Nate Hagens (00:00:02):

You're listening to The Great Simplification with Nate Hagens. That's me. On this show, we try to explore and simplify what's happening with energy, the economy, the environment, and our society. Together with scientists, experts, and leaders, this show is about understanding the bird's eye view of how everything fits together, where we go from here, and what we can do about it as a society and as individuals.

(00:00:33):

Simon Michaux is a professor of geometallurgy at the Geological Survey of Finland. He has degrees in physics and geology and a PhD in mining engineering. Simon's long-term work is on the development and transformation towards a circular economy, navigating the twin challenges of the increasing scarcity of minerals and the eventual but inevitable transition away from fossil carbon and hydrocarbons.

(00:01:04):

On this show, I often use the term energy blindness to represent how little our culture understands and appreciates how energy, particularly cheap and abundant fossil energy, underpins our society and current living standards. Today, Simon and I talk about minerals blindness or how in a similar way we also ignore mineral and material limits that will affect human futures. This is a wide and deep topic and Simon has a lot to say. So please enjoy what will probably be part one of a series of conversations with Dr. Simon Michaux.

(00:01:58):

Greetings, my friend.

Simon Michaux (00:01:59):

Good day, Nate, how're you doing?

Nate Hagens (00:02:00):

I am doing well. How do I greet an Australian who's in Helsinki, Finland?

Simon Michaux (00:02:06):

Hello is a good one.

Nate Hagens (00:02:07):

Okay.

Simon Michaux (00:02:08):

Good day is also… The locals have no idea how to speak Australian and so… Well, I'm trying to teach the bus drivers like, Good day, mate. Cheers.

Nate Hagens (00:02:17):

Well, we are going to attempt the diurnal impacting the future caffeine ethanol merger conversation here. I'm having my coffee. You're probably ready for a glass of whiskey given you're nine hours ahead of me.

Simon Michaux (00:02:33):

I have coffee, whiskey, and water.

Nate Hagens (00:02:36):

Excellent, excellent. Could you briefly tell me your job and your position?

Simon Michaux (00:02:44):

Okay. I'm from the Australian mining industry originally. I'm now working for GTK, which is the Geological Survey of Finland. I'm an associate professor attached to the Mintec pilot plant in Finland. And I'm operating on four fronts. My job is to develop the Mintec pilot plant, which they're digitizing and modernizing that process plant. I'm to develop what's called geometallurgy, which is the Handshake mineral engineering and geology. I'm reinventing the circular economy into something more sensible 'cause at the moment it's not really that sensible. The fourth front is I'm mapping data patterns in the industrial ecosystem. Four basic jobs I have at the moment.

Nate Hagens (00:03:28):

So you were like the Finish version of the sustainable version of King Midas.

Simon Michaux (00:03:33):

King Midas. Actually, yeah, I don't catch gold. Gold is tends to be taken off me.

Nate Hagens (00:03:44):

Okay. So if you don't mind, Simon, I've recently been starting my polymath guests that could talk for hours on a subject with a little bit of a speed round. So I've got a little bit of a list here and give me your best shot in kind of 30 seconds to a minute on these. You're ready?

Simon Michaux (00:04:04):

Yep.

Nate Hagens (00:04:04):

All right. So how tight is the link between energy and GDP? And a related question, how tight is the link between materials, your expertise, and GDP?

Simon Michaux (00:04:17):

I believe that there are different aspects of the same thing, right? I see what we're looking at as a fourfold entity between energy, materials and in technology and economics, right? Energy is minerals. Energy at the moment is oil and gas. It will soon be solar panels, which come from metals, which come from minerals. GDP is energy because it is needed to do physical useful work. You need minerals to do physical useful work. So what you're seeing here is when you see one, you see the other three, you cannot untangle them really.

Nate Hagens (00:04:50):

The other three being energy, materials, and GDP, what's the fourth one?

Simon Michaux (00:04:55):

Technology. Technology is our ability to use all those things. More technology is more GDP, more technology is using energy more efficiently, but also using more energy and using more minerals.

Nate Hagens (00:05:07):

So technology also could be described as information?

Simon Michaux (00:05:11):

In fact, from a physicist point of view, information is also energy.

Nate Hagens (00:05:14):

How is that?

Simon Michaux (00:05:15):

So information is when you actually record and code something. There is a concept that a battery is storing information in the form of electrons. When it comes out, what form does it come out in? So from an abstract point of view, information can be seen as a form of energy, and energy can be seen as a form of information.

Nate Hagens (00:05:34):

Okay, we're going to come back to that, I think. So what are materials? Give us a whirlwind list of some of the major materials needed in the complex current global economy.

Simon Michaux (00:05:46):

Okay. So when we talk about materials, we're talking about raw things that we make stuff out of. So a material is we take a natural resource in some form and we do something to it to make it useful, to make something. For example, we take a tree, and when it's a tree, it's a natural product. We'll cut that tree down, cut it up into planks. Those planks can then be used to make a table.

Nate Hagens (00:06:08):

So the planks are called materials?

Simon Michaux (00:06:09):

Yes, that's right. So when we take raw mineral out of the ground, what we really want is the metal. Once we extract the metal, the metal becomes a material and we use that metal to make a car.

Nate Hagens (00:06:21):

So the copper in the ground is that the copper with all the rock that accompanies it? The whole thing is called a mineral or just the copper portion?

Simon Michaux (00:06:31):

Well, you can find natural copper, which is... You get these substances, which are actually both the material and the natural form. But a mineral is like the elements of something that have been assembled into a natural form that's stable. And so you tend to have copper mixed in with sulfur, mixed in with silicon. They're all assembled in a crystalline form. And so you can have natural copper, a copper nugget found in a stream, but it's generally associated and pinned in a mineral crystalline lattice. So to make it useful, generally, we've got to take a raw material and do something to it to make it suitable for some sort of engineering purpose. So a material is actually an engineering term.

