

An Interview with Martin Wikelski: Conducted by Harold Rhenisch

Harold Rhenisch

Wikelski, Martin. *The Internet of Animals: Discovering the Collective Intelligence of Life on Earth*. Greystone Books, 2024.

I spoke to Martin Wikelski for an hour on June 19, as a member of the Trumpeter Board. After introducing myself as a Canadian writer of 34 books, as well as close editing four books of environmental photography, two in partnership with working scientists, I explained my hope that, as a board member, experience of cross-genre writing could be a resource for ecologists working with lyrical methods of inquiry. “I hope we can have a conversation that wanders between the poles of talking about writing and talking about science,” I said, and added, “That’s probably pretty perfect for the Trumpeter.” Then we plunged right in.

This interview has been edited for length and clarity.

HR: So, the big question is: what is the collective intelligence of animals? And that leads us to the question, what is intelligence? How are you using that word?

MW: Well, I think the collective intelligence is (in a way) a concept that's been around for 2,000 years, since Aristotle and then Alexander von Humboldt, who basically showed that as soon as you bring particles together and you understand the interactions, you have a novel system. In this case, it's a novel system of information gathering. I think this is really what we have missed out on. The sixth sense of animals is not something magical or mystical. It's something that is a physical principle of interacting sensors. As we deal with the most intelligent sensors on our planet, having them interact — which they do all the time, but we haven't really tuned into that — I think that is the major advance of what we are facing.

Just to go sideways from that, Goethe said that humans were the most sensitive measuring devices. So, you're extending that to animals because he left it out?

Yes, I think Goethe was wrong, in the sense that it was this typical human *hübris* that claimed that we are better in so many things, which we are not. I mean, if you think about now, what we have in the MoveBank alone, we have 1,400 species of animals — being measured, being sensed, being studied. And obviously, those animals know in their complexity much more than humans. If you just think about a dog knowing where an avalanche-covered person is, or finding a blood trail, we can't do that. So, I think Goethe was just plain wrong.

Goethe had a curious thing in mind about exactly what should be measured and how the measuring tool changes what is measured. So...what is an Internet of Animals?

I think it's simply the collective: the linking together of the information that we get from individual animals. It's really what we have in the Internet of Humans. We link together information and get new information. That's what the Internet of Animals is. I always compare it to Google traffic. If you think back to 2007: there was no Google Earth; there was no Google traffic. Google is just linking stupid cell phones in cars that only give positional information, and from that, we have a most intelligent sensing system of traffic — that everybody is using now.

Okay. So, the year is 2009. I'm in Dresden and we're driving through town. And I say to my cousin, "All of us are driving in the same strange way through town because Google is leading us there." And she said, "Yes, however, you weren't here so you don't know that before Google Maps got good enough, traffic was terrible. And as soon as they improved the maps and we all started doing this, traffic congestion decreased overnight by 30%." So, these tools have real effects in the world. Do you foresee real effects on the behavior of animals by measuring them in some way? Is there some way that this is going to affect them?

I think massively. I mean, for the benefit of animals, I think we can do dynamic conservation. You know, a whale coming into the sound somewhere in Eastern Canada is being protected, or a group of whales is being protected. Or a group of waders flying from Mauritania to Holland, but because of climate change has to stop in France somewhere, on a beach; we can protect that beach. We can close that beach down for two days to give the birds enough food. So, I think for the animals, it's a massive advantage. From a human perspective, I think we have even more to gain from the knowledge of animals than we have from the knowledge of cell phones in Google. For example, what we are now doing with disaster forecasts seems to be working

better and better. We can see long-term climate predictions coming from animals. If you link all the seabirds in the Indo-Pacific, you know much better what the next El Niño would look like. Pandemics. I mean, just to understand where Ebola really hides or where the next pandemic will start, is such a major turning point in what we know about the world that I think this is much better than 30% traffic improvement.

So, there are a lot of insects on this planet, right? You mentioned dragonflies, because they're large, but is the world of insects and the internet of insects on your radar? Have you thought about it and devised ideas for measuring what they're doing?

Yes. For example, what we can now do with Icarus and the new IT technology is to track insectivorous bats through Europe, but soon it will be around the world. For them, we actually devised a way to count insects at night from drones — also during the daytime. These systems are getting much better. We also have ideas — not in the book, but in a scientific publication that I wrote with Roland Case — to use the LiDAR systems that are in cars to prevent crashes in the future to actually count insects. That would be a really nice way to get a global count on insect availability or insect numbers, because we don't have any numbers on insects. We know they are declining, but where, when, and how, and what's behind that, that's still, I think, partially unclear.

