagine a construction site. Want to map that construction site or ensure the safety. I want to have an understanding of what's going on in that construction site. So I'm going to use a drone to do that. Walk me through what the drone is doing as its flying over or through the construction site. How is the data getting recorded? How is it getting sent to the cloud? Or is it like sitting on the drone and then the drone lands and you have to upload it? Take me through the technical process.

[00:20:46] CA: I'll describe sort of the optimal process. For our larger customers, they've kind of – They got all very efficient. The optimal process is that this is being done every day. Maybe in

the morning and the evening. The temporal resolution, not just the spatial. Because our objective here is to create what's called a digital twin.

Back in the day, construction was started on screens with a CAD file. But the moment they started digging, it was analog, paper, blueprints, notepads and things like that. We want that digital file, that digital plan to reflect reality. As they say, no plan survives the first shop. No construction project survives the first pay to dirt. Something changed.

If you don't update the digital file, then that digital file – There's entropy. It sort of loses its relevance as it becomes less and less reflective in reality. There's something called reality capture, and the objective is to have the digital file like you would with software. You want people to commit their software back to the master, so the master is canonical.

In this case, it's not a GitHub repository. It's a CAD file, and that CAD file should be updated every day to reflect reality. How do you reflect reality? Well, back in the old days people would have to like type in, "Here's what I did." Too laborious. Now you want the scan to automatically capture reality and then update the BIM to show what happened when. That's what we're doing at the headquarters. They've said, "Okay. This is the site and we want it to, let's say, capture the whole scan both the horizontal and the vertical structures and want to capture at 7:00 in the morning and at 5:00 at night." The plan is that the drone is sitting in some spot, in a box. What's going to happen is that somebody's going to walk in the site in the morning, unlock the gates, unlock the trailer, turn on the generator and open the drone box and take the drone out. Maybe stick a battery in.

At that point, somebody, a construction, will touch a button on an iPad and a plan that has already been loaded to that iPad from headquarters is going to be uploaded to the drone. The drone will take off. It will do a lawnmower pattern or a circular pattern or a spiral pattern depending on what the site is at the point. It will take about somewhere between 9 and 10 minutes to do the whole site. It will take probably about 200 images flying at about 250 feet and then will land on its own.

At that point, someone will put the drone back in the box and they'll touch another button on the iPad and the imagery from that drone will go into the iPad and then automatically be uploaded

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to the cloud, to our cloud. At that point, all those photos then get through a process called photogrammetry. All those photos get sort of analyzed. Basically, the way photogrammetry works, it's called structure for motion. But when you see the same object from different perspectives, using the parallax effect, you can actually see the depth of that.

Although the photos were all 2D, when you combine a bunch of 2D photos, you end up with a 3D model and that will be a point cloud or a mesh or something like that. That's automatically generated. Then that is automatically synced up with the CAD file and you have these things called ground control points. So in the course of flying over, certain features are had known position. They have like an X or some sort of fiducial optical, automatically recognized. That aligns this 3D model to the same locations. So it snaps into location and now this becomes a layer in the CAD file and you can basically scroll forward and backwards through time and see how things change. Because these are meshes, they're actually geometries which can be snapped in alignment with the underlying CAD file and you could say, "Oh! That post was supposed to be here, but it's actually two meters over. There's probably a reason why they moved that post two meters over. There's a rock or something like that. Okay. Well, that's good to know."

Now the digital twin says, "Okay, guys. Going forward, note that that post is not where it was supposed to be, but it's now over here." When you put the trench, now you have to more the trench as well. When you're going to be cutting the steel beam to go on that post, note that the steel beam is going to be changed as well. Now all that information goes into the supply chain and the scheduling going forward and they make better choices, because it reflected reality.

[00:24:58] JM: Your software is open source or some of it.

[00:25:01] CA: Yeah. It's actually not. The software on the drone – The drone we might be using are the software that we originally developed or the software that we're now working on as part of the drone code project, part of the Linux Foundation. The software on the drone is probably open source. It might be a DJI vehicle, which is close source or might be one of the open source ones based on drone code. That's just to operate the drone and mission, all these kind of stuff. The data on the other hand goes into the cloud, and that's all close source.