Nate Hagens (00:07:12):

What is your favorite mineral? Trick question.

Simon Michaux (00:07:15):

Okay. This might sound a little odd. Sheet silicate clays.

Nate Hagens (00:07:19):

That does sound odd.

Simon Michaux (00:07:20):

Now clays are interesting. They're very complex to understand and they cause me a lot of grief professionally. They're terrible for flotation and leaching, so we're always trying to remove clays, right? But clays are also the crossover point between life systems and mineral systems because they're in soil and they're actually allow the support of the food web in soil. So you've got the crossover between life systems and mineral systems, but they also either retain water or they prevent water from happening. And so it's a combination of life systems meet mineral systems meet water systems, and it's all in one mineral, clays.

Nate Hagens (00:07:56):

Here's a naive question. I think most listeners, if not the general public, understand that fossil energy is finite, but minerals also are finite. We are drawing-

Simon Michaux (00:08:10):

Yes, they are.

Nate Hagens (00:08:10):

Okay. Can you just speak to that a little bit?

Simon Michaux (00:08:12):

Okay. So minerals are formed ranging from a couple of seconds over to tens of years to, in some cases thousands of years in the case of say a cooling magnet to become a granite. So they're formed in geological processes. Generally, you've got a rock and a fluid is being pushed through the rock, has lots of elements in it, and a change in temperature, a change in pressure will change the chemistry of the fluid and something will deposit out of that fluid. That's how we get copper and gold deposits.

(00:08:42):

A mineral is a natural assemblage of elements that was created some time ago, usually millions of years driven by geological events, which don't happen all of the time. So it's not like a regular thing unless you get down to the seabed floor where you've actually got the parting of the tectonic plates. But we can't get there with our current technology in what we needed. We have these minerals and metals in the ground in deposits, which are finite. And once we consume those resources, they don't grow back.

Nate Hagens (00:09:10):

On human timescales.

Simon Michaux (00:09:11):

Not on human timescales. Or rather if we do have them grow back, it means some large volcanic event has happened on a worldwide scale, which means we're not going to bother extracting minerals anymore anyway.

Nate Hagens (00:09:23):

But in that case, they won't be growing back. They would be unearthed from where they were before or would they literally be growing back?

Simon Michaux (00:09:30):

Some will be unearthed, some will be chemically transformed. So you've got an existing geological system and fluids will be pushed through and they chemically transform some of the rocks in place through a process called metamorphosis.

Nate Hagens (00:09:45):

So that would be one of the be careful what you wish for scenarios.

Simon Michaux (00:09:49):

Yeah, exactly. What could possibly go wrong? Yes. Don't want that.

Nate Hagens (00:09:54):

So today we're going to be talking generally about how humanity can move from our current society into something more sustainable, more livable, perhaps more desirable. And that's going to effectively be a revolution from where we are today. And you've written about it being a Fourth Industrial Revolution. What is the Fourth Industrial Revolution? And maybe you could briefly define what the first three industrial revolutions were.

Simon Michaux (00:10:23):

Okay. The First Industrial Revolution, there's a couple of different definitions around. So it depends on what speaks to you. One school of thought says it's the moment when we start using metals and stones for tools. But that to me is not industry. To me, IR1, the First Industrial Revolution starts when machinery is used to supplant human labor on a wide scale. The machinery that is powered, technology that is powered by something, in this case coal and sometimes wood. So IR2 as I see it, and again there are several definitions around and opinions IR2 is when internal combustion engines took off powered by petroleum. So we had the idea that we could take petroleum, which is an amazing energy source and turn it into an internal combustion engine which can power all sorts of industrial things. That's IR2. And also at the same time, petrochemicals were invented later became the plastics industry.

(00:11:22):

So IR3 is when they started using electrical technology and electricity started taking over. In IR3, not only did we have the electric motor, but we've also got the transistor and the microchip. So IR3 has had several stages of evolution. So IR4, now things are getting complicated. Now IR4 is seen as an information revolution where what they're trying to promote is the merging of everything about us at a biological level with information and with technology. So we as a species will change and we as a community will change in all aspects.

Nate Hagens (00:12:02):

So is the Fourth Industrial Revolution, the Great Reset?

Simon Michaux (00:12:06):

The Great Reset is the people who are promoting the Fourth Industrial Revolution. It is a concept that was actually released, I think it was by the World Economic Forum. And so they want to actually evolve and revolutionize society at the moment. They want to essentially instrument everything. They talk about the internet of things where everything in your house, for example, harvests information like your toaster and your fridge and then uploads it to the internet web to a central server. It's literally surveillance inside the home. But they're also talking about biometrically merging human activity with technology as well. Now I think this concept is flawed. I understand what they're trying to achieve and what they do, but it is setting us up for a world of unintended consequences.

Nate Hagens (00:12:53):

Well, not to mention it's energy blind and materials blind.

Simon Michaux (00:12:58):

It's not going to work. It's going to require such an unprecedented amount of complex materials and energy. And then to maintain all this, what will end up happening, I think if, let's say they go down this road, the Fourth Industrial Revolution will happen for very rich people in a functional way and everyone else, because it's not going to arrive in time and work, you're going to have this dysfunctional system that doesn't work and everyone has to make do with what they have. And so you'll end up with society like the movie Elysium, not in a good way.

Nate Hagens (00:13:30):

Right. So the subtitle of the Fourth Industrial Revolution is gigafamine.

Simon Michaux (00:13:34):

Well, yeah. So the stuff we talk about is there. You can't undo that and ignoring it won't help.

Nate Hagens (00:13:40):

How much of our materials and minerals that we use in today's industrial economy are recycled? And put that in the context of what we're going to have to do in the future.

Simon Michaux (00:13:54):

Okay. At the moment, our technology the past couple of centuries has been based on metals like steel, iron, copper, aluminum, what have you.

Nate Hagens (00:14:04):

What is steel, Simon?