All right! So, those are the big questions. And now, questions about the book: what is your model for it? Is it von Humboldt, or is it Lorenz, or is it Wohlleben — what is your model? It's not a scientific text. It's a story, but it's written in a particular way. You must have a model.

Not really. I like to pick the best of what I like in reading. And I like to read what individual people tell me. For example, the autobiography of Nelson Mandela. Those kinds of things. I would have liked to know more, for example, from Nelson Mandela: what his thoughts were — of the deep insights that he gained from meeting people, sitting in his cell for 25 years. *That* I was actually missing in his book. I tried to do a little bit of that in a way that is easy to digest, because I didn't want to write a book for scientists. I mean, for one, they don't read anyways. And second, they always know better. And they don't need books. So I thought to have something that is light, readable, and still with some insights.

I like what you said about insights, because that is a strong part of the book. There are these moments, these encounters with animals, where there are “aha” moments of insight. Is there a particular process by which you translate those personal encounters into the data measurement system? How do you make the switch from the personal to the system-wide approach?

I think I want to take the reader along in that process, because it has been a process for myself. I grew up on a farm with my grandfather. Then I thought that I wanted to become a scientist — and that has nothing to do with the usual things on a farm — animals and whatnot. It's all about science and knowledge and systematically gaining or improving that knowledge. Then there were these moments that told me, well, you know, our theory of biology, for example, doesn't really tell us what we are seeing there. There are so many things that are outside of our framework of science. I think that's where I want to take the reader along and say, well, you know, there are many things that we just don't understand. I mean, I just had another visit from our partner group in Bhutan. They are very spiritual, and they often know things. They predict things. I don't know how they do it. This is something that I don't know how that works. I just know it does work, and it does work in animals. Maybe eventually we can understand even in humans how these kinds of spiritual things are working, but in animals it's easier because we can now understand this sixth sense, this interaction, this emergent new property of sensing the environment and predicting the future. I think that is something solid. In a way, the book is very, very restrictive to just that point. But it hopefully stimulates people to think beyond just the sixth sense of animals, because it's almost like there's a world out there that we have ignored in the past. Mostly. At least we cannot ignore the sixth sense of animals anymore, because we know it exists. I mean, it's a physical property of interacting particles. And if you know that, then you should know that there's so much more to explore and to know that we don't know.

So how does this sixth sense of animals relate to Indigenous people?

Well, they also have an intimate relationship with the environment and modes of consciousness that are tied to it in different ways than standard Western culture. Every time we go to a place in the world where Indigenous cultures are still somewhat prevalent, we see that they have a better tuning into the environment — to what animals are doing. It's only local knowledge, but that's fine because that's all they need. It seems that if you are constantly observing animal interactions, then maybe you get some insight into what's going on. Indigenous cultures seem

to often have a clear insight into at least some of these interactions between animals — which is now this emergent property of knowledge.

I live in an Indigenous area, the Okanagan Valley of British Columbia. The Indigenous people who live here are called the Syilx. It is the foundation of their culture that humans are tasked with looking after all living things, which also includes the land and the water, and weaving them together in the most complex web so that all will be abundant and will thrive so that humans can live off the excess.

Right.

Because humans don't have anything else to contribute. When Euro-American people came here around 1810, they encountered what they read as a landscape, as nature. But it was actually a social and cultural creation.

Right.

And I think that's part of Indigenous life. It's not that Indigenous people necessarily have learned to live in an environment. They've actually created it. So, to extend that forward with your desire to move that kind of adaptation into a global sphere, what do you see us able to do to weave a better landscape in that Indigenous way using your tools?

I think you phrased it perfectly there. I mean, what you said initially: how this Indigenous nation is seeing itself and the world. I think that's a perfect sort of a small-scale description of what we should do globally. I think I can't say it much better than that. That's fine. If we talk about it, I think we already take ourselves and also, in a way, Indigenous people outside of natural systems. So we're saying, "Oh, we are or they were creating this natural system." I think maybe that is our fallacy in human culture in general: that we take ourselves outside, that it's humans — and the rest of nature and the planet. I think that in the future, it has to be. It has to come together. It has to. We can't take ourselves outside of nature and the planet because if we do, we think we can live without the rest. And I don't think we can. So, maybe even our wording and our thinking, or the thinking that comes from the wording or influences the wording, has to change — in the sense that we always highlight that we are part of this. We are not creating

something *outside of* nature. We are *part of* nature. We are. So nature is us. And if we think we can be sort of superior and sit on top, it doesn't work.

