Beyond the Hype: The Reality of Precision-Strike Weapons in Ukraine

Ryan Vest: Welcome to *Horns of a Dilemma*, the podcast of the *Texas National Security Review*. I'm Ryan Vest, executive editor of TNSR, and I'm here with our editor-in-chief, Dr. Sheena Chestnut Greitens. We're pleased to have joining us today, Cameron Tracy, author of the article, " Technological Surprise and Normalization Through Use: The Tactical and Discursive Effects of New Precision-Strike Weapons in the Russo-Ukrainian War." Cameron Tracy is a senior research scholar at the Berkeley Risk and Security Lab in the University of California Berkeley's Goldman School of Public Policy. Cameron, welcome to *Horns of a Dilemma.* It's great to have you on the show.

Cameron Tracy: Thanks so much for having me.

Sheena Chestnut Greitens: To start us off, I wanted to ask you a little bit about your motivations for writing this article. It seems like the nature of the conflict in Ukraine really shaped this piece, and so I wondered if you could talk about how the nature of the fighting between Russia and Ukraine motivated you to write the piece. And what do you think the world has learned or has watched and observed in the conflict that is most relevant for the arguments you make in this piece?

Cameron Tracy: Yeah, so it's not frequent in the last few decades that major military powers have engaged in the full scale invasion of a well-armed adversary. And so we don't have here necessarily a war between great powers, but we do have Russia, a technologically advanced military power, and on the other side, Ukraine—a nation backed by many EU states, by the US in several ways.

And so we have major military powers engaging in a conflict in a variety of matters against one another. So I see this as a great chance to look back at some of our recent prognostications of what war would look like in the near future—especially the looming threat of great power war—and then to look at what analysts of this got right, but more interestingly, what they might have gotten wrong.

Iteration is probably imperative if we want to improve the way that we forecast the nature of war. Looking at this conflict specifically, quite famously, drones

have become a major component of war fighting that was absent from previous conflicts.

And as an example, Dominika Kunertova had a great article in 2023 in *Contemporary Security Policy* looking at how most analysts had sort of misplaced their attention on drone technologies, thinking mainly about large sort of exquisite systems, Predator-style drones. And what we see instead is widespread use of rather small, cheap drones, often wire-controlled rather than radio.

So this is a sign that this conflict is a great opportunity for us to look at how well we did on our forecasting and to identify ways that we might be able to do it better given, as in this example, how many of us were a bit wrong here.

In other instances, Russia has had a quite difficult time in, for example, establishing air superiority early on in the conflict. They expected to quite quickly gain that and then attack through a combined ground-air invasion, never managed to obtain air superiority over Ukraine, and so they've still been able to effectively threaten Ukrainian positions through the use of standoff attacks with missiles and glide bombs from outside of contested airspace, but they as well seem to have gotten many of their predictions of how this conflict would play out and the roles that certain technologies would play in the conflict quite wrong. And in hindsight, I'm sure they wish they had predicted this better.

So that is to say none of this is abnormal. If we look at history, wars quite frequently unfold in a very different manner than they were predicted to. But what's really important is that when we get opportunities like this to reassess those prior imaginings, we should take the opportunity to do so and learn what we can from it, which is exactly what I'm trying to do with this work.

Ryan Vest: In your article, you talk a lot about how technological surprise often takes the form of systems either exceeding or underperforming or failing to live up to the expectations. When you look at the weapons that have started to come out recently in modern conflict, how does this framework help explain why these new weapons have changed the nature of war?

Cameron Tracy: Yeah, so I like to think of war quite often as a contest, a technological contest where two adversaries will bring to bear whatever weapons, technologies, and technological systems—which include human soldiers, war fighters— will bring those to bear against one another and see whose technological system prevails.

And so I think it's really useful to turn to the field of science and technology studies or STS, sometimes called the sociology of technology, to look at just what we know about how we predict the performance of new technologies, how we assess those technologies once they're used, and then how we reframe those technologies once we encounter that battlefield experience.

So I borrow a lot in this article from that field of STS, specifically from a strain of literature dealing with the sociology of technological expectations. And so a central theme of that work is that we're pretty bad—we being humans —are pretty bad at anticipating technological futures. So this process of prospection where we try to imagine a future scenario and then assess how realistic, how likely it is once we get to that future —these imaginings and these evaluations —in general, we have a lot of trouble there.