[00:25:29] JM: What's the reasoning behind – I guess the open source project is you just join or cofounded the Linux Foundation project, subproject?

[00:25:37] CA: I created it. Yeah.

[00:25:38] JM: Okay. What have been the ramifications of the open source – I mean, just to give some context. You told quite a great story at the Open Core Summit. I know we can't go through that in the entirety, but maybe you can give a condensed highlights version of that story perhaps. The evolution of your code being used by constituencies of various ethical flavors.

[00:26:06] CA: Got it. Got it. Okay. Yeah. When I started, I started as a hobby. I was the editor of WIRED. It was just something I was doing for my kids. It became a community. It took off and everything I do as a community has always been open source, whether it's creative commons or actual code. It was just a default open because it was a hobby.

Then as it got bigger, it became sort of better organized and proper code development processes and maintainers and things like that. As it got bigger yet, it became clear that we had the opportunity to create and cinch the Android of UAVs, unmanned aerial vehicles. I was like, "Okay. Well, this is starting to look like smartphones." DJI was doing really well. DJI was very much modeled after Apple. DJI came out of the Shenzhen Pearl River Delta and was one of those companies that was formed by people who had been building iPhones in the factories around there for the last 10 years and sort of taking notes the whole time. Very much modeled after Apple. Close source, vertically integrated, but with an app layer.

We're like, "Well, okay. I think there's probably room for an Android as well. Open is good." The nice thing about Android is it allowed this proliferation of form factors. With drones, you also do want a proliferation of form factors. You want airplanes and vertical takeoff. You want big helicopters and little helicopters. We're too soon. I mean, with phones, you can argue there's sort of maybe a limited number of form factors, small, medium, large, etc. With drones it's like everything, deliveries, military, the work. Open platforms makes sense when you want to separate the software and the hardware.

That said, DJI was doing such a good job. There really wasn't sufficient demand. Everyone was like, "Gosh! We're just getting crushed by DJI. Nobody is big enough to be the Google of this operating system, if you will." It was kind of an academic project I think for a long time.

What happened then is that – It was like who wouldn't want to use DJI? Who wouldn't want an open source one? Well, it's hobbyist for sure. It was academics. But then it was also bad guys. We found that as – Because when you make something DYI, it becomes very cheap and open and easy. The vast majority of the uses were good, but there were clearly some people who were they were terrorists, there was ISIS, who were going to be using it for ill. We thought about this and we said, "What should we be doing about that?" So we talked to our friends at the CIA and the NSA and the FBI, etc., and we said, "Look. We want to be super transparent about this. We know that people are using this software for ill." They're like, "Thanks for telling us." We're like, "We don't know what to do differently. We can't close it off, because what's the point? We can't put in backdoors, because people won't use them. We can't track these things, because we'll just turn of the trackers. It's open source, etc." They're like, "Yeah, we can't think of anything you can do either. If you see anyone doing anything bad, just let us know." So we told our community, "Look. If you tell us that you want to deliver 55 pounds 2000 kilometers, we don't think that's a good idea and you shouldn't do that and we're probably going to tell our friends at the FBI that this is happening." Now, we don't really know who these people are. So we just sort of say, "Hey! FBI, check this thing out." We were pretty transparent that was what we're going to do.

Then we said, "Well, look. We really can't stop bad people from using the code, but we can encourage good people to use the code as well." We spent a lot of time informing the U.S. government about the advantages of the open source drones and we said, "Look. Right now you got an asymmetrical warfare and you got ISIS using [inaudible 00:29:33] together drones with hand grenades. Meanwhile, you've got these multimillion dollar anti-aircraft missiles, etc. It's just kind of disproportionate. You should probably also have cheap open drones. By the way, it's free, and here, go at it."

To their credit, parts of the government including the Whitehouse during the Obama regime totally embraced openness and the office of science and technology policy actually created a whitepaper encouraging this. Subsequently, it's been a long process of educating the

government including the military and the policy, etc., about the advantages of these kind of consumer grade drones. We're coming around to it.