The charge, rightly or wrongly, of colonialism is often applied in Indigenous situations. How would you respond if someone were to say, “But, Martin, that's a colonial attitude. That's European and we're different here?”

I think that colonialism is at the root of all evil that has occurred in the last hundreds of years. I think it's the most evil thing and the most evil thinking that anybody can have. And I think it's still here today. I see, for example, how Europeans try to treat the South African nations in cities and the conventions of trade in endangered species because we are trying — as Europeans — to tell them how to deal with their rhinos, and we make their laws for them because they are too stupid to make them. Those kinds of things — that's new colonialism. For example, our environmental minister recently told Botswana that they shouldn't shoot the elephants. And then Botswana said, “Well, you're welcome. We'll send you 20,000 of our elephants and you can have them in Germany.” You know, those kinds of things. So there is still colonialism in our thinking. It's also colonialism what the Russians are doing right now.

In their book, *The Big Conservation Lie*, John Mbaria and Mordecai Ogada from Kenya are quite upset that game farms are being manipulated by wealthy white Africans to control access to game, blocking traditional human harvesting methods and depriving black Africans of territory, traditional lifestyles, and everything. Here is a clash of cultures exactly as you described. You propose an animal banking system as a possible solution. How would that work? You go over it lightly in the book. If you could explain, that would be great.

That is something we are trying right now. For example, we are starting with our partner group in Bhutan. There's one valley system in Bhutan where you have all the major cats. There are a whole bunch of tigers. There are snow leopards. There are clouded leopards. Everybody is there and they also eat livestock. There is this conflict, but people still love their large animals. They keep certain areas of the forest holy. They don't enter. In that area, what we want to do is really give these animals a bank account. If the tiger needs to eat, we still try to prevent the tiger from eating livestock, but if it catches livestock, then people get compensated. Also, if they can show us on camera traps or on tagged animals that they are healthy, that they're doing well, that they are thriving in that area, then they get direct payouts. We hope that over

the next five years or so we can convince the world that biodiversity credits should be tied to the direct measurement of biodiversity by local people. If they can show that what they have now is being preserved and maybe even becoming more diverse, then they should get payouts.

But it must be really difficult. You're dealing with human beings, who can be difficult. In this region, just reintroducing grizzly bears into the North Cascades across the Canada/US border has been 15 years of fraught negotiations. Such complications are also present in case of the current breakdown on communication between Russia and your project. *Consolations of the Forest* is a book by the French journalist Sylvain Tesson. He spent the winter on Lake Baikal. It's a beautiful book. However, he notes that a Russian game warden working in the national park, a really great guy, who really cared about his animals, was supplementing his income by tracking the animals until they were outside the park boundary and then shooting them and selling their furs for profit — which kind of negated the whole project.

Right.

You could have really nice tracking numbers in the park but leave off the fact that they're all dead because you shot them. So... given that humans can behave in this way, and your statement that Russia is a vitally important region to global animal monitoring, and you don't currently have access to Russia, what do you do?

Well, we already decided that we want to tag animals all around Russia. That's one thing. They are flying in and telling us what's happening there. Birds, especially. Next, the mammals. Eventually the situation that we have now will be over. It may be five years, or ten years, it could be twenty years, until the crazy rulers are gone, and then the good people that are there in Russia to study animals — we have really good colleagues and friends there — they will still be there. They *will* join the global community again. They are just waiting right now. I think, let's just develop another five, ten, or twenty years of technology to study things better, and as soon as Russia joins the world again, we'll be there.

You write of your frustration dealing with Russian political interference — and even obstruction — in science, and that some of it's just plain mysterious, like why is the space station backwards?

Right.

In reading your book, I noticed that this interference took a lot of time from implementing your project, but the other thing that took a lot of time from implementing the project was just plain Western bureaucratic procedures. The question that came to me is: aren't they kind of the same? The result was the same. A lot of time was spent and it's amazing that you kept going and it's great, but it's like the obstruction was consistent.

It's a really interesting thought. I never saw it that way, but I think you're totally right. It's our Achilles tendon. We are drowning ourselves in stupid administration while the Russians are drowning themselves in stupid obstruction.

So, is this a perennial problem with working with global scientific initiatives or is it a perennial problem with science in a world that misinterprets what it's doing?