So one particularly notable pathology that we suffer from widespread across humanity is in this process of prospection, a reliance on extremes. So we tend to, when judging from past experiences and trying to extrapolate that into the future, most heavily weight the most extreme examples of the phenomenon that we're trying to evaluate or extrapolate.

So I cite an article in this article from the psychology literature, and I really like one example it gives of this related to someone who takes a train to work. And every once in a while the train is a few minutes late, and so they get to the office a few minutes late and it's no big deal. No one really cares.

But one out of a hundred times they miss an important meeting and then they don't get the promotion that they were hoping for. And you get these cascading negative events. And so the next time the person is thinking about the deleterious effects of late trains, they're going to completely ignore the 99 times when a train was late and it had no serious ill effect. They're going to focus extensively or exclusively on the one time where it had this very extreme outcome.

And so this is representative of how we forecast most things that we might try to forecast, including things like the future of warfare or the role of certain technologies in that future. So if we most heavily weight these particularly extreme instances of a certain thing, then we're going to expect when it comes to things like technological aspects of war, the most unrepresentative extremes occurring, perhaps much more often than it would be kind of reasonable to expect them to happen.

So we tend to expect revolutions around every quarter despite the fact that, you know, nature of the word revolution suggests that they should be pretty rare—that things, if they get disrupted too often, those disruptions can't be actually as disruptive as we're talking about them being. So there's little room in this forecasting process often for things like what we might call normal technologies—things that are integrated into war as currently practiced and might have some incremental effect on it, but don't change the game, so to say. So that's really what I'm focusing on here.

I quote in the article somewhere from a paper by Van Lente et al. from the sociology of expectations literature, where he says, to paraphrase, something along the lines of, the study of technological hype is actually less interesting than the study of what happens after hype. And so the argument here is that all of these things we're talking about, these attempts to predict the future, these reliance on representative extremes, these are what we might call constitutive—meaning they can shape action, they can shape the way that militaries prepare for war, they can shape the way that states get into and behave in war.

And so these forecasting shortcomings, I argue, are quite important to study because they can shape not just how we prepare, but also how we adapt to technological surprise that we will experience in war when those erroneous or misplaced expectations we have fail to come to pass. So what I argue here is that what we see in the rest of the Ukrainian war, the commonality of technological surprise is not abnormal. Weapons technologies very frequently overperform or underperform our generally extreme or unrepresentative expectations of them, but there's a lot that we can learn from studying that process.

Sheena Chestnut Greitens: Let me ask you a little bit about what comes after the hype to go back to a point that you raised a moment ago. You talk in the article about the idea that analysts and scholars who make predictions about the future effects of emerging technologies aren't always, or often, held accountable for the accuracy of those predictions. Some of that might be due to personnel or organizational turnover, but how do you think this lack of accountability has constrained learning or shaped the way that we think about weapons platforms and new technologies today?

Cameron Tracy: Yeah, so beyond the difficulty that we as humans tend to have with prediction or forecasting, we are often associated with organizational contexts in which, unfortunately, we tend to be rewarded for associating ourselves with big dramatic shifts or changes. So if you think about on your resume, if you are, you know, working in manufacturing, you don't want to say,

"In my tenure in this position, I increase the production of widgets by 0.8%." You want to say, "increased by 800%," obviously. So big changes are better; we're professionally rewarded for them.

And there's something quite similar when it comes to forecasting. If you want to establish yourself as a thought leader to gain political capital within an organization, you want to associate yourselves with big dramatic changes. And when it comes to imaginings of the future, one has great leeway to do that. It's very easy to imagine a future where everything is constantly disrupted because there's really nothing to stop you from doing so.

And so in that incentive, as accompanied by these biases that make the imagining of extreme futures more prevalent than they might otherwise be, you have this sort of confluence of incentives to, like I was saying earlier, expect a revolution around every corner.

So we see this, for example, with the recent rise of the category or label of emerging technologies, which kind of casts the humans involved in technological change as nothing more than observers, while the technologies themselves are leading the way forward by some autonomous logic of their own.

So we see this in the scholarly literature, which is permeated by predictions of cyber warfare replacing physical wars, terrorist groups getting their hands on 3D printers and using them to make nuclear weapons, blockchain solving all the problems of arms control—this was a hot thing five or 10 years ago. But this isn't confined to the scholarly arena either.

If you look at, for example, the testimony of defense officials to congressional appropriators, you'll see that these same sorts of revolutionary narratives can serve as powerful arguments in favor of things like greater funding for the organizational body that you're serving as a proponent of. So if you talk about how adversaries are poised to leapfrog the US technologically, then that's a good way of saying, "You really need to fund us to develop thing A, B, and C that I'm trying to raise money for."

