Complex Adaptive Systems

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Interview with: Dr. Sean Lawson

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Dr. Sean Lawson, University of Utah

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Dr. Sean Lawson, University of Utah[1]

[Note: The transcript of this conversation has been edited for length and clarity.]

In his interview with Lt Col David Lyle (US Air Force Academy) on 4 June 2019, Dr. Sean Lawson discusses how complexity might inform SMA's *Future of Global Competition & Conflict* study. More specifically, Dr. Lawson argues that although it is important to look back at previous instances of the butterfly effect, butterfly effects are not possible to control because they are merely byproducts of a system's existence. An inability to control certain butterfly effects, however, does not diminish the importance of expecting and planning for them, as well as developing the ability to react and adapt to changing circumstances. Dr. Lawson also speaks about the OODA Loop (observe, orient, decide, act), highlighting that US decision makers should not abandon it, but they should rethink its application and the way in which they study it. He also warns decision makers that they must maintain their trust in experts in order to avoid a potential negative feedback loop in the midst of an increasingly chaotic world. The interview continues with a discussion about potential factors that could cause a phase change in the current political and economic world order. Dr. Lawson argues that migration and climate change are the two factors that could most likely instigate this change. Dr. Lawson continues by explaining that the stability of the US's own system is currently in flux, and it is difficult to say whether it can count on its own foundations as the bases of its stability anymore.

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The Butterfly Effect

Lt Col David Lyle: Thank you for joining us, Sean. Our first question is about avoiding the butterfly effect. When we talk about the butterfly effect, we are talking about vastly disruptive changes that people might not have expected that could very quickly cascade into most likely undesirable consequences.

Considering this, how do we avoid the worst possible negative feedback loops and the unintentional consequences of escalation? How can non-linear complex science help us understand how the world is becoming increasingly connected, and what can the US do to combat China's increasing economic influence or political leverage?

Dr. Sean Lawson: So, a couple prefatory remarks. For those of you who have looked at my book, you know that it mainly focused on prior attempts by the US military to try to learn lessons from complexity theory and apply those lessons to policy, strategy, and doctrine, mostly in the 90s and into the era of the immediate post-9/11 environment. I'll be honest, I came out of that experience pretty pessimistic about whether or not there are actual lessons that can really be applied effectively here. I have only recently come back around to examining the questions of if the lessons we tried to learn before were maybe not the right lessons and ended up leading us astray, and how the United States can do better. Part of the reason I have come back around to those questions is precisely because of some of the more recent work that the military has been doing in the last decade or so. This is really related to the rise of systems thinking in the military design movement and some of the kind of writing that Dave Lyle and others have been doing. These changes have given me a little bit of renewed interest and hope that maybe there is, in fact, something valuable that can be learned and applied here from complexity and system sciences more broadly.

The concern about butterfly effects since the early 2000s relates to: what can we do about them, specifically to prevent the bad ones or perhaps even control or cause them, especially the good ones? In the process of interacting with you folks in calls like this and through the SMA talk that I gave a month or so ago, and also in reading what the military has been writing and thinking about in the wake of Iraq and counterinsurgency (2007 and after), I think there has been a real evolution in the thinking about these things that has actually been pretty productive. It's also more encouraging than the writings we saw prior to that (in the early 2000s and immediately post 9/11).

This idea of butterfly effects and what you do about them, how you prevent them, and how you perhaps control them is one of military strategists' main concerns as well. My short answer to that would be—*I don't think you can entirely prevent butterfly effects and certainly not control them*. At the broadest level, that would sort of be like trying to avoid the very fact of hurricanes' existence. The tendency to

have butterfly effects is just part of how complex systems operate. It's a natural and inevitable feature of any complex system.

That said, I think we can perhaps try to shape the likelihood of the butterfly effect a little more in social complex systems than we can in the case of natural complex systems. In international security, we're dealing with social phenomena in which we are one of the primary actors, and given the power of the United States, we have a lot more influence than lots of the actors in the system.