I think it's both. In a way, I think we've abandoned the global approach now. Not the global approach, but global financing and global initiatives. We are doing it now in Germany with German rocket launchers, with German companies. Sovereignty in space is now the big thing for every country. We just ride that wave, even though we know that, obviously, space is global. So we do a German system, but for a global community of scientists. In Germany, that's doable. It's accepted. I think in other countries, it wouldn't be. So that's the good thing. But then the second part — I forgot the second part of your question.

Is this a perennial problem with science in a world that, seemingly, increasingly misunderstands what science even is?

I think it is. I think that the problem is that you are rewarded for describing things well, somehow, in an application. You're not rewarded for really doing things. Except in some systems. For example, in the Swiss system, they look at your track record. If you have done well, they give you more money, with a one-page application for another five years. The Max Planck Institute is a little bit like that, or it has been. It's not yet the good old Max Planck, but it has been like that. They trust the person to do things that you can't do in a regular system

because you are bound to stupid peer reviews where everybody has to agree that an application is excellent, which means it's at best average. Because "excellent" means that you are offending some people, while some think that that the idea is good, you always get this mix of people that really like it and people that really hate it. If you write an average application, everybody says, "Oh, yeah, this is something. It's an incremental step. This will result in something." This is not really science. This is just a slow advance in everyday business that some people call science. But it's nonsense.

So if your book is a model, you're more interested in making large leaps forward based upon gathering new data and integrating it. Is that correct?

I think that's what it will be. I mean, no matter whether we will do it, or our successors will do it, it will come. If you look back to real transformations — I mean, look at Galileo: they hated him because he had completely new ideas, but it was unstoppable because that's just how you know. That's how things go. If you find something that is a powerful system to gain knowledge, it will prevail. Somebody will make it happen.

That takes me back to my question. I'll rephrase it. There's a kind of standard view of science that appears in popular media here in North America, at least, that science is a collection of facts about the earth and the processes and creatures on it. There's nothing about method or procedure or the nuts and bolts of building technology that you're doing. It's just this collection of facts. I gather from the book that you've chosen the particular form of the book to speak to this popular culture and present reasons why science might be useful to it. Yet it strikes me that science remains vulnerable and has to continually reinvent itself and be vigilant because that drive to make everything just as base normal as possible seems to be profoundly human as well.

I think you absolutely nailed it there. If this came across a little bit in the book, then I'm super happy, because I did want to show that what we often do in science is exactly what you said. We just collect more and more and more. We have our standard set of theories and, you know, this is how it goes. The real science, the real progress, I think, is when you break out of that system. I think we should probably allow more people, especially more young people, to break out of that system and really go new ways, almost like a startup culture — where you may fail,

but you may also discover a hell of a lot of new things that you didn't expect. And that's not possible nowadays.

For the most part, people live in local environments, and you're asking us to think globally. You're not the only one. It's common. I've spoken to people about the grasslands in the Okanagan Valley where I live. These grasslands are very interesting. They collect water in seasons where the standard models don't say that they do. They store it. They share it with each other. There are all kinds of this activity going on. The grasslands are endangered by human activity and by animal grazing, by cattle, etcetera. And that changes how much water is available for human use.

Right.

And that changes the environment in many profound ways. So, I've said to people, you know, those hills right there, which are covered in weeds, it is possible that we can intervene and deal with the grass and have all these benefits.

Right.

And the response I continually get is "Everything changes, Harold. You have to go with the change." That's the one response. The other response is "There is a great sea of plastic floating in the middle of the Indian Ocean." We have to deal with that. Yes. There's a lot of climate change going on. And we have to think about global carbon emissions. That is true. However, the local stuff is important, because if the climate is changing and we have a more resilient local environment, we are better set to meet the changing climate, as opposed to meeting it from an impoverished point. So...you have spoken about local and global and have said we are "unable any longer to hide in our local valley." What do you say to my observation that some people are hiding in the global and ignoring the other side, which is local.

That is actually a really interesting thought. I didn't see that or hear that thought before. I think you're totally right, that some people hide in the global — in the grandiose of globalness. I think that the combination is what really gets us forward — in the sense that animals are the best

agents for preserving our climate. That is part of this payout that we want to do. For example, a muskox that is grazing down bushes in the Arctic so that there is no bush encroachment on these

grassland areas changes the albedo and the rays that are, so to speak, sent back into space. So it keeps the area cooler. It keeps the permafrost from thawing. And that prevents massive amounts of CO2 from being released into the atmosphere. It is a local thing that has to be guarded by and implemented by the Indigenous people in the polar areas, but it has effects on the global scale. In your valley, that's exactly the same thing. You have to do it locally, for the global environment. You're totally right. We can't hide in global pattern descriptions and also in our inability to do something because it's global.