And so this is, again, a quite effective argument because we as humans are so predisposed to this kind of anxiety about technological surprise, about extreme imagining sort of grave technological futures. Why these things are so persistent, why we rarely hold them to account has exactly to do with this fact that they're so useful and so prevalent and so pervasive as arguments for obtaining what one needs to obtain in their organizational role. Because by the

time that your prediction, perhaps, has been proven wrong by experience in this case on the battlefield. Then everyone has moved on to a new topic of forecasting the next emerging technology.

So we don't talk much about blockchain and its implications for arms control anymore because the same people who are all worked up about blockchain a few years ago have now moved on to LLMs and other AI related technologies.

So there's really not a lot of downside to making these kinds of arguments, and a ton of short-term upside if you are trying to raise money, establish your professional reputation, or do something similar.

Sheena Chestnut Greitens: You've talked about these organizational and human psychological factors. It also seems to me that for many policymakers that I hear talk about this, there's an ethical calculation that they're making, which has to do with the—I think of, for example, you know, Condoleezza Rice saying, "We don't want the smoking gun to be a mushroom cloud," with respect to the concern that Iraq had WMD.

And without going down the rabbit hole of that case and who knew what and motivations of various actors involved in that decision-making, I think that encapsulates the sort of the ethical dimension of some of these human factors—which is that the potential cost of being wrong if you underestimate often seems psychologically to people to be much bigger. And the sort of damage to countries or people or organizations that you care about might be much bigger with underestimating than overestimating.

And your article talks about both, right? It talks about that sometimes policymakers underestimate, sometimes they overestimate the capacity of these new weapons systems. But is the danger of over and underestimating equal or does human psychology tend to evaluate them differently? I just wondered if you could talk about those relative risks as your article talks about how both converge over time, but, I wondered if you could unpack that a little bit for us.

Cameron Tracy: Yeah, that's a really important question because getting the future wrong can obviously go in two different directions: over or underestimating. I mean, sometimes you can go kind of perpendicularly, but those are the big categories that it's most useful to talk about. And in the article, I assess processes that move in both of those directions.

And so the risks that you face when it comes to either over or underestimation are quite different. There are risks associated with both, but the way that they

play out are quite different. So starting with underestimation, because as you mentioned, that's kind of the most intuitive, the most obvious. I open the article with a quote from Kissinger in a *Foreign Affairs* piece that he wrote, where he talks about how every country lives with the nightmare that its survival may be jeopardized by a technological breakthrough on the part of its opponent.

And so this is just summing up the same argument that, well, it's going to be really bad if they have something and we're not ready for it. So this is a kind of super-weapon narrative, where if they get the nuclear bomb before we do or something like this in the Second World War we're in a bad place. We're going to lose.

An example I like to use in my teaching is the US development of penetration aids for the Poseidon, a submarine-launched missile in the 1960s. So penetration aids were technologies meant to help a missile get past interception by missile defenses. Graham Spinardi wrote an excellent book on this, *From Polaris to Trident*.

So in the sixties, the US was building its Nike Zeus Missile Defense System. So this one is very, you know, interesting to me. I'm in the Bay Area out in Berkeley, and we have a bunch of installations still on the mountaintops of these old Nike Zeus systems where they were installed to protect ports, defense production facilities here in the Bay Area.

So, Nike Zeus was a very particular system meant to shoot down incoming warheads in their final moments of flight, right after they had reentered earth's atmosphere and were flying towards their targets in, for example, the San Francisco Bay. US weapons designers assumed, which seems like a rational assumption at the time, that the Soviets were designing essentially the exact same system.

Of course, you know, they found the same best solution that we found here—and air quotes around "best solution" there. Until in 1964 there's a Soviet military parade where they show their Galosh missile defense system and it's completely different: much larger nuclear warheads on their interceptors, radars designed for detecting threats outside of the atmosphere because that's where the Soviets are trying to do the interception.

So the US penetration aids, the technologies they had been developing—things like decoys to get us warheads past the expected Soviet missile defenses—were exactly wrong in every way. They were too small for the Soviet radars to even see them, and of course, you want your decoys to be seen. They were not spaced

out enough that an explosion from one of these large Soviet nuclear warheads couldn't simply wipe all the decoys plus the missile that they're trying to protect out in one blast.