That said, I think one of the lessons we need to learn from the prior attempts that I discussed in my talk a month or so ago is that we shouldn't get too confident and too cocky. We should act with caution and try to avoid injecting unnecessary chaos and instability into the system. One of the analogies or the examples that I can think of comes from complex systems biologist, Stuart Kauffman. He wrote a famous book, titled *At Home in the Universe*, in which he talks about what he calls the "space of the adjacent possible." He notes that if you put a lot of chemical compounds together and sort of slosh them around, you can get spontaneous formations of new chemicals, and you can't really predict which compounds you're going to get from doing this. Also, not all of those compounds are equally likely, right? The ones that are most likely are those that are going to be built from the existing possible structures within the mixture. Within this space you can't really predict exactly what's going to happen, but certain things are more likely or more possible to happen than others.

I think there are a couple of lessons to learn from this. First is that adding more chemicals, agitation, or elements to the system increases the chance that these spontaneous new formations will occur, and they might very well be ones that you didn't expect or desire or are able to control. But even if we are not able to predict the particular outcomes in advance, there's still a little bit of hope here. We can see the existence of possible conditions for certain types of outcomes. We can perhaps at least see warning signs or indicators of what's possible between a certain range of potential outcomes. For example, when you watch news reports of a hurricane heading towards the coast, and you always get that sort of cone—as it gets farther out, it gets wider. In risk analysis, they call this the fat tail of uncertainty, right? So, the farther you get out in space and time in these models, the more uncertain it is, as is exactly where the hurricane is going to be and what strength it's going to be when it lands. Nonetheless, you still have a range that you can look at. I think that's something to keep in mind when we're thinking about how we act in the face of potential butterfly effects that are always going to be there. You're never going to get rid of the potential that you're going to have these system shocks that could potentially lead you into an entirely different phase of the system.

We need to expect and plan for butterfly effects. This means planning for resilience and the ability to mitigate those effects when they do occur as best as possible. I think it means, in some ways, getting back to a lot of the advice that civilian scientists and political science folks from the pre-9/11 period and the mid-1990s were providing in terms of what lessons there are for complexity theory and national

security—the ability to react and adapt quickly to changing circumstances is ultimately the most important skill. We would *like* to be able to take action and drive the system in a certain direction or to perhaps be able to predict or even control where things are going to go. But the only thing that is certain is that there's always going to be the possibility of butterfly effects that are going to lead to situations that we couldn't have predicted or controlled. So, the most important thing is to be able to respond and react to those in an effective and productive way.

We had this moment in the mid to late 90s/early 2000s where we had one group of people saying that the lessons of butterfly effects and complexity are, most fundamentally, we have to be able to be resilient, react, and adapt because we're never going to be able to entirely predict and control. Then we had another school of thought that said, "You know what, if we're the ones driving the chaos, we can just act faster and drive the chaos. Then, we don't have to react or maybe even really deal with the consequences of what happens. It's everyone else that's going to be reacting in our wake." I don't think that turned out to be correct. So, there's maybe an opportunity to go back and look more closely at the path or the road not taken in terms of the lessons that we could have learned when thinking about butterfly effects.

I don't know if that is what you wanted to hear. You want to know how we prevent these and what do we do about them. At some level, I don't know that you can predict and control them.

Lt Col Lyle: One of the worries I have is that China is creating their own potential butterfly contagion situation with their social credit system. Are there any specific areas of competition or interaction that you think are presenting the greatest potential for a negative butterfly effect, especially between the US and China?

Dr. Lawson: I would extend this question to Russia as well. Actually, part of the reason I thought about this is, I just saw an announcement for a panel discussion that's happening right now in DC at the New America Foundation about data governance and global great power competition. So, you mentioning China's social credit system makes me think about something that I've been thinking about for quite a while, especially in the wake of 2016. It caused me to go back and re-watch a talk that Martin Libicki gave at the 2016 NATO CyCon conference in Estonia, and it's quite prophetic, in retrospect. This talk happened maybe a week or two before we got the first news story about the Russian hack of the DNC. Then, of course, there's been an avalanche of information since then about, not just about hacking the DNC and releasing that information in the WikiLeaks, but also the use of online bots and trolls, the gaming of algorithms and social media algorithms and recommendation engines.

One of the things he talked about in that talk really stuck with me, and I think it's only gotten worse and is only going to continue to get worse. He sets up the possibility for the kind of technological interconnection butterfly effect that you're alluding to. There's all of this data laying around in all of

these systems around the world, whether it's cloud systems or what Facebook has gathered about all of us or advertising information that all the different ad networks are collecting about all of us constantly. He basically said: Look all of this stuff is akin to the dead branches and brush and kindling that accumulates in our forests. It only takes a spark for all of that to go off, and then you have this massive wildfire, this massive conflagration that gets completely out of control. I think 2016 was a little bit of a taste of that. I mean, the ripple effects of what happened there are already plain to see, and I think it's already helped tip us into what I think is more of a phase transition than it is just a realigning of power, adaptation, and competition. So, I've sort of jumped on ahead a little bit, but I think that possibility is only going to get worse.