Today, you're starting out, there's a company called Anduril. Has a drone killer drone. It's one drone that kind of chases and kills another drone. That drone happens to be based on our software. You're starting to see the small drones based on our software, our software being the drone code PX4 software.

I think the message is getting through and I think all we can do as a community is sort of bend over backwards to educate those who are trusted to protect us and otherwise just remain consistent to the spirit of openness and not try to kind of sneakily put in backdoors or try to game the system just to educate.

[00:30:49] JM: It's no surprise that you have to bend over backwards to educate the regulatory bodies. What about customers? If you're trying to sell to construction companies or oil refineries or these likely candidates as early customers of consumer drone technology, how ready they are to buy?

[00:31:16] CA: Not very ready is the answer. There are two hard things about selling to enterprise, business-to-business, SaaS and all these kind of stuff. One hard thing is just that there's this sale cycle for large companies. You have to kind of – You're asking them to build a return on investment decision. They have to change their processes. That's a long process. Then when you have a brand new technology that's highly regulated, it's even harder yet.

Unlike mature technologies where it's like, "I'm going to use this HR software versus that HR software." When you're saying like flying robots on your construction site, there're a lot of people who need to kind of be convinced. The general council, the CFO, the site manager, maybe local constituencies like the city government, etc., construction workers, etc. It's been a long process, and typically what happens is it starts with a proof of concept. We do one. The one sort of works okay.

Then you sort of extend the proof of concept and you sort of say, "Okay. Well, we flew that in the site. We got the data and now the data is available to people who aren't on the site, the client, or

the construction manager, or the CFO, or whatever." They're like, "Oh! Okay. Now I can see the data. I can see actually how I'm going to use that." Then maybe they win a lawsuit because they had evidence that they were not at fault. They're like, "Whoa! Okay. Now I can see the virtue of recording this." Then they're like, "Okay. We're going to standardize on this. Now we're going to do more sites. We're going to do all of our sites this way."

Then one construction company sees another construction company standardizing." It's like, "Oh! Okay. We're talking 10 years it can take to do that." That's been a challenge. They actually don't care whether it's open source or not. They just care about the data, and we want them to be totally agnostic about the capture side. Push a button and magic happens.

The open source stuff is more relevant, has become relevant for two big reasons. One, is that the paranoia about China, the Huawei stuff, etc., has led the U.S. government to discourage the use of DJI vehicles both over critical infrastructure ports, transportation, energy, etc., and also military infrastructure. There's been this vacuum in the market, basically a lot of fleets, government fleets, are now grounded because of this DJI ban. Everyone's like, "Well, is there something else out there that's trusted?" Then this has been a big motive for the adaption of the open source stuff.

Second is that the FAA created this new certification process for drones and we're going to be the first going through, and the FAA also wanted to embrace a kind of an industry standard rather than a single company's one. So these open source ones are going to be the first to be approved, certified, so they're going to be able – The first to be able to fly beyond visual line of sight and all those other things.

In a sense, the government is driving the adaption of open source by, A, banning the close source alternative and, B, standardizing on the open source development processes being the one that they trust to be certified.

[SPONSOR MESSAGE]

[00:34:09] JM: As business has become more integrated with their software than ever before, it has become possible to understand the business more clearly through monitoring, logging and

advanced data visibility. Sumo Logic is a continuous intelligence platform that builds tools for operations, security and cloud native infrastructure.

The company has studied thousands of businesses to get an understanding of modern continuous intelligence and then compiled that information into the continuous intelligence report, which is available at softwareengineeringdaily.com/sumologic.

The Sumo Logic continuous intelligence report contains statistics about the modern world of infrastructure. Here are some statistics I found particularly useful. 64% of the businesses in the survey were entirely on Amazon Web Services, which was vastly more than any other cloud provider, or multi-cloud, or on-prem deployment. That's a lot of infrastructure on AWS.

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[INTERVIEW CONTINUED]

[00:35:59] JM: In your talk, you described competing with China on a piece of drone hardware as I think you said your first encounter with superior species.

[00:36:15] CA: Yeah. Yeah!