So the system was wrong in every way, in part because of these pitfalls of underestimating what arrival is doing. And this also gets into some kind of pattern matching pathologies here, which can get things wrong. So this is a case where the US spent a lot of time and a lot of money and ended up in a bad place because we weren't ready. We had underestimated what the Soviets were doing.

But I like the missile defense case here because it also gives us a good example of some of the pitfalls of overestimating. And so the example I'll use here is overestimation of one's own technological capabilities with the Reagan administration's 1980 Strategic Defense Initiative, or Star Wars, as it was colloquially known.

So the Reagan administration famously overestimated the efficacy and the practicability of things like directed energy systems—so lasers and particle beams meant to achieve the same missile defense mission by shooting down adversary reentry vehicles and missiles before they could make it to their targets.

So, these technologies, many of them simply never were materialized despite the administration spending many billions of dollars on them. And so of course there are echoes of this today with Golden Dome. There's a lot of renewed interest in some of these same systems, but it's important to remember that this is 40 years later. That was 40 years of overestimation of what the US was able to accomplish.

Maybe it's different now. We'll see. But so a big downside there is that every dollar you spend on something like a directed energy weapon that never actually materializes is a dollar you didn't spend on something that does work in the near term.

And so I think it's easy to say that this is maybe less of a problem than overestimation. But again, look at what happens when you get into a war situation. Let's think about Russia's performance in the early days of the Russo-Ukrainian War, where I mentioned their inability to establish air superiority as they expected and as they had based their war plans on. Jay Sankaran at UT Austin had a great 2024 article on this in the *Journal of Strategic Studies* where he walks through why that happened.

And in hindsight, had the Russians better prepared to attack and to suppress Ukrainian air defenses and air fields from which they launched their fighters, then enabling that joint ground-air advance that they had planned for in the early days of the war might have gone much better for them. And so by underestimating Ukrainian countermeasures and by overestimating their own air capabilities, but especially that overestimation of their own capabilities, they imposed on themselves a significant risk which came to pass that it really hindered their advance in the early days of the war.

And so overestimation, especially of what you yourself have, can prove quite detrimental as a form of technological surprise in addition to underestimation of what an adversary might do.

Ryan Vest: I'd like to talk a little bit more about overestimation because this is, you know, something I'm really excited about. The Russians for many, many years have been talking about forecasting the future and investing in things that are really gonna matter, and they've invested an enormous amount of money in things like hypersonics. And you talk about that in the article a little bit how some of these precision weapon systems like Kinzhal and Tsirkon are very much an overestimation of emerging technologies that just didn't live up to the hype.

I'm just wondering, in your research, how have you seen the discourse around these weapons, especially from the Russian side, and these platforms shift and recalibrate over the past couple of years as they've not lived up to the hype in Ukraine?

Cameron Tracy: Yeah, so hypersonic weapons are something that I've been interested in for quite a while. So since 2019, 2018 or so, I've been working with a colleague of mine at MIT, David Wright, in their nuclear engineering department trying to better understand exactly what these supposedly emerging missile technologies will do on the battlefield because they've been subject to so much of these hype narratives.

Now, one thing I want to mention, and I go into this a bit in the article, whether Kinzhal should properly be termed a hypersonic weapon is up for debate. I would describe the term hypersonic weapon as ambiguous, fuzzy, poorly defined, and much less analytically useful than we tend to think of it as. But I do still think it's fair to say at least that Kinzhal has been in many circles painted with kind of this hypersonic hype brush.

The Tsirkon is unambiguously a hypersonic cruise missile. So there, there's less of this problem. So just to be clear, I'm not necessarily saying that Kinzhal should be in this category, but if we're talking about hype narratives, I think it works fine there. So, like I was saying, my colleague and I, we've published a series of papers in the *Journal of Science and Global Security* over the past five years comparing the performance of hypersonic missiles with alternative technologies like supersonic cruise missiles or ballistic missiles.

And that's specifically because what we see in the late 2010s and early 2020s particularly, are these narratives of a hypersonic revolution that you see promoted by scholars and the academic literature, by defense officials, by the press. And there are three main arguments I would say that underpin this narrative: the first, that these weapons reach their targets faster than any alternative system; the second, that existing sensors simply can't see hypersonic weapons; and the third, and what I would say is most influential in many military planning circles, is that defense against hypersonic systems is impossible—that all of the missile defenses we've developed so far simply can't compete with this new emerging missile technology.