In a project that I'm working on with one of my colleagues, Dr. Robert Gehl, here at University of Utah right now, one of the things that we're looking at is this idea of social engineering and how it has changed over time from the early 20th century and through the 60s and early 70s. Social engineering as a concept really meant engineering all of society through the use of technocratic means, government experts, and top-down big society kind of projects. But then, in the 70s, 80s, and up through the current period, social engineering sort of means more in the hacker sense. The term gets used more in this sort of hacker and information security sense of—you're still sort of trying to engineer social relations and people, but more at an individual level, for exploitation.

Part of what we're going to argue is that what we see happening in 2016 is the ability to sort of do individual social engineering but at scale. That's what we see the Russians are able to do, or at least are attempting to do with this exploitation of all of the digital personal detritus that we all leave laying around everywhere we go on the Internet, which lots of companies are, of course, collecting for profit. It's creating this wildfire situation where all of that information can be harnessed in some way, and we're not entirely sure yet what that looks like. It can be exploited to really manipulate individuals, but in a mass way—in a kind of way that we've never really seen before. We had the era of mass communication where we were trying to socially engineer society through the use of broadcast technologies, and everyone was freaking out about that at the time. A lot of the same have freaked out about we're having right now with the Internet, social media, and whatnot. People were having the same kind of concerns about radio and television back in the day. "Oh my God, what's going to happen? It's a whole new world."

I think there really is something qualitatively different about what we're seeing right now. There's just all of this data and information that's laying around, and it's often not secured very well. There's the technology and the capability there to exploit it, and I just don't think we quite understand yet what those possibilities are. So, I do think that what you're talking about in terms of 5G, artificial intelligence, machine learning, the coming increasing computing abilities that we're going to have with quantum computing…you put all of that together with this mass of digital data that's just lying around everywhere, and the possibilities for unpredictable negative outcomes of that, I think, is a real concern.

OODA Loops

Lt Col Lyle: Do you have any methodologies or tools that, given the challenges you just described, would be most helpful? Or maybe it's combinations of tools? One of the models that we often like to talk about in the military is John Boyd's OODA Loop—observe, orient, decide, and act. Is the OODA Loop still a viable construct, or do we need to rethink it? Has anything changed since Boyd that would make us relook the way he designed it? Has technology changed the OODA Loop in any way?

Dr. Lawson: There's really a lot more there to the OODA Loop than what you typically get in that snake eating its own tail kind of model. You're sometimes just back-flipping as fast as you can, just for the sake of doing it. At its worst, the OODA Loop can end up in that space. I don't think we should get rid of the OODA Loop, but I think we do need to rethink studying and applying Boyd. There's a lot of depth and nuance to Boyd's OODA Loop. This is a point that Frans Osinga made in his book on Boyd. I don't know how widely read Frans Osinga's book *Science and Strategy* is in the military community, but I really think it's the best intellectual treatment of Boyd, his thinking, and the formative factors that went into his thinking, which includes cybernetics. But Boyd has other material as well. Boyd was a really expansive thinker and a really expansive reader of history, science, philosophy, and Eastern mysticism. He brought all of this stuff together in the work that he did. So, I think Osinga really does the best job of getting at that, in terms of recommendations of things to read or look at, if it's not something that people are already reading.

As I argued in my SMA talk, after 9/11, we tried to apply simplistic thinking about the OODA Loop to foreign policy and grand strategy. Act and react faster than the adversary; get out in front of them, and if you can do that, you're going to be able to drive the system in a direction that you want it to go. That didn't really work out as planned. But there's a lot more to Boyd's teaching than just OODA Loops or certainly just fast OODA Loops. So, when it comes to grand strategy, for example, his discussion of what he calls the "strategic game of isolation and interaction," I think, are probably more important than the OODA Loop. I think certain aspects of Boyd's thinking that you apply are more appropriate depending on what level of interaction you're talking about. Fast OODA Loops might be really appropriate in the context of one-on-one, air-to-air combat, or even a maneuver ground engagement. When you're talking about grand strategy and foreign policy over a longer period of time, there may be other elements of Boyd's thinking that are more appropriate.