Simon Michaux (00:14:05):

Steel is iron. So you got the element of iron, and steel is where they actually smelt it and they refine it by mixing in carbon and they make it. It's a fundamentally stronger material.

Nate Hagens (00:14:16):

Where does the carbon come from?

Simon Michaux (00:14:18):

They use coking coal. They use coking coal or... There's actually several methods where they can actually get the carbon from other sources, but coking coal is the preferred way to do things at the moment.

Nate Hagens (00:14:31):

Sorry to digress, but there's so much of what you work on and talk about that no one talks about. It's like you're in the dungeon working on this stuff and it doesn't see the light of day and yet it's super important because it powers everything. So are there ways, I mean we take iron and coal and energy and we make steel. Are there ways to make it in a low carbon way and is it that vastly more expensive?

Simon Michaux (00:15:00):

You can, for example, make steel with just an electric arc furnace. So instead of using coal for heat, you use the electric arc furnace. That's what I use in my scenarios already. There's a new project coming up in Sweden where they make steel with just a hydrogen atmosphere and they're patting themselves in the back on that, but they have not considered what it will cost to produce the hydrogen. 'Cause at the moment, hydrogen's produced with gas. And so if you were to make hydrogen with electrolysis, now you need electricity, and it's very expensive. With all of these things, it's done in isolation.

Nate Hagens (00:15:34):

Yeah, I mean this speed round is kind of morphing into some of the other questions I want to ask you, and it's so hard to separate them. But the way that I see it, and I'd like your opinion on this, is people often get confused about does this technology exist? And they conflate that with is this technology scalable and affordable? Because the benefits that we get from scaling the processes from the first and second industrial revolution where we add little bits of human labor and massive amounts of fossil energy to a process, the gargantuan magical benefits we get from that transformation are underappreciated and they're also scaled to 8 billion people. So if all of a sudden we have a new technology that absolutely is viable, it doesn't give us the same benefits because we have to spend two or three times the energy, which massively reduces the benefits that humans get. Any thoughts on that?

Simon Michaux (00:16:45):

Lots of people have lots of good ideas. There's just plenty of solutions out there, but they all operate in a small scale in a system that's supported by fossil fuels around it. The hilarity ensues when you want to scale it up to make it accessible to everyone. And the bottlenecks tend to be very practical in things that people took for granted. It takes five years to build a industrial coal-fired power station and something like 15 or 20 to build a nuclear power plant. That's when we know what we're doing.

(00:17:14):

But if we came up with a new technology tomorrow on how to actually build a new power plant of a new technology, let's say the number of plants that we would have to make and our ability to make as many of them would have to be strung out over many decades, but we would need that capacity online in a couple of years. And so it takes time to scale things up. And then from a technology point of view, when you're actually on a small scale, it might work on a small scale to more small scale metrics. But when you need to apply it many times, a lot of the things that the business model would take for granted at the small scale is actually not possible at a larger scale.

Nate Hagens (00:17:52):

Okay. There's a few things here that I'd like to unpack. First of all, it's not just the technology, it's also the scalability, the affordability and the timeline. You mentioned that if we need... For instance, this interview is being recorded on March 29, 2022, in the middle of the... Well, we don't know if it's the middle of the Ukraine-Russian situation, and Europe is rethinking some of their energy for plans and forecasts. And nuclear is all of a sudden being thrust to the forefront again. But you just said if we wanted to build new nuclear capacity, it takes 10 to 15 years.

Simon Michaux (00:18:35):

In the incubation cycle you've got permitting, you've got to get people to agree where to put it. Then you need the industrial infrastructure to support the nuclear fuel cycle. And then when the spent nuclear fuel rods come out the other end, you need somewhere to put them. And so there's a lot of things that is actually quite complicated that need to actually be talked through. At the moment, we're taking about 15 to 20 years to build a single nuclear power plant. But if we actually got behind it all, let's say we boiled it down to five years, does that help? The answer is no.

Nate Hagens (00:19:04):

Why?

Simon Michaux (00:19:05):

Because the nuclear fleet at the moment when 2018 it represented, I think it was about five or 6% of electrical power produced. It was producing 2,474 terawatt hours. Now a watt is a unit of energy. A watt hour is energy delivered over one hour. A terawatt is a trillion such watts delivered over an hour.

Nate Hagens (00:19:36):

And right now we have a 19 terawatt continuous power society more or less.

Simon Michaux (00:19:42):

Yeah, so that's a lot of energy. But let's say the nuclear system in 2018 was 440 nuclear power plants and we were producing 2,400 odd terawatt hours a year. So to expand that, let's say if we are… At the moment we're producing a lot of those nuclear power plants have to be decommissioned very carefully. And as they go offline, new ones have to come online. And so we're getting say, one or two a year extra over time. That's a lot of work. That's really straining our current industrial capability. And very few operations are actually able to make nuclear power plants and a lot of them are Russian.

Nate Hagens (00:20:22):

Wait a minute. We have 440 nuclear power plants in the world and we're on average adding one to two per year globally.

Simon Michaux (00:20:29):

They go for a periods where nothing is added at all. And sometimes it reduces because they're decommissioned. And so it's a graph that undulates. But in general, we are adding one or two a year over time. So yeah.

Nate Hagens (00:20:44):

So you've added another constraint. There's affordability, there's scalability, there's time, and then there's also complexity because to add dozens or a hundred nuclear power plants, it would have to change the governance and economic structure for such a thing to happen as well.

Simon Michaux (00:21:03):

Yes, from a governance point of view, it's all fun till someone bleeds. This is a very complicated problem that would require change. So let's say in my scenario for this, let's say if we added 25 new nuclear power plants that are generation three plus like the best we can at the moment every year. So we're talking about a massive expansion and we did that every year from the year 2025 onwards. So we're expanding as fast as we humanly can. That is an aggressive expansion that frankly is not practical.

Nate Hagens (00:21:37):

Right? That's 10 to 20 times faster than we're doing today.