So, David Wright and I have been arguing for a while that none of these three narratives really align with physical reality, but particularly that third narrative. So in the early 2020s, the first few years of the decade, we were doing a lot of modeling, computational modeling, of the engagement between a hypersonic vehicle of some kind— cruise missiles, hypersonic boost glide vehicles, and missile defenses—looking especially at US Patriot systems, so defenses that try to engage an incoming missile threat in the terminal phase in the last few minutes before they strike their targets.

And we had been predicting for a while that these hypersonic weapons would actually be uniquely vulnerable to terminal defenses because they spend so much time gliding through the atmosphere where they're subjected to the effects of drag, that they're actually traveling quite slowly—slowly relative to other missile systems— in those last few moments of flight, making them easier to intercept.

So it was pretty validating when in 2023, Ukrainian forces first intercepted a Kinzhal supposedly hypersonic missile with a US Patriot system, which was provided by Germany. And they've continued to do so recurrently since then. In 2024, they first intercepted a Tsirkon, so an unambiguous hypersonic cruise missile.

And what's notable about these interceptions is that they didn't do it with the best system available. So, as I mentioned, this was a German supplied Patriot system. The interceptor it was armed with, the PAC-3 CRI, CRI is for cost reduction initiative. And as the name mentions, it's not the best you can get, right? It's the cheaper version. It's the mid 1990s version of the technology, and yet it's still intercepting this missile design that supposedly, according to these hype narratives, was the best of the best.

Now what I'm really interested in this article is, as I mentioned before, what happens after hype. So if you say it's impossible to defend against these things, the Ukrainians start intercepting them with this kind of lower tier missile defense system.

What'll those same people who are all worked up about the vulnerability or invulnerability of these hypersonic glide vehicles—what'll they say next? What happens to that hype discourse? And so here, I think we have a great example of this crick, this rapid normalization process as I term it, where something goes from discursively revolutionary to discursively normal or of modest military implication.

So what you have there [are] defense officials, many of the same officials who just a few years ago, were telling Congressional appropriators or the Senate Armed Services Committee, House Armed Services Committee, that we have no way to defend against hypersonic weapons. Now all of a sudden they're saying defense is feasible.

We have these Patriot systems. We need to get more of those in the places where they can be most effective. And so a complete shift, which in a way is nice, you know, this adaptability, this ability to quickly move away from our erroneous earlier predictions. But as we talked about earlier, this also means that there's little space created for looking at why we got it wrong in the first place.

We're also very quick to forget our erroneous processes that led us to that point in the first place when we so quickly abandoned our previous predictions in the face of battlefield experience. So it's in many way[s], a double-edged sword. We can quickly erase those expectations and not be hindered by them going forward, but we have no opportunity for a reckoning of why we got it so wrong in the first place if we don't go back and assess exactly why that happened and what forecasting pathologies led to it.

Sheena Chestnut Greitens: So Ryan's asked about two of the case studies in the article, and I wanted to ask about the other two because they highlight, you

know, again, how battlefield effects prompt reassessments of the framing and the assessment of the effects of these weapons.

But in these cases there was not a lot of anticipation followed by a recalibration. So I wondered if you could tell us, why do we need these cases and what do they tell us that's different from the other two?

Cameron Tracy: Yeah, so the other two cases: the Oreshnik, this intermediate range ballistic missile, maybe a medium range ballistic missile, the distinction is not so important—a range of, you know, around a thousand or a little more kilometers; the second, the UMPK glide bomb kit.

So I'll talk about the Oreshnik first, and anyone who is following the news heard about that. There have been two launches of it now. The second was just in January. So I really like both of those cases and I think they contribute a lot to the theory here because they help us move past the simpler hype cycle framework. So if you haven't heard about Hype Cycles, the most famous of these is the Gartner Hype Cycle, first proposed I believe in the 1990s by the Gartner Tech Consultancy.

So the argument here is that technologies tend to emerge along a sequential process where initially there's some great hype, there's overestimation of what they will do in the future, the performance that they will demonstrate. Followed by disillusionment when everyone realizes, oh, these things aren't going to be as wonderful and as revolutionary as we expected them to. And then eventually what I would call a normalization process where people find, okay, there are modest efficacy applications of this sort of thing. It's not the best thing in the world, but it's not useless either. So that's the Gartner hype cycle.

And that captures one process, one direction of technological surprise, and then technological reassessment or normalization. So with these other two cases, what I'm trying to capture there is what happens when things move in another direction?