His discussion of incompleteness and uncertainty should remind us of the ideas of reflexivity and bounded rationality, meaning that we have our knowledge of systems, and if we can't get outside and get a god's eye view on it, our knowledge will always be limited. The fact that our actions will change the system further is also going to limit our understanding and knowledge. He also points out that there's always a time delay. He talks about feedback—that we have to take feedback and use it. But often times, we sort of gloss over the fact that feedback is not instantaneous. We're always, to a certain

degree, making decisions and taking action on the last system's state, the one immediately prior to the one that we actually live in. Even if you have immediate, perfect knowledge of the present moment, you can't do anything about it. The present, by the time you're able to make a decision and take action, will always already have been the past, right? Again, this calls into question the idea of lifting the fog of war and that we're going to have perfect information and a frictionless environment by doing that. That's why he argued against those kinds of ideas, and I think maybe he went a little too far, or at least some of his acolytes went a little too far in arguing against technology. Nonetheless, the argument was based on a fundamentally solid premise. It's that we're always acting after the fact; no matter how quickly or how perfect the information we have is, there's always that delay.

Next, he talks about creating and avoiding mismatches. He said we should avoid mismatches between who we say we are, what we say our values are, and the way we act—the images that we project to others. At the same time, we should try to promote the creation of such perceived mismatches among our adversaries. We want to add allies to our side and remove them from the adversaries' side. Again, it's that game of isolation and interaction. We want to increase our ability to interact productively with others while isolating the bad guys from doing the same thing. So, he also talks about the moral, mental, and physical realms of conflict, saying that the moral is ultimately the most important. This idea, again, gets back to the idea of mismatches and other factors beyond just acting quickly.

One of his criticisms, and I think this is a criticism, of the way we've been dealing with cyber a lot of times is we will apply that idea of isolation in interactions or mismatches often at the physical level. I think of all of the stories we saw of US Cyber Command trying to prevent Russian trolling and social media activities from the Internet Research Agency during the 2018 mid-term elections. They were very proud of the fact that they were able to hack in and mess with their computers, cut-off their access to the Internet, and prevent them from carrying out their nefarious deeds. Of course, it's a good thing that they were able to do that. But ultimately, what we're talking about in terms of gray zone conflict/political warfare are battles around ideology and exploiting domestic political rifts that are long-standing in American culture. Of course, the Russians are doing this throughout Europe and elsewhere in the world as well, not just to the United States. Ultimately, it's good to play this game of isolation and interaction, to hack in and cut them off in a physical sense from accessing the network during a key period of time to prevent them from doing what they're trying to do. Ultimately, we need to think about what the game of isolation and interaction looks like, what the game of decreasing our own mismatches and increasing theirs looks like in a more ideological, mental, cognitive, and moral sense of conflict. Just cutting off their internet connection for a time is not really going to be a long-term strategy.

Finally, I think a really important thing that he emphasizes and advocates is a way of thinking and an approach to problem solving that emphasizes interdisciplinarity, creativity, experimentation, and lack of rigidity. He famously argued against doctrine because doctrine is a fine idea; the problem is, in practice, it often turns into dogma, and then we just follow it step by step. It stifles our ability to respond

productively and effectively when the world doesn't really turn out the way we want it to. So, those are some of the aspects of Boyd's thinking that I really encourage people to go back to, and they shouldn't get so fixated on the OODA Loop and certainly not on the idea of, "We have to go through OODA Loops more quickly than the adversary." That's the most important thing. There's a lot of depth and richness there that I think still very much apply to the world that we live in, but we, unfortunately, have this really simplistic view of what he was trying to teach.

Potential Phase Change Indicators

Lt Col Lyle: With regards to crashes, connections, and potential phase changes caused by crashes, what rates—whether it's economic growth, migration, climate change, or fuel price changes—do we think might be the indicators of a threshold that's being crossed that could cause a phase change in the current world system? So, what do you think might be the biggest types of changes or connections that would result in a phase change from the current political and economic world order that we should probably watch for?