Simon Michaux (00:21:40):

Right. Will that work? And so at the moment, for example, if we left the nuclear power plant fleet as it is and we just let it go, our current uranium reserves would last about 300 years before we needed to go and find more. And that that's quite safe and simple. But before we expand at this rate like 25 a year, those reserves will last 76 years and they'll be exhausted in the year 2101. In 2101, we'll only get 68% of the way to generate enough electrical power to phase out fossil fuels. So what that means is nuclear cannot scale up fast enough to be useful. And even if it could, our reserves won't last long enough. Once those reserves are exhausted, we've then got to deal with a massive stockpile of spent nuclear fuel, which requires power to manage it. When it first comes out of the reactors, it's very hot and very radioactive, and you've got to have it in powers cooling.

Nate Hagens (00:22:35):

How much of our current minerals and materials are recycled? And when we talk about a circular economy, how would that be different?

Simon Michaux (00:22:44):

Okay. Currently, all the base metals like aluminum and steel and copper, we're recycling about 30 to 50% or 60%. That's fairly mature. All the technology metals that go into our iPhones, things like gallium and indium, we don't recycle those at all. Or if we do, it's very little. 'Cause the way those metals are used, it's very difficult to recycle them.

Nate Hagens (00:23:06):

Once this iPhone goes in the landfill one day, the energy required to get the tiny amount of gold or gallium or whatever out of there would be prohibitive relative to its economic value. Yes?

Simon Michaux (00:23:19):

That's correct. It's worse than that. If you were to collect all iPhones together and try and recycle them, could you do something? And so for the last couple of generations of iPhone, like going back to say 2015, the degree of micronization and the degree of integration is so high, you cannot... There's no recycling solution possible. And so for many years now the solution's just been put them in the furnace and just kiss all that goodbye. So okay, Apple is making a robot that can disassemble an iPhone but whether it works or it's good enough or fast enough, I don't know. But the way we do things at the moment, it's not designed to be recycled, therefore it's not.

Nate Hagens (00:23:58):

When people talk about a circular economy, how do they envision iPhones or what do they mean by that?

Simon Michaux (00:24:04):

The answer is they don't. The circular economy is talked about in vague terms to make people feel good about themselves. The idea is that all materials from consumption are collected and recycled and then we use the material from that for manufacture and that's when the thinking stops. 'Cause what they mean is the material gotten from recycling equals the material needed for manufacture. But manufacturing each generation of technology is different, and so there's different requirements needed. We can't even collect all our waste to recycle it. And when we do, there's an efficiency rate where most of what we need isn't recycled anyway. So you have these imbalanced streams where the only way out of it is to mine more materials and then put stuff in landfill.

Nate Hagens (00:24:47):

So just conceptually, divorced from our current reality, given what you know, what is the best case a hundred years from now, 500 years from now sometime in the future on how we could recycle? How much of our economy could we get to recycle?

Simon Michaux (00:25:05):

So we change our relationship with materials, but also with manufactured goods. We manufacture things where they can be recycled. We also manufacture things in terms of not performance, but long-term sustainability goals, which means we accept a lesser performance. This is the resource balanced economy where we recognize that some material is taken from the ground and some material is then lost to the environment because it's just not possible in anywhere else. But in between, we do our level best to get the maximum amount of use out of each material stream, whether it be recycling waste or valorizing waste streams. And so it's a system that instead of valuing things with money, we're valuing things that actually honors the value of the material stream. And this is the new energy return.

Nate Hagens (00:25:52):

We need culture change before material recycling change.

Simon Michaux (00:25:56):

So social contract change first. Second, we change our relationship with materials at the same time we change our relationship with the planetary environment. Then we develop a new system of actually managing our materials in our societies. That's a new society. And then we develop a new way of managing what we call the replacement for money. So instead of money being used as a decision making system of who gets what and why, we need something else. That's the evolution. It's going to look completely different to what it is now. If I was to repeat the limits to growth study and extend it to 2019 with all that new data and we're asking the express question, what was the influence of quantitative easing and the printing of money on the rest of society where we had a dynamic interaction between industrial production and pollution and food production? What was the true influence of quantitative easing?

Nate Hagens (00:26:49):

I think the answer to that is power is energy access per unit time. And I think credit writ large credit in the commercial banking system from the seventies until 2008, and then credit in the commercial banks or the central banks taking over the credit mechanism since 2008 and going into turbocharge since COVID will act as a magic wand that accelerated the scale of the enterprise at a cost of a steeper decline in the future is what I think the ultimate role of quantitative easing will be. It grew our system faster and higher than it otherwise would've been. And that means that the deceleration would also have to be steeper, but maybe it also uncovered other resource pools and technologies that we wouldn't have had.

Simon Michaux (00:27:47):

So trying to make a system that'll capture that which will tell us if we have to do this sometime in the future, should we do it again or not. That's the outcome.

Nate Hagens (00:27:57):

Well, should we do it or not will be a far less potent question than will we do it or not because as biological cultural system, we will continue to print money and do quantitative easing four, five, and six because the alternative is a different system, and a different system will be too threatening to the people calling the shots and too painful to populations. I wish that we could construct some sort of a freeze-frame, let's go this path instead people. But I'm so far pretty skeptical that will happen.

(00:28:36):

Okay, let me understand this. A nuclear scale up would be technically feasible. There would be a time lag and a complexity problem, but the reserves would only last 70 years or something like that, which to people in power, they wouldn't care because 70 years is three generations. So it would help the intermediate power situation for humans until we found something different. Let me ask you a couple questions on that. Number one, couldn't we find more uranium or thorium or whatever over time with new extraction methods or digging deeper or whatever?

Simon Michaux (00:29:19):

So yes, we could find more. There's obviously more to be found. I looked at thorium as well. Thorium has a different spent nuclear fuel profile. It's not as radioactive. The fuel cycle is a bit more complicated. So it's a bit more complex to deal with, but it's not as energy effective as uranium. So if uranium can't scale up, thorium won't be able to do it either.