So the Oreshnik and the UMPK, the glide bomb system, I would argue neither of them were seen or anticipated to be harbingers of some technological military revolution. Neither was given much attention. So what this means is that in both cases you have a kind of blank slate for responses to their battlefield performance.

And now with Oreshnik, you see rapid attempts to fill that blank slate in the initial stages after its use with these dire warnings of what it might do. So

people are describing this as a hypersonic weapon initially, as a nuclear weapon initially, and it's clearly neither of those.

So Oreshnik being a medium or intermediate range ballistic missile is, in many ways, kind of the most basic missile technology we can think of. You have a rocket engine that is a bit larger than what you would see on shorter range ballistic missiles, but that's all. It's larger, so the missile can go a little further. It flies a little faster, but it still follows a pretty typical ballistic trajectory.

What's a little weird about this intermediate range is that it's something that the US, and Russia at least, haven't deployed for many decades. Because under the terms of the INF Treaty, the Intermediate Range Nuclear Forces Treaty, neither was allowed to, and this was meant to constrain their deployments of nuclear armed intermediate range ballistic missiles, mainly in the European theater, so that Europe wasn't kind of caught in the crosshairs between two rival military powers.

But it turns out you can put a conventional explosive on the front of an intermediate range ballistic missile. You can put, actually, no explosive payload on the front of them. And I believe with at least the first use of an Oreshnik, it was argued that there probably was no explosive payload on it at all.

So in a way, it's not a very exciting thing that happened. But what we saw was, at least in the short term, people getting very worked up about it. But then those initial kind of dramatic reactions very quickly gave way again to normalization, to recognition that this is a missile—happens to have a certain maximum range that is different from that of missile technologies that we're more familiar with, shorter than that of an intercontinental range ballistic missile that many nations deploy quite widely, longer than that of a short range ballistic missile that many nations deploy and that is fairly frequently used in war—but that this intermediate range doesn't actually pose any revolutionary tactical concern.

So, in other words, we see normalization there from this kind of blank slate starting space. Now with the UMPK glide bomb kit, we see again something a little bit different. So glide bombs have been a quite familiar weapons technology since their debut in the Second World War. In no way can we consider these a game changer or a part of a military revolution.

So all you're really doing is taking a bomb, putting some small control surfaces on it—little winglets, fins, something like that—and then usually rudimentary and cheap guidance system. So rather than just falling under the influence of

gravity, your bomb can kind of do a paper airplane glide under guided conditions to a target, hit it with some degree of accuracy.

So what we see here with this weapon that is not revolutionary, but turns out to actually perform for the Russians quite well on the battlefield is a different kind of technological surprise than what we saw, for example, with the hypersonic systems, where under the particular conditions of the Russo-Ukrainian war, where you have this lack of air superiority on the Russian side, or on either side, and reliance on standoff weapons. Then executing concentrated attacks with large numbers of glide bombs ends up being quite effective.

And the Russians happen to have pretty large stockpiles of their FAB 300, 500, 1500, kind of what we might call dumb bombs, unguided bombs, that you can quite easily and cheaply put these UMPK kits on, turn them into glide bomb standoff weapons, attack from behind the front lines outside the range of Ukrainian air defenses.

And so what we see here in response to this technological surprise, which goes from a state of underestimation to a state of modest military efficacy, is again, a dramatic evolution of the narratives about these weapons towards a normalized discourse, but going in that opposite direction.

So, early on, analysts talk about Russia's use of glide bombs as a sign of their desperation. They're running out of stocks of their more advanced missile systems. They weren't ready for this war, and so they're turning to whatever they have in the stockpile. But then actually it turns out that many of the things that make these weapons seem so primitive are actually advantages in terms of their performance in this specific context.

They, compared to missile technologies, tend to be pretty small in volume, they fly at pretty low speeds, and they don't have propulsion systems, they just glide. So all of this together means that they have very little thermal or radar signature. They're kind of hard to see with the systems that you would use to watch for incoming aircraft or missiles, and that, of course, makes them harder to defend against.

So actually the thing that many people were worried about hypersonic weapons doing, which was getting past defenses—air and missile defenses—the hypersonic weapons failed to do, at least to the extent that people were hoping or fearing. Whereas the primitive glide bomb actually achieves that to a certain degree, and because of their low cost, Russia can use so many of them, attack in

bulk, that even if you had highly effective defenses, it's hard to shoot all of them down.