Dr. Lawson: I think rapid changes in any of the examples that you've mentioned could cause massive changes in the world system, at least for a period of time. But the two that I currently see most implicated in a possible phase change to a new, more chaotic system would be migration and climate change, in part because they interact with one another. We see examples of that in the Arab Spring, food costs, and some of the things that happened related to that, helping this spark some of the migration and the political instability that we saw there. We're already seeing the impacts of migration. In the US and in Europe, migration has been a key issue helping to fuel the rise of right-wing populist political movements. In turn, we're seeing a rapid erosion, I think, of the post-World War II world orders.

The shifts have been very rapid. Obviously, the conditions of possibility for this shift were in place prior to 2016. But honestly, I don't know how many folks really saw what was coming. The ascendance of far-right movements to either take or threaten to take power largely caught most people off-guard. Beyond that, climate change is likely to exacerbate the migration problems that we're already seeing. It's going to have an impact on agriculture, food prices, and water availability, particularly in some of those places in the world that are already sort of perennial hot spots and trouble areas, like the Middle East and North Africa.

Additionally, we don't know what kinds of butterfly effects or tipping point kinds of moments that we're likely to have. If you look at a lot of the reports on climate change and where we're heading, a lot of those assume or project a smooth transition from the current climatic state to the next state and assume that we're going to have time to adapt to that. The IPCC will project an average of I think it's like 0.2 Celsius rise in temperature over the next however many years out until 2100 or something. But this doesn't take into account the possibility for non-linear butterfly effect kinds of situations that can

emerge. We're already in an unprecedented situation in recorded human history, where we're not entirely sure how the planet's going to react. We're not entirely sure at what point we might get to a rapid onset of an irreversible kind of change as a result of hitting a tipping point that we just didn't know about or see coming that then unleashes some sort of catastrophic or cascading changes that we just couldn't have predicted and that we're ill-equipped to respond to.

We are already seeing hints of the ripples of chaos as we move into a new period of world history or a new phase transition. It's common to hear that we're in a post-truth era with fake news, et cetera. It's almost become cliché at this point, but we've seen points of turmoil in the past that are similar in terms of resulting in widespread distrust of science and expertise.

We've seen a period like this post-World War I. Prior to World War I, we had a lot of experts telling the world, "Growing interconnection is going to mean everyone is going to become democratic. We're not going to all fight each other anymore as we become more connected. That's not going to happen; there will be liberal peace." Of course, that didn't turn out. In the wake of the disaster of World War I, we saw a lot of mistrust in expertise, and this helped contribute to the rise of right-wing ideologies in governments in Europe. World War II and the immediate post-war period, of course, helped rehabilitate science and expertise, especially in the United States, where they were seen as a high watermark. World War II science helped us win the war; technology helped us win the war. Then, we went into outer space; we went to the moon. So, scientific expertise and expert management of state affairs by technocrats, these are all sort of high watermarks for the period during and right after World War II.

This even led to the creation of whole new disciplines, like public administration, for example. The very idea was we're going to apply engineering principles and scientific expertise to the management of government. But then, Vietnam happened, and we had the failed war on poverty and the great society programs, neither of which really turned out the way all of the experts and technocrats told us. We saw a backlash, again, inside the US military against technocratic forms of management, and we had McNamara and his Whiz Kids. Along with that, we had a renewed embrace of more romantic forms of knowledge like history, classics of military theory, et cetera. So, I think if we end up in a situation as a result of accelerating and non-linear climate change where our abilities to predict and control the various aspects of social, economic, and political life are even more challenging or even worse than they often already are, we could see a further move away from science and expertise. We could see a further move into the direction of resurgent religious fundamentalism and an embrace of mystical forms of thinking.

I'm reminded here of a classic science fiction story called *A Canticle for Leibowitz*, where in a post nuclear apocalypse, United States scientists and experts are not just untrusted, but they're demonized for having caused that apocalypse, for having created the technologies that caused the apocalypse, and for having failed to be able to control it or predict what was to come. So, I worry about getting ourselves,

as the world becomes more chaotic, into a situation where we need expertise to help us cope with the dangers we face, but our trust in that expertise is increasingly at an all-time low. This could be a dangerous negative feedback loop that we could get ourselves into.

Lt Col Lyle: As we look at the challenges of rate changes, a lot those issues, I think, are driving the Joint Staff's push towards global integration. This goes back to what we talked about earlier with the cult of the quick, the faster OODA Loop idea—create your own chaos. This has increasingly backlashed.