Nate Hagens (00:29:41):

But if it's half as effective and we found twice as much, then it would be scalable. Yes?

Simon Michaux (00:29:47):

Well, you've got the problem of let's say for example, at the end of that 76 years you've got this massive stockpile of spent nuclear fuel that requires power in powered storage to keep it cool for a period of time before you can store it underground, and the nuclear fuel cycle requires quite a lot of very sensitive and complex industrialization to keep it going. You've got a complexity problem here. So yes, you could say, "Oh, we'll just scale up nuclear." But to do that we would have to have an industrialization forced march much the same way that World War II... In World War II, the United States and Great Britain industrialized their economy to meet the war effort. It would have to change everything. It would dominate everything and there wouldn't be any room for anything else. So at the end of that time, nothing else would be done. And now you've got this massive problem because the more you do it, the bigger the pile of spent nuclear fuel.

Nate Hagens (00:30:44):

Right.

Simon Michaux (00:30:45):

So finding more doesn't necessarily fix the problem.

Nate Hagens (00:30:48):

So we've got affordability, scalability, time, complexity, depletion, and I'll add another to the mix, which is energy properties or energy fungibility. We have much of our global economy now is dependent on six continent supply chains and liquid fuels. And when people say, "Oh, nuclear, we need to go more nuclear," that's for electricity and we can't overnight switch our supply chains to being powered by nuclear. So there's an energy quality aspect of all this as well. Our current civilization is not set up to be run on nuclear. That too would take a lot of time and massive change. Yes?

Simon Michaux (00:31:33):

Yes, it would. And when you get to the end of that change, are you in a net position that is better? Or what will probably happen when nuclear comes to the point where we need to start thinking about what to do next, we have saddled ourselves with an enormous legacy problem that will go for a very, very long time that if we don't meet with energy, right, we've got a very serious environmental problem on our hands.

Nate Hagens (00:32:01):

I don't know the answer to this, which is why I'm asking. What is the implicit plan for those that advocate nuclear power for 50 years from now, a hundred years from now, 200 years from now? Is it the standard macroeconomic Cobb-Douglass function that human societies will grow forever, it'll just look differently and we will mitigate these environmental risks at that time as part of our economy? Is that just kind of implied?

Simon Michaux (00:32:32):

That's implied. So first they believe that these problems can just be absorbed as we get bigger, right? There's also the belief that for example, generation four nuclear power will come online. That was one of my scenarios. So let's say we have a traveling wave reactor with 75% of its fuel can be spent nuclear fuel from somewhere else. So if we can start chewing through the spent nuclear fuel pile stockpile, the problem there is we have to expand the reactors so much that we are actually having to mine fuel as well. And so what it does is it extends the life of the nuclear fuel cycle out. I think that cycle, it goes out for 180 years instead of 76, but at the end of that time, you're in exactly the same position where you've got this massive stockpile, you've got several thousand nuclear power plants that need decommissioning because now you're out of uranium.

(00:33:25):

So there's the belief for example, when you talk to the supporters of nuclear technology that human society will be always as stable as it is now, which is what's required to mine uranium, enrich uranium, make fuel rods, do the nuclear power without doing a Chernobyl, and then managing the spent nuclear waste coming out the other end. It's quite a complex industrial system and it's implied that that will never end and we'll just get better as we go along. It's also implied that somewhere someone will think of something better.

Nate Hagens (00:33:59):

Because they always have.

Simon Michaux (00:34:00):

Yeah.

Nate Hagens (00:34:01):

So this is the curse of us wearing the Cassandra hat, Simon, is that people don't understand the ubiquity and cheapness of the energy ocean that we swim in right now is a one-time thing in our culture and we are alive during the decades of plentiful, abundant energy and cheap goods and stuff. This is not permanent. And as oil and other things decline, it in the rearview mirror, we will see this as a fantastically unique period in human history and we are squandering now the time needed to cross the bridge, cross the chasm into maybe from a 19-terawatt system down to something.

Your research suggests maybe 10 terawatts is maybe feasible or sustainable down the road. But how do we get there is the question.

(00:34:59):

So let's dive into that a little bit. Lots of people are somewhat aware that oil is finite. I still believe the end of 2018 will prove to have been peak oil probably unless there's some central bank orgy of credit that allows us to get the next lower tranche. But it's soon anyways. It doesn't mean we're out of oil, it just means that we're not going to be able to grow the amount as we have the last hundred years for much longer and we'll be having to deal with less and it'll be more costly. That's starting to be seen with what's happening with Russia. We've got a hundred dollar oil.

(00:35:41):

What's not often talked about is the mineral implications both of energy depletion and of mineral depletion. So let's look at some of just the generic 100% renewable forecast where we need to either for depletion reasons or for carbon climate reasons, get off of fossil fuels and move to something renewable. You think that the amount of minerals and materials that we're going to need to do that will preclude that from happening. Can you just give us a big picture overview of that situation?

Simon Michaux (00:36:20):

Okay, the story behind this, I was having a cup of coffee with my management a couple of years ago and they asked me the very basic question, what minerals and how much will be needed to feed the gigafactories of Europe? Go away and find that out. This was the mineral intelligence requirements. What I quickly found was the very basics behind that question simply had not been done.

Nate Hagens (00:36:43):

Well, what's a gigafactory first of all?

Simon Michaux (00:36:45):

So you've got a plan to actually make lots of electric vehicle batteries in Europe and they've got this term called gigafactories. And so they want like 50 of these humongous factories to produce batteries in Europe. They haven't thought about where they're going to get the minerals for that from, they just assume they can just buy it off the market. They also haven't assumed, for example, the industrial ecosystem around each factory. Is it even possible? They just plant one on the map.