So this has proven to be an ongoing problem for Ukraine: how to counter these glide bomb attacks. But importantly, they're not now seen as super weapons by any stretch of the imagination, but rather we, again, even though it proceeds in the opposite direction, we see this process of normalization that I'm arguing is something we should actually expect very often as a response to our inability to properly forecast the performance and security implications of new, unfamiliar, or unexpected military technologies.

Ryan Vest: So I want to back that up just a little bit and, you know, kind of scale out. We've talked about some very specific weapons that have been used in Ukraine, but in the article you talk a little bit about these concepts of offset strategies and revolutions in military affairs.

For listeners who may not be familiar with these concepts, I was wondering if you could talk a little bit about what they refer to and how this affects the argument that you're making with these new weapons in Ukraine.

Cameron Tracy: Yeah, so both of them are really interesting frameworks for attempting to best imagine the technologies that will play key roles in the future of warfare, and their implications for how warfare is fought, and they're actually closely related to one another. So I'll start with the revolution in military affairs or the RMA.

So this is, to summarize things, the idea that war as a technological contest evolves according to some sort of concept of punctuated equilibrium—where you have stretches where things don't change too much war is fought as war is fought, but then it's punctuated by these recurrent and brief periods where some sort of revolution occurs, the nature of war is disrupted often by the emergence of new technologies, and then it reshapes how war is fought, which then will continue for some period of stagnation before the next revolution in the line.

So this originally comes from Soviet military science. In the 1970s, the Soviets were really into the belief that this was a time of unprecedented technological change. Just as an aside, everyone seems to think that they're always in the time of the most rapid and the most unprecedented and the most meaningful technological change. I think there's something we can learn from that, but the Soviets thought so in the seventies, and so they came up with this concept that was later adopted by US analysts and has since become a pretty dominant

narrative, especially when one is pushing for the adoption of a certain new technology that one is a proponent of.

It's again, a very convincing and very persuasive argument to say, "Hey, this is a harbinger of a technological revolution. If you don't get on top of it, you're going to be left behind." Right? So that technological anxiety that leaders have of underestimating or failing to anticipate can make this a very persuasive axis of argument.

So there's a really interesting kind of internal tension in RMA theory where it pushes us to always be on the lookout for the next revolution, because of course, you don't want to be left in the dust by your adversaries. But at the same time, this very idea of revolutions in military affairs and the nature of how war is fought in disruptions to that kind of suggests these things shouldn't be easy to anticipate. For something to be disruptive, it's almost a necessity that no one has anticipated it, or if people have, they can't come up with a way to adapt before it, you know, is upon you. So, when it comes to how we should actually behave and act, how war planners should best plan for military revolutions, that's a little bit tough because, you know, the very idea of a revolution kind of tells you that's difficult to do.

Now a kind of sister to this idea is the offset strategy, which gives us a little more guidance about, okay, what as a war planner do you actually want to do when you think about the way that technologies, especially new technologies, can be put to use in war? So offset strategies point to the argument that one can identify specific kind of tailored technologies to offset or to compensate for disadvantages that one might have vis-a-vis in adversary.

So this is a concept first developed in the Cold War, when US planners were looking to offset perceived advantages in Soviet conventional forces and numbers, especially in the European theater. So the idea was that the US for a time had a monopoly on nuclear weapons, and even after the Soviets developed them, still was leading there in that technology and in long range delivery systems—ICBMs, for example—for a certain period of time.

And the idea was that the US could rely on nuclear deterrence to offset disadvantages the US had relative to the Soviets. So central to this is simply the idea that if you have the right technology at the right time, particularly if it's one of these revolutionary technologies, that can override other considerations.

And so we've had subsequent offset strategies since then in the US: dealing with ISR technologies, intelligence, surveillance, and reconnaissance; dealing with

precision guidance technologies for things like missiles and smart bombs; stealth; un-crewed vehicles. Again, the idea that if one masters these technologies and figures out how best to harness them and incorporate them into military doctrine, they can override other disadvantages that one might have relative to their adversaries.

Sheena Chestnut Greitens: Let me ask another question about how to put all the pieces in this article together 'cause it's a really interesting set of case studies, and obviously looking at performance in an ongoing conflict.

And toward the conclusion of your article, you talk about how this cycle of misalignment and recalibration that you call normalization through use right, affects overall patterns of international security. And among the conclusions you draw are that the nature of warfare is often actually more durable and less volatile than policymakers people looking at contemporary emerging technology and warfare give credit for, and that old technology often actually blends in and coexists with the new.