[00:36:18] JM: Can you give me a nuanced perspective and prediction on our relationship with China as a business and technology community?

[00:36:32] CA: Sure. First, some disclosures. I guess a disclosure is I've lived in China for four years. Some of my children were born there. I'm a huge ChinaFile. I think we're going to lose in many ways to China and I'm completely okay with that. Just putting that aside. Okay. You can take away my maga hat and all that.

Look. I am an nationalistic. I'm British by birth. I live in America. My children are raised from – I mean, I'm pro-technology and I just like want the best technology wherever it happens, and if one country does better than other, peace. God be with you. That said, I'm running a business and I want to do it well and win. When I lived in China from '97 through 2000, it was kind of the dawn of the modern Chinese.

I was like capping out on the floors of Huawei. It was pretty clear to me then that everything I've been told about China was wrong. I was told, "Oh! They can't innovate. They only copy." "Oh! Don't worry. They can only do hardware. They can't do software." "Oh! Don't worry. They can't do global marketing. They can do global reach." "Oh! Don't worry. They don't understand user interfaces."

I was pretty clear all that was wrong. It was like, "Don't worry, China can't do X." I could not find an X. I was like, "Okay." When I started the company, 3DR, and we actually started in 2013, although the company started earlier, but the company that I ran today stared in 2013. We're like, "Okay. We know there's no X." That China can do everything. How could we possibly start a company that would compete with China?

I thought – I think rightly, but wrongly, that I found the X, and the X was open source. I said the one thing that we have going for us is that we really understand open source. We build communities. We motivate communities. For whatever reason, China has used open source, but they haven't really contributed to open source. They haven't built a kind of internal culture of open source. So we think that open sources are a secret sauce. The only thing cheaper than Chinese engineers are free engineers.

Okay. Sadly, I think I'm right about that. China has still failed to really embrace open source from the contributing side. That said, where I was wrong is the notion that open source engineers are free engineers. They're by no means free engineers. If you do it right, you're basically paying

people to contribute to an open source project. We didn't have the economic advantage that we thought we did.

In addition, at this immature stage of the business, you can't just sort of open source the software and assume that somebody else is going to make great hardware. You actually had vertically – You create a hardware-software combination. There, we were at a massive disadvantage. DJI is I think one of the best companies in the world. Certainly, one of the best companies in China.

When I talked about superior species, DJI is kind of a 21st century Chinese company. Not like the old ones that kind of migrated. This was one who was kind of born in the clarifying fires of the Apple supply chain. They did everything right and they kicked our ass fair and square. They raised more money. They had more engineers. They were faster. They innovated, etc.

On the hardware side, although we were manufacturing in Shenzhen, we weren't native. So we were always going to be slower, more expensive. Less funding, less engineers, etc. Once I realized that I was like, "I don't think that American hardware companies are a thing." I think hardware should be done in China. The next question is, "Well, are American software companies a thing?" The answer is yes, they still are. Why are American software companies still a thing?

I think number one is I think we really do do – I think open source really is not just sort of technically opening stuff. It is the community building and the sharing and the poll requests are much more important than the downloads, if you will. Poll requests are still a really unusual thing in China. Why would you submit your secret bug fix to your competitors, etc? I think that's a bit [inaudible 00:40:19] we still have here.

The other is that the great firewall of China works both ways. As software becomes more cloud and data and less sort of running on devices, you're starting to see that people just don't want to put their data in a Chinese cloud, and that Chinese cloud is considered subject to Beijing's influence, which I think is increasingly the case.

That firewall, although there's no firewall in hardware, tear-offs aside, there really is a firewall on cloud and data. I think we're starting to see that we actually have two Internets. You got the batch, the Baidu, Alibaba, Tencent Internet on one side. Then you have the FANGs, the Facebook, Amazon, Microsoft and Google, one FANG. I don't know how to pronounce that exactly. Etc. Those two worlds really – I do see them continuing for a longtime. I'm bearish on non-Chinese hardware, but bullish on non-Chinese software and communities.

[00:41:14] JM: There's a whole lot more I could ask you about there, but we're nearing the end of our time. So I just want to ask you a few things that I can also get a distinct opinion on. You are deeply familiar with the scientific journals, nature and science. What's the future of those periodicals and their influence?