Nate Hagens (00:37:12):

Quick interjection there. If they say, "Oh, we're going to need these gigafactories to develop batteries and related equipment for electric cars, so we don't need oil or gasoline fraction of oil for the cars anymore, let's just look at the prices of copper and lithium, et cetera." Do they just extrapolate those prices forward or do they include a 500% increase in their forecast?

Simon Michaux (00:37:39):

Not even, it's just vague. They just have this vague assumption that it will work out okay. They'll talk in terms of market share and they'll do price predictions and yes, they'll extrapolate from the past and they'll look at this through rose-tinted glasses in a very simplistic fashion. They don't consider, for example, wear. Like copper for example, is we've already got structural supply problems with copper now because the entire Andes Mountain range is a copper deposit that's low grade. We're not going to run out copper deposits. What we are going to run out is the ability to extract that copper viably. It's more energy, it's more water, it's the cost involved, and so then we're not putting the money in to develop the necessary minds.

(00:38:24):

So there's structural supply problems on the books now for both copper, lithium, nickel, and cobalt, and there's no visible supply stuff for the last three coming online before 2025. This is a money problem. So when we have the problem with the mining industry the way it is at the moment versus about this idea that we're going to suddenly bring on to the market 300% increase of copper, the people making these predictions have no engineering behind them. They just make numbers. They just invent and say, "Oh, the market will come. We make the market and they will come." That seems to be the thinking.

Nate Hagens (00:39:02):

So when we talk about a transition away from fossil fuels, we want to use the flows of the sun and the wind and technology, which I refer to as rebuildable because we have to rebuild the solar and wind every 20, 30 years or so, which is another issue which we can unpack in a bit. But when we talk about this, we're talking about a new infrastructure basically that not only do you need to build the solar panels and the wind turbines, but you need to have the batteries for when the solar and wind, the sun's not shining, the wind's not blowing, and the transmission lines that interconnect everything. And all three of those things require minerals and materials.

Simon Michaux (00:39:50):

Correct.

Nate Hagens (00:39:51):

There are some popular, one might always say religious forecasts out there that the entire society, the world society can shift to a hundred percent renewables. Obviously, that can happen because not too long ago we were a hundred percent renewable, we just had far fewer people and lower per capita consumption. So I am in favor of moving towards largely renewables. The question is, I don't think the current thinking on that... I wrote an essay called Renewables, Right Answer To The Wrong Question. The question is what is our society going to look like? How many people? What sort of living standards do we have? But my question to you is, and you've spent a lot of time working on this, under those scenarios, the optimistic, let's just transition to a 19 terawatt or higher global society using mostly renewables. I've debunked that from an energy standpoint, but you have insights onto the minerals required for such a thing. Can you talk about that a bit?

Simon Michaux (00:41:03):

Right. For example, once we've actually worked out the size of the problem, if we were to take the entire transport fleet electric and a combination of electric and hydrogen, we will need a certain amount of electrical power on top of what we need now to charge those batteries and to make that hydrogen. So now we have an idea of how much electricity we will need. We know how much batteries we need based on the number of vehicles we have. Once you've actually got the split of what's a hydrogen vehicle and what's a electric vehicle, we have a rough idea of that. Now each of those batteries, the vast majority of them haven't been built yet. So we're talking about extracting it from mining. It can't be recycled. You can't recycle something that's not constructed. So we know we have a volume of batteries and we have an idea of... Because of the power grid size, we now have an estimate of stationary power storage.

(00:41:54):

And so the numbers I've come up with, it's roughly 2.8 billion tons of batteries, if we were to look at lithium ion battery chemistry like NMC 811. Now there are other chemistries and so I do have a study that show that different chemistries of what it will likely be in 2040. I've actually assembled the number of batteries and assembled the different chemistries of what the IEA thinks it will be in 2040. And then I've estimated, well given the chemistries, what mass of metals will be needed once you actually sum the aggregate together. Wind turbines were included. For example, in each wind turbine you've got a two ton neodymium magnet. Now these things only last 20 years.

Nate Hagens (00:42:36):

There's 4,000 pounds of neodymium in one wind turbine?

Simon Michaux (00:42:40):

There's 4,000 pounds of neodymium magnet. How much neodymium is in there I've yet to actually establish.

Nate Hagens (00:42:46):

Okay. Got it.

Simon Michaux (00:42:47):

It's not all neodymium. It's an alloy with something else, but it's a lot. We're talking about more than a couple of kilos.

Nate Hagens (00:42:53):

Right.

Simon Michaux (00:42:53):

So once we actually sum all those numbers up together and then compare that against say 2019 production, if we were to produce metals at the same rate, how many years would we need to meet those targets? The answer is we need several decades to several hundred years to several thousand years depending on the metal to produce enough of that metal to replace the existing system as it is now. Now that's important because the current thinking is one third of the existing system will be electrified by

2030 or so say the European Commission. So we have an idea of how much we think we're going to be by 2030, and so we simply don't have the time, I think it's like 16,000 years of lithium production to produce enough lithium in all the batteries needed by 2040, in the 2040 split to replace the existing system as it is now.

(00:43:49):

That said, what that suggests is existing mines are not enough and they say, "Oh, we'll just open more mines then." So I put that up against global reserves and then I found across the board we've got about between 10 and 15% of global reserves as stated in 2021. About 10 to 15% of the amount of metal needed to produce one generation of batteries and one generation of wind turbines to replace the existing system where 20 years later we do it all again. So it's not enough is the answer.

Nate Hagens (00:44:20):

So my fear all along is that as we get closer to limits, we are going to focus on growing the gross and ignoring the net. And the default human trajectory is that in 2030 or 2040, we're allocating, not really, but close to, metaphorically half of our economy is mining and the other half is remediating the environmental damage from mining. It's like a Mordor economy. But under such a scenario, where is the energy for hospitals and shopping centers and museums and schools and food production, et cetera? The more that we allocate towards finding the energy and materials needed for our system, the less energy and materials are available for the rest of functioning society. Yes?