Yeah. So the people in this valley have been working for twenty years to bring the salmon back, which were extirpated. They're having some success doing that — on the principle that they will apply Indigenous values and Indigenous knowledge using the best of Western science to support it. So the question is, what can Icarus do to support these local Indigenous initiatives? What data can you provide that makes them more successful?

Well, I think that that is a really good point. That's one way I think Icarus would be at its most powerful application, because we can give all these local people tools to follow the animals to really understand them better, but also to do their own analysis. And that's what we installed in a system that's linked to MoveBank. It's called MoveApps. It brings together programmers. It could be somebody who works in a bank or at Google in their regular life, but they want to do something for the good, so they are programming analysis tools according to, say, what a farmer in Nigeria needs or our Bhutanese partner group needs. Then the people who can't code and analyze, they can just click together these different analysis modules. For example, our Bhutanese partners can say, take these ten hornbills and these twenty takins and these five tigers and every morning run this analysis — an agreed upon analysis by the global science community working on this. Then, if a certain threshold is met, send me an SMS or WhatsApp or an email, and do this every day or every few hours.

So this is something where I talked with the head of the NASA Earth observation system, Karen St. Germain. She runs a two-billion-dollar budget but is super interested in these kinds of systems because, she says, people are not listening. They don't trust the government anymore. They want to do their own analysis. In a way, like in any app system, they want to build their

own app structures to come up with their own analysis of what's happening in their environment, and how that links to the rest of the world. I think that's perfect for local people who need information, for example, for salmon. Salmon are difficult because they're in water. In water, it's always difficult to get information flowing out into the atmosphere or into space. But in principle, if you had the system, you could track salmon. For example, this little salmon is going here and experiencing all of that throughout its life, or it's dying here or it's surviving here. You can really do something, because you can link to the areas where your salmon are and what they need for survival there to be able to come back. I think that's super important. In a way, you have all these people making their apps, or the people in Bhutan asking for specific analyses daily.

Are you providing the people with the apps with the data that they can analyze? Are you freely giving the data away for analysis?

Yes, right now, it's a free system. If you go to moveapps.org you can see published data sets and published analysis sets that you can use for your own data. We have these systems now that farmers in Ecuador or our conservation colleagues in Namibia use. So this is really something that I think democratizes the information gathering and analysis system around the world in that field. That's very exciting.

It almost sounds like you're creating an equivalent of the United Nations of Animals where the animals get to administrate human activity by providing data, perhaps not consciously, but maybe so through their sixth sense. The human-oriented United Nations, though, has political problems and doesn't function quite right — to be mild about it. Given that a consortium of scientists who are humans are providing this information, is it prone to interference? How do you safeguard against that? Or is the UN of Animals just naturally better than one of humans?

Well, I think it's naturally better because of the data that animals provide. They don't lie. I mean, they do their thing. They tell us 24/7 what's happening out there. Every time we analyze human data, somebody puts a cell phone aside, puts it in a car, puts it on the rocking chair, whatever, to show activity. Animals don't do that. They are honest in what they tell us. Therefore, I think that the data can't be manipulated anymore once they are in a public database. After that, everything that is done is visible and all the analysis flows are published.

You can go there and say, "OK, this is how scientists X and Y have analyzed this data. It's a published analysis flow. Maybe I don't agree with that or maybe I do, but at least I can follow every single step, from the sensor that measures things on animals down to the analysis and the interpretation." I think that's very powerful, because it takes the nonsense out of the equation that is introduced in these United Nations decisions and information systems.

Speaking of interference, the AfD party in Germany has a program which is readily available on the Internet. If you look up their ecological environmental program, three things jump out. One, it's not very extensive. Two, in terms of the oceans, the program is to protect German captains so that they maintain access to fish over those from other nations. This doesn't seem to be a really complete, robust environmental program. It's a political program. Three, in terms of the protection of nature, the party stresses that it sees hunters, German hunters in Germany, as experts on animals in their environments, and who must be given more rights so they can continue to protect animals outside of their base of knowledge. That sounds like a little bit of interference.

Right.

How do you protect against that kind of double speak?