I think we need to have the capability to think across the traditional, artificial fault lines that we draw up. We're trying to come up with ways to deal with that and to think a little more systemically in some ways. The classic assumption is that if we have the right data, if we have the right equations and right knowledge, we can basically manage the world. We're actually predictably irrational people, and if morals are still dominant, we may not convince others that our technical solutions are sufficient or acceptable in this narrative sense. It's a classic philosophy of science question that we continue to see play out. Maybe we haven't fully grasped that as we keep making a lot of the same mistakes or are not learning the right lessons. We continue to be flummoxed by our inability to manage and get the results we want.

Dr. Lawson: Well, I think an important aspect of what you mentioned there is that, a lot of times, the most important effects from some particular action or set of actions are not the immediate first order results from that action, but they could be the second, third, or fourth order level of impacts that spin out from that. Syria is an example of that. What's actually happening on the ground in Syria… most people in Europe or in the United States, in their day to day lives, they don't really care. They don't care about what tribe or what faction just took over which village, or where the lines are drawn between ISIS and the other different factions of the government. But at the point at which Europeans, for example, see on the television all of these migrants arriving on the shore or arriving at their airports or at their borders, then that's something that they worry about. But that's a second or third order effect. There is physical conflict going on in the ground which causes migration to happen. The migration ends up resulting in television images that get broadcast into people's homes, and it's almost like the real effect of what's going on in the ground is the second or third order information effect. The information operation ends up as a spin-off effect that maybe we couldn't have predicted or known in advance.

Regulatory Institutions and Regimes: Which Will Remain Stable and Which Will Become Wildcards?

Lt Col Lyle: So, I'm going to reframe the last question in a slightly different way. With the emergence of a more multi-polar world and the erosion of some regulatory institutions and regimes that have worked in favor of US interests in the past, which ones do you think will endure and be the basis for stability, prediction, and planning, and which ones do you think will be wildcards that we'll just have to hedge?

Dr. Lawson: I'll be honest and say I really don't know. I'm sort of a pessimist. From my vantage point, I'm sort of Eeyore, saying, "The sky is falling. Everything is falling apart." I think there are a couple of important moments coming up in the future. One is going to be our own 2020 election, and we'll see what happens with that. I don't even know that we can count on our own stability at the moment. I think we're well into a constitutional crisis that nobody really wants to call as such. The stability of our own system, and what we can even say our own foundation is, I think, is very much in flux at the moment. We'll see what happens with impeachment. We'll see what happens with the 2020 election and what happens after that.

Of course, there's the assumption that, at least among folks who are not fans of Trump, if we can defeat him in 2020 and get somebody else in there, maybe we can start to rebuild foundations and re-establish the norms that have taken a hit in the last several years. Maybe we can start to heal some of the damage and stabilize our own domestic situation. Even if Trump is gone, there is still no guarantee that we'll be able to do that. Whatever instability and rifts that we have on our own foundations and our own system are not solely because of Trump or the Russians. There's a reason why he was able to win. There was a reason why the Russians were able to successfully exploit rifts to the degree that they were because a lot of those rifts are real, and they have been there for a long time.

So, whether or not we can even count on our own foundations as the base of stability is in question. I think the next thing will be to see what happens with Europe. Is Europe going to fragment, or is Europe going to come together and assert some sort of continent-wide set of interests, even if those interests may diverge from those of the United States. The key question is, are organizations like NATO and EU in some form going to continue going forward, even if the United States continues to pull back from those organizations, especially after 2020 and depending on what happens in our own domestic political situation?

I don't even know if that is totally stable. There's a lot of push from the far right in France, in Germany, and in the UK as well. I don't know; I don't think I have a good answer. I'm not convinced that NATO and the EU, for example, are going to continue to be bases of stability or something off of which we can predict. I wish I had a more optimistic answer.

Potential Tipping Points

Lt Col Lyle: Actually, I can add some optimism. Sometimes, within certain regimes, you can create vulnerabilities, like our vulnerability to Chinese intellectual property theft. There's awareness of what has been happening with Huawei and its connections, and whether or not you like how it got there, there is definitely a greater appreciation for that in discussions right now. We're also developing a couple different types of internet too. The challenge is ours is open and vulnerable, and China's is

closed. But there's vulnerabilities with closed systems too, and there are things that we might be able to exploit as a part of our strategies for competition and for conflict if we ever needed to. If I really want to mess up China, I'd mess up their social system, or at least threaten to, and then try to find an off ramp because ultimately, we're all connected. We've created this global world. So, is there anything that you're seeing with the current round of tariffs and sanctions that is revealing anything like a stress-test would or that might give us more resilience?