Simon Michaux (00:45:18):

That's where the math takes us. You're absolutely right, but complexity will break it first. Before we get there, before we get to the Mordor economy, which is a brilliant term by the way, you've come up with a few corkers. So before we get to the Mordor economy or even close, other forms of complexity will come in and destroy our path and force us to go down a different path. It won't necessarily be very polite, but our plans to maintain the existing system, our demand into the equation is what will simply... The oxygen will simply be turned off.

Nate Hagens (00:45:53):

Well, here's the thing. You see every day articles about the 100% renewable economy in various countries around the world. Brandenburg, Germany just stated that they're going to be a hundred percent renewable by 2030. They might be able to do it for their electricity, but only if no one around them does that because there's a system there with inputs and outputs from other sections. The whole world doing that... First of all, right now we're at like 4% renewable. And so this carrot of going to a hundred percent renewables, I wonder how much is that needs to be stated as a optimistic endpoint so that people have hope for the future and how much of it is really technically possible because the things you're telling me, many of which I've known already, it's just absolutely impossible to get to that outcome.

(00:46:57):

I'm just curious why... I mean I want to ask you some deeper questions on this, but just on a philosophical social science standpoint, and you work for a government and you're talking to a lot of government people, where is the disconnect? Why is what you and I and our colleagues see as so clear not discussed with the elites in Europe who are planning for a net-zero, a hundred percent renewable economy.

Simon Michaux (00:47:25):

Question. Of the people you come in contact with and who are in charge, how many of them have an understanding of ecology or biology or even physics?

Nate Hagens (00:47:34):

You mean in the policy discussions that I'm having?

Simon Michaux (00:47:38):

Yeah. Our leaders, our leaders, the people who actually-

Nate Hagens (00:47:39):

Yeah. Very, very few. I mean they've had high school biology or college biology, but ecology and physics, very few.

Simon Michaux (00:47:47):

I'm a physicist first, a geologist second, and a mining engineer third. That's my qualification set. So what I've come across, I've been talking to... I used to work in the corporate world, the corporate mining industry in Australia, both in research and in the private sector. So what I've come across is the dominant paradigm for how things are done at the moment is based around the idea of the economic model that doesn't actually include energy at all or minerals or raw materials. It is the idea that there are no limits, we can just expand. All questions are economic in nature. If the price goes up, we'll go and find more natural resources, they're there. We've just got to find them. And if the price does go, if it becomes too difficult, someone will come up with something as an innovative solution. But even those solutions are technology based.

(00:48:39):

They're not considering where the raw materials for that technology comes from. So not only are we energy blind, but we are materials or minerals blind as well. Every single one of the dominant paradigm, every single one of the people I talk to who are in charge of things have not even asked the basic question along the lines of where do these raw materials come from? They're starting to ask the question of what is our environment and why do we care? That's only a fairly recent thing, but they have yet to ask where do our raw materials come from and can we innovate our way out of that?

Nate Hagens (00:49:16):

So we've financialized the human experience and the political elite discussions are also financialized.

Simon Michaux (00:49:24):

Yeah.

Nate Hagens (00:49:24):

We've started to become aware that we are on this orbiting the sun and it's our spaceship and the environment is pretty fricking important and that's good that we're talking about that. But as to what powers our economy and where do the things come from and how rapidly are they depleting is not yet in the halls of power. Maybe it's not because these people are ignorant or dumb, it may be because it's just too difficult a question to be voiced publicly.

Simon Michaux (00:49:55):

I actually have been voicing a few things publicly and I have a few insights to share with you. I stood up in a middle of a European Commission meeting in Brussels once in one of these think tanks. And I said, "Look guys, if you think you're going to have all these new solar panels and wind turbines, great. Magnificent plan, magnificent." How many solar panels are produced in Europe? I said, "Well, there are some small manufacturing, but all the components are manufactured in China and most solar panels are manufactured in China." Where do wind turbines come from? China. Where do electric vehicles come from? Mostly China, but the ones that are manufactured in Europe, all the components are manufactured in China.

(00:50:33):

So I pointed this out and then there is a question of where do the minerals and the metals come from? That's also China, so hang on. So if we don't control the manufacture or the sourcing of the raw materials and we no longer have much money compared to everyone else, how are we going to guarantee supply of this stuff if it does turn out that there's actually not enough to go around? And when I promote that, there was just silence, a room full of 200 people.

Nate Hagens (00:51:02):

Because there are no politically acceptable answers to that. So let's go down that path a little bit. Let's ignore for the moment the 100% renewable scenarios that are floating around. Let's just look at the present day. What's happening with Ukraine and Russia in the best of outcomes? Ukraine is going to be partitioned like Germany was to the east, Donetsk and Crimea will be part of Russia and the west of Ukraine will be linked with Europe somehow.

(00:51:36):

But then we start this new multipolar order where the energy and materials blinders come off a little bit because we see the centrality of energy and commodities that have been underpinning the papered over financial representations of our true wealth. And a lot of those come from Russia and China. So let's just look at... Forgetting about the renewable energy scenarios, what is our material and mineral situation in the coming years just under business as usual? Are we going to face issues on the material side?

Simon Michaux (00:52:19):

So yes, the elephant in the room that is flashing red at the moment is gas. In Europe, we need a lot of gas to heat our building.

Nate Hagens (00:52:26):

Natural gas.

Simon Michaux (00:52:27):

Natural gas for survival. Quite a lot of it comes from Russia. A lot. The majority of European gas, natural gas comes from Russia where about a third to about 40% of it comes through Ukraine. Now, if our leaders have allowed ourselves to let a conflict happen in the first place, like conflicts don't happen in a vacuum. So the conflict itself is terrible. I have a few Ukrainian friends and the situation there is not good. We've allowed ourselves a situation where we are dependent on a particular nation for most of our gas, right?