That seems to be what it is. That is very dangerous. But I think it goes more in the human domain. And I am often lost for solutions. I would probably refer to people that know the human domain better. Yeah, I think it's a world that has all kinds of deceptions, including willful deceptions. Maybe that's one thing we can learn from animals. Actually, we're trying to do that now with our colleague Meg Crofoot. She's trying to understand how social systems in animals can be robust against all kinds of change. The change can be an environmental disaster. It can be climate change. It can also be invasions. It can be population declines. It can also be that there are sort of cheaters in the system. I think that is something that we maybe also have to learn much better from animals, because our understanding of democracy is still largely based on what the Greek philosophers did two thousand years ago. At least the US Constitution is based upon that. I think we have to maybe do some reassessment, sit down and say, well, what can we learn from all the social systems in other animals that make them more robust against the kind of nonsense that we are facing right now? I don't think that the founding fathers or the Greeks could have foreseen what's happening now with social systems. I think we should sit

down and make at least a few amendments to our social rules to prevent craziness and bullshit in the future.

That's inspiring. One thing comes to mind is salmon. There's something like four percent of salmon which don't follow the four-year rule and because of them, they've repopulated vast areas that were covered in ice.

And that's wonderful.

Two other things before we go. One is in this area, beavers have been extirpated since 1817, which means that all environmental data that we have, all ecological data, everything, is based on an absence. Now, since species are going extinct right now, do you have a way of protecting against misreadings based upon these increasing number of absences? Is that something your system can deal with, or is that just something you're trying to prevent?

That is why we were so adamant fifteen years ago to build an eternal database of animal behavior and movement, because we didn't want to go that route to say, you know, in twenty years, "Oh, all of those species are gone. We don't know what they ever did and where they were and what their role was." We think this is like a natural history museum. They were started 300 years ago. They didn't even know that DNA was in all of those specimens that are in the museum, but now we can recreate evolutionary histories of animals based on stuff that we didn't know even existed 300 years ago. That's why we think the kind of information we now have in these global databases, where the whole world — the whole scientific world — works together, creates that knowledge. This is something that hopefully will help us understand, especially with new tools in the future, what we have lost and where we have to be careful.

You also wrote out many beautiful examples — they are quite inspiring — of animals that manipulate humans in order to create situations beneficial to them. Hansi the stork, for one. What a sweet guy! It strikes me, though, that one of the main defensive activities of many animals is to hide — to not be there.

Right.

So, if animals have this sixth sense, and are as attuned as you claim, and notice patterns created innocently by your program, and change their behavior to hide from it...is that something that you've included into your calculations, and do you have a response to that behavior?

That's an interesting one. I mean, the problem is that we are so early in this observation program. I think that animals won't be able to hide anymore in the future. If they have a transmitter attached, we will know where they are and what they're doing. That will tell us something. I think probably what we need fairly quickly is almost like an agent-based model prediction of what animals are doing. For example, the gaming industry is pretty good at that. They make these stupid little rules for online games. Then you have interacting players in a landscape or in your iPhone game or in your computer game that do intelligent things. We actually want to reach out to those kinds of people and say, "Well, can we start putting these rules into animals, in this breadth?" This is like what you just mentioned about the salmon — that there are always some that do it exactly differently than everybody else, that don't obey the rules. Once we have those kinds of rules sets in place and see how we can create — or whether we can create — anything that's similar to what we see out there, I think then we will probably understand better what these animals are doing that are hiding or retrieving or following different decision rules. But I think for now it's probably too early to go that route.

Yeah. I asked because I figured that since you're working with a system, building rules in at the foundation is sometimes the easiest way of doing it. I like that you brought up gaming and rules. That was really great.

Well, we've talked for an hour here. It's been very enjoyable. I hope my questions weren't annoying or anything. I was just trying to see what interesting things you could say! And you said many interesting things. So that's great!

Those were super questions. I wish I had them before I wrote the book and could have responded to them earlier. They were really super stimulating to hear, because you are thinking very differently from most scientists and most people. I think more broadly. Interesting ideas!

Well, thank you. And it's really nice to speak to you in Konstanz — to be back in Konstanz for an hour. The last time I was there, I was visiting my grandmother in an old folk's home.

If you ever come back, visit us at the Max Planck Institute. That would be very fun.

It's been wonderful. It's nice to meet you. Good luck with continuing your project. I hope the book does really well.

Thanks a lot for your interest. I hope to see you in Konstanz.

I hope so too!