Dr. Lawson: I can't really speak as confidently about that. International finance and international economics are really not my strong suits. However, one thing I do notice in all of this, and I hate to say it, but when President Trump initially started talking about, "We're going to get rid of the tariffs. We're going to start some trade wars," a lot of experts came out and said, "Well, that's immediately going to cause catastrophe. You're going to immediately have massive shocks through the global economic system, and it's going to be a disaster." So far, that hasn't entirely turned out to be the case. There have been negative implications, and there are still predictions that there are negative implications yet to come and maybe we just haven't seen all of the ripple effects from this yet. But we haven't seen the immediate catastrophe that a lot of people were predicting. Maybe that shows that there's a little more resilience, a little more slack in the system than what a lot of folks had thought. That might be a good thing. However, the other thing we know from complex system science is that there are always these possibilities for tipping points and butterfly effects. So, with the degree of global interconnection that we have, I don't know that we entirely understand where those tipping points might be and at what point we have pushed too far with the tariffs or with the trade war. Then, we could end up triggering some sort of tipping point, and we could end up in a situation that we don't want, we couldn't predict, and we can't control. So, my thinking on it would be that we still need to be very cautious. Maybe what we're seeing at the moment is there's a little more slack, and there's a little more resilience than what a lot of folks who said, "As soon as you take on any tariffs, as soon as you announce you're doing a trade war, that in and of itself is going trigger some sort of calamity" initially had thought. Nonetheless, I think it's still possible. Given what we know of how complex systems operate, there is always the possibility for tipping points and butterfly effects, and I don't know how close we're treading to that line at the moment.

Recommended Reading

Lt Col Lyle: What would you suggest we do/read/watch/listen to/teach to improve our overall “nonlinear literacy”? I don't think we're going to figure all this out today, but what can we do to give us a leg up on at least avoiding over-simplistic framings of the world that'd get us into more trouble than they would help? What would you recommend that we do to improve people’s ability to understand these things and take their understanding to the next level?

Dr. Lawson: I've already mentioned Frans Osinga. As military folks, I think you need to continue to understand your own history of interacting with complexity science and system science. That's part of what my book does.

As I sort of alluded to earlier, I think there is a little bit of confusion in the military literature on the relationship between complexity and the various system sciences that arose in the '50s and '60s. System sciences are linked with McNamara, The Whiz Kids, and failure in Vietnam. Often times, when you see military folks writing about complexity, they sort of set complexity science up as a counter to that, as, "Before we tried to do this, and that was stupid, but now we're going to do complexity." And that's sort of an enlightened replacement for that McNamara system science stuff. But the systems thinking that is so common today and is getting used in the military does have its roots in those very same system sciences from back in the day that were not necessarily applied as well as they could have been. I think even when we looked at system sciences in the '50s and '60s—I wrote about this in one of the chapters of my book, and I have another article on this in the journal, *Cold War History*—we can see the early formations of a more nonlinear worldview attuned to issues of complexity, even in those early days of the system sciences. So, going back and looking at this, some of it might even seem like ancient history at this point.

We had another period in the late '60s and early '70s with the McNamara era and the attempt to apply systems analysis and system sciences. This is sort of similar to what we saw in the early 2000s with the network-centric warfare and that early attempt to apply complexity science, which is to say there are lots of good ideas in both of those sciences. Complexity comes out of the emergence of system sciences in the post-World War II period, but in both cases, early attempts by the military to learn lessons and apply those sciences didn't necessarily work out as planned. Maybe, in both of those cases, it was because the initial vision of those sciences and how to apply them was too technocratic and too limited in scope. So, there's always a plug for reading more history. I didn't write down in my notes here any particular books to read or articles to read on that, but if you want me to, I can think up some for you, if you'd like.