And so I wondered if you could help us think about, you know, if policymakers are going to take one lesson away from this article, what do you want it to be? And then how would you apply that to the ongoing conflict that they are having to make decisions about, which is the war between Russia and Ukraine?

Cameron Tracy: Yeah, I'd say there's one key headline lesson that I hope a reader would take away from this, and then one proposed; I'm proposing one corrective to this. So the lesson I think here is that sometimes, perhaps oftentimes, the more one worries about and attempts to anticipate and mitigate for a technological surprise, actually oftentimes the less prepared one is for that surprise.

And so the empirical evidence—if as in this paper, we look specifically at processes of weapons technological change, or even if we look at human psychology and forecasting in general—the evidence shows that we often overestimate the implications of things like emerging technologies. And as a result of that, our attention is drawn away from other technologies that we might want to be looking at, you know, if we look at things in hindsight, and thus we underestimate the impacts of other technologies.

And so we've already talked about how either of these can prove harmful in terms of misappropriated defense funds, in terms of surprise on the battlefield and an inability to quickly adapt to what an adversary is doing that one didn't expect them to do.

So one corrective to this is to recognize that actually adaptation is often far more important and far more useful than anticipation. If we place a little bit less emphasis on attempts to anticipate what is going to be the source of the next revolution in military affairs, when oftentimes we're wrong about that, and instead dedicate some of that mental energy, some of those resources towards being ready to adapt to an uncertain future on the battlefield, oftentimes we'll be better off.

So what I think this work best shows is that many of those expectations we have mean little to nothing after we encounter a battlefield experience with a certain weapons technology, even too to us, us being the people making these predictions in the first place. We're so quick discursively to forget about what we were saying last week and instead to say something completely new as if we had been saying it all along, which is good for adaption maybe, but not great for, as I've mentioned, anticipating better in the future.

So there's not much hope for us to get better at forecasting, unfortunately. But what we can do is prepare ourselves to do exactly this process of quickly dropping our preconceptions when we realize that they're wrong. And then figuring out how to go about this new future that we found ourselves in—this threat that we didn't anticipate, but now somehow have to get ready quickly to face.

So there's a really nice quote I given the article. It's from, I believe an article in *The Economist* shortly after the first interception of Kinzhals by Ukrainian Patriot operators, where the journalist actually quotes one of the operators of the Patriot system that did the interception, and is talking to him about, you know, what do you do now? How are you approaching your job differently after this huge technological surprise when you intercepted this missile that no one thought it was possible to defend against?

And the Patriot operator says something along the lines of, "well, what I've realized now is that these weapons are not fundamentally different from those that I've been trained and that I have experienced with intercepting before"—so things like Russian Kalibr is more conventionally armed missiles. And the operator says that this is quote, as he realizes now, "just a matter of getting on with the job."

And I think this is a great example of this adaptation process, where if we can drop that technological anxiety we had, if we can just accept the fact of technological surprise, and then we can immediately start assessing how can the systems we have now deal with this? What capabilities do we have? What

capabilities should we be developing but maybe not relying on because it takes a while to develop new capabilities. That's probably a better way of thinking about how new technologies alter the nature of warfare, which is to say, how does it fit into warfare as we fight it today? And thus, how can the systems that we have today counter that rather than imagining warfare fought in an entirely different manner again and again and again.

Ryan Vest: That's a good way to bring this discussion to a close. I love that. It's a great little wrap there.

Well, Cameron, we want to thank you very much for joining us today. This has been a really interesting discussion.

Cameron Tracy: Thanks so much for having me, and I hope everyone who's listening can either read this paper or read some of the others in the collection that this is a part of on emerging technologies and the future of war.

Ryan Vest: It is a fantastic collection, so I join you in hoping that everybody has a chance to really dig into those. Thanks for joining us on *Horns of a Dilemma* from the *Texas National Security Review*. Our guest today has been Cameron Tracy, author of the article, "Technological Surprise and Normalization Through Use: The Tactical and Discursive Effects of New Precision Strike Weapons in the Russo-Ukrainian War," which as always can be accessed for free on our website, TNSR.org.

If you enjoyed this episode, be sure to subscribe and leave a review wherever you listen, and you can always find more of our work at TNSR.org. Today's episode was produced by TNSR Digital and Technical Manager Jordan Morning, and was made possible by The University of Texas System. This is Ryan Vest and Sheena Chestnut Greitens. Thanks for listening.