[00:41:36] CA: That is a great question. Science and nature are the two premier scientific journals and they're a career maker. You get published in science and nature and a few others, tenure citations. All that stuff. Academia, and science in particular, is built on reputation economy. Your grants, your position in universities, your ability to recruit students, etc., it's all based on your reputation. In reputation economy, the carriers of reputation are the journals and their citation, their authority if you will. That's just the way science works.

There's also peer review and all that kind of stuff, but it's a reputation economy and reputation is formed by the journals. I think nature and science will be fine forevermore, but there are also about 100,000 other journals below them of diminishing reputation. There, the process of going into one of those journals involving a year of peer review, publishing is something that cost a lot of money. Not being able to give free access to other things becomes actually a hindrance to science. So there's this open general method that has been taking off for the last few years especially in physics, computer science.

But now also in biological sciences where people are saying, "Why don't we just open source science and create a community that will peer review a community that will edit and share and reference, etc., and take the monetary, take all the disadvantages that the commercial journals out of that process. That's working well. It's slower than you would expect and it's slower than you expect, because again the reputation – Because the reputation economy is so entrenched in traditional academic incentives.

It's really hard for someone to say, "Hey! You know what? My great paper, I'm not going to publish in nature. I'm just going to publish it in PLOS Two, which is public library of sciences and open access journal. I'm going to publish in PLOS Two. Now, I think that's awesome and I'm super glad they did, but they may feel that it gives them slightly less credibility and slightly less chance of getting tenure and it is important that they may choose to kind of support the old system because it's a little thing for the system, but it's a lot for them.

I think that long-term, what we're going to see is a win-win. It's a little bit like media. Newspapers are a shit show unless you're the Wall Street Journal, the New York Times, maybe the Washington Post. You're seeing three entities that remain, have the reputation or the backing of Bezos or whatever to maintain. Then the San Francisco Chronicles of the world are just host. I think you're going to see the same thing in scientific publishing, the natures and the sciences and the cells and a few others are going to be fine. Then there's a bazillion smaller journals especially in fast-moving industries like computer science that are just going to go away and that will go – The long-tail of publishing is going to go open access and the head is going to remain the premier commercial journals.

[00:44:24] JM: Then the limit on both those domains, do we want this kind of esteemed voice, this esteemed trusted voice? Is that useful or do we want everything to be crowd-sourced and open?

[00:44:39] CA: Well, I mean the reputation of the science and natures comes not just from their title, but because the rigorous process that go through to decide what they publish and what they don't. Peer review, but editors, etc.

Science is complicated. Most science is wrong. That's cool. That happens. That's just the way scientific works. Figuring out what science is wrong and not wrong is very hard. You often need peers. Those peers are busy. Sometimes they're conflicted, etc. I think that we really do need an editing process for science, a review process, a way to figure out what science is better than other science. The question is how do we pay for it?

The journals pay for it commercially. The open access ones do it with non-monetary motivations. Just the say way open source works. Essentially, non-monetary motivations, but they too have a business to run and editors to pay. So I think that the experiments are going to play out first in computer science, and computer science is starting to move away from the commercial journals.

Physics is also moving away from the physics journals. I think we're going to see this play out in computer science because it's fast moving, there are lots of other ways to discern what's real and what's not. Watch that space. Watch how the academic computer scientists start building reputation in a more open access way, and that's going to be the path for the rest of the disciplines.

[00:45:53] JM: Chris Anderson, thank you very much.

[00:45:54] CA: Thank you.

[END OF INTERVIEW]

[00:46:04] JM: As a programmer, you think an object. With MongoDB, so does your database. MongoDB is the most popular document-based database built for modern application developers and the cloud area. Millions of developers use MongoDB to power the world's most innovative products and services, from crypto currency, to online gaming, IoT and more. Try Mongo DB today with Atlas, the global cloud database service that runs on AWS, Azure and Google Cloud. Configure, deploy and connect to your database in just a few minutes. Check it out at mongodb.com/atlas. That's mongodb.com/atlas.

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