Now, I think in looking at what people have been doing in military design and in the design thinking movement in the US military, and among the Australians as well, over the last like 10 years or so, there has been a really interesting attempt to start to incorporate some of the social theory and post-modernist theory that has an affinity with complexity theory into military thinking. I mean, my jaw literally dropped the first time when, in *Military Review*, I saw somebody cite Foucault. I thought, "I never thought I would see tough guys in green suits with guns citing postmodernism and Foucault." Seriously. I thought to myself, I read Foucault, and this author's not wrong. He's doing it right. This is amazing. I never thought this would happen. There's other work in that genre that I have not seen used as much that I think would be helpful. One of those is work by a sociologist named Niklas Luhmann on social systems theory and communication. He was influenced by cybernetics and systems thinking, in

particular the work of Humberto Maturana and Francisco Varela, who are systems biologists from Chile. Luhmann's work has application to understanding social systems and communication, and he provides a theory of communication that really goes beyond linear, sender-receiver, effects-based, “magic bullet” theories of communication that are still quite dominant in communication theory in the Unites States today—that messages are essentially projectiles that you throw at other people to achieve effects, or messages are things that you shoot out in mass to try to affect people and societies to get them to do what you want. His theory of communication is more process-based than it is effects-based and really provides a more nuanced view of communication in line with the kinds of system theories and complexity theory that you are already interested in.

It would be really interesting to see, for example, when we're talking about information operations in the context of multidomain or gray zone kinds of conflict, what would talking about information operations, thinking about strategizing them, and implementing them look like? If we had a theory of communication along the lines of Niklas Luhmann, I think that is more appropriate for the complex, nonlinear worldview that is otherwise being talked about when we're talking about gray zone and multidomain operations. I feel like there's sort of a mismatch between… we're having a nuanced understanding of the world emerge when we're talking about gray zone, multi-domain, etcetera. But then, when it comes to communication, we're still using sort of sender-receiver, effects-based models of communication from the early 20th century. So, they're a little out of date.

The second person I don't see military folks reading or citing a lot, and I think would be helpful, is Bruno Latour and actor network theory, which is what he's famous for. Also, in that same genre is a British sociologist by the name of John Law. He's written a lot on what he calls “heterogeneous engineering.” I think this kind of work would help with understanding the idea of the bounded rationality of actors within complex systems. It takes the idea of net assessment in a direction of trying to understand other actors’ perspectives on their own terms and understanding the bounded nature of their own rationality and their own knowledge. So, I think that would be a scholar that would be helpful to look at.

Another person I haven't seen cited too much that, again, I think would be helpful is a philosopher named Paul Cilliers, and he has a great book called *Complexity and Postmodernism*. It's a great translation between complex systems and postmodern or post-structuralist philosophy. It's sort of a bridge between the two and translates each in terms of the other. For example, I did a lot of reading about complexity theory and chaos theory as an undergrad and then during my master's program. Then, when I got into my PhD program, my PhD advisor was really into postmodernist philosophy, and he was having me read Derrida and Foucault and all this stuff. Initially, it was very challenging. I thought, "What are these crazy French guys talking about?" One of the things that he assigned to me to read was Cillier's book *Complexity and Postmodernism*. He said, "Okay. You already understand the complexity stuff really well. He's going to explain postmodernist philosophy to you in terms of complexity theory." And vice versa—if you know postmodernist philosophy pretty well but you don't know anything about

complexity theory, his book would be a good read because he sort of puts the two in conversation with one another and shows all the affinities between the two.

In terms of concrete methods, Charles Ragin—he's a sociologist—and a bunch of other folks have followed off of his original work on this. He's done work on a method that he calls qualitative comparative analysis that uses Boolean logic to try to study not the causal relationships between individual variables in a system, but the configurations of variables, or the presence and absence of different variables in combinations that are more or less likely to lead to certain outcomes. He specifically does this as a way of trying to deal with complexity, and says that often times, we want to just focus in on one variable and say: Okay. Is this variable correlated with some other variable to a statistically significant degree?" But other times, in the real world of complex interactions, it's the confluence or the coming together of multiple factors that lead to outcomes, not just one particular variable. He's come up with a really interesting method for doing those kinds of studies that's still systematic but qualitative, and that's something that I think has a lot of potential. I'm sort of surprised I haven't seen it used more.

Finally, again, a plug for reading history—it's always good to go back to the work of John Lewis Gaddis on the relationship between the studies of history and complexity. If people aren't aware of his book on that, *The Landscape of History*, it's a great thing to read to help you think about complexity while you are perhaps deepening your understanding about what's happening in the world.