(00:53:01):

Now, if the American's system was able to come in and deliver gas, they couldn't. I saw the numbers the other day, it's something like 130 billion cubic meters of a large portion of gas that was coming through a pipeline now has to come over in large ships. We don't have the capacity in Europe to receive large ships like that of that capacity and then distribute the gas across Europe. We just don't have the infrastructure in place and it will take years to build if we did. And then there's the question is, can the American system deliver that gas? And if it did, you've got a long supply chain where it's got to travel from one side of the planet to the other.

Nate Hagens (00:53:42):

When you liquefy gas and then unliquify it, you lose like 30% percent lose plus of the energy content.

Simon Michaux (00:53:49):

You lose energy. Right. So it's a losing game. And so we've allowed the situation to happen where basically gas is one way or another going to go offline and we don't have any viable alternative. How do we heat our buildings through winter without gas? That's going to make life difficult for the population.

Nate Hagens (00:54:07):

And just to tie in the earlier discussion, even nuclear isn't an answer for that, first of all because of the issues you raised on complexity and timeline. But there's another aspect which is nuclear is flat and you turn a nuclear plant on and it's flat throughout the day. Our demand structure is variable, so what ends up coupling nuclear and solar and wind to demand is gas.

Simon Michaux (00:54:34):

Gas, right.

Nate Hagens (00:54:36):

Which is the thing that we're going to be running short of.

Simon Michaux (00:54:38):

Everything has to be completely re-engineered to a completely new metric. All of the electrical equipment around us has to be re-engineered into something else.

Nate Hagens (00:54:47):

Here's the problem with that is well not... And there's a momentum to our current system. We have self-organized as families, small businesses, corporations, nation states, towards maximizing monetary representations of surplus. That is our goal. So when we're faced with a technical anthropological culture-wide challenge like this, we can't just freeze everyone and figure out a plan because everyone's day jobs are already doing what they're doing to continue this process.

(00:55:22):

Okay, so let me put a pin in this because this is the ultimate question I want to ask you, but I want you to answer the question I asked earlier. In addition to gas, what are other material thresholds that we're going to face regardless in coming years? Do we have a problem with commodities and inflation and depletion not of energy but of minerals? Is that in the next decade or is that an issue? Could you give a few minute overview of that?

Simon Michaux (00:55:54):

We already have difficulties for the mining industry to expand production now. It's hitting difficulties now. The idea that the future is going to be metals based in renewables, and a lot of those metals are quite exotic that are not mined in very large quantities at the moment. We just don't have the infrastructure to supply a lot of those metals. So they're just not going to arrive in time. So anything to make solar panels, wind turbines, electric vehicles, and then a lot of the electronics in general that we have that we need for the fourth industrial revolution, all are going to have multiple supply shortages and supply bottlenecks right across the value chain, right across the planet.

(00:56:34):

And so this idea where things just magically happens so smoothly, you can click on Amazon and say, "I'll buy that book" and the book just appears two days later, and it all happens in the background just magically and smoothly. It won't be smooth anymore. It's material shortage. And what I haven't spoken to about at the moment is what will happen with industrial agriculture, what I believe. So that's actually the next macro scale problem behind the mineral shortage. And that's probably 10 years away from its pain threshold. But the mineral shortage, that's four or five years away from its pain threshold.

Nate Hagens (00:57:12):

Minerals like phosphorus or what are you thinking?

Simon Michaux (00:57:16):

So you've got copper. A vast amount of copper is needed for electronics, but also every electrical device requires copper. And from every wind turbine there's a copper cable as thick as your leg connecting that copper wind turbine to the grid. So if it's out to sea like offshore, it's a longer cable. So we have copper, we have nickel, we have lithium, cobalt, graphite, silver. I think they're the ones I sort of picked so far, but yet they're the ones... This is just to actually make the existing grid. But the existing system is also struggling to deliver 'cause everything it depends upon is related to energy and fossil fuels became unreliable around 2018.

(00:57:57):

I do believe that will later prove to be peak oil. We won't really know till 2024 or 2025 or something like that, but it's around now. So oil, gas and coal. Peak coal was around 2013. That's related to Chinese manufacture. Gas peaked around 2019, but that could be an artifact of the COVID-19 pandemics.

Nate Hagens (00:58:17):

Yeah, I think we have couple decades if we have complexity hold together, I mean Qatar and Russia and Iran. Keep going.

Simon Michaux (00:58:25):

But supply of that gas, if you turn energy is the master resource, if our current systems are energy based in fossil fuels, but that fossil fuels becomes unreliable in the open market, then everything it attaches to will become unreliable. So the entire value chain to actually deliver raw materials to things like manufacturer will become unreliable. And then there comes a problem of, well, we won't be able to source a lot of these minerals at all. So a lot of products that we take for granted are just simply going to go offline.

(00:58:54):

We're seeing it now. For example, microchips in cars in the United States. Now that's an above ground limitation. What happens when we can't, say, supply a particular rare-earth element. And so yeah, we will see mineral shortages of all kinds and there's structural shortages there now. So as we actually want more electric vehicles on the road and we actually want more of the grid to be renewable, we will see more of these problems. And that's now.

Nate Hagens (00:59:23):

It's that nursery rhyme or fable for want of a nail, the horse lost a shoe, the shoe lost the horse, the horse and the soldier, and the soldier and the kingdom. We don't know what the nail is going to be, but it's incredibly complex and everything is predicated on complex supply chains and it's predicated on energy being the master resource. So it's hard to predict where the shortages will be, but it's relatively easy to predict that there will be shortages.

Simon Michaux (00:59:56):

So 500 years ago, everything you needed to do to survive, you controlled directly like you grew your own food or you knew personally the person who did. In your village was everything you ever needed. And if you did need metals, they came from a relatively local source. And so it was relatively easy and flexible just to respond to external emergencies. Since we've had this really, really cool energy source for such a long time, we've now developed a system where a six-continent supply chain of a just in time supply grid of such complexity, we can't even describe it. Remove the oxygen from that system that's energy. What happens to that supply system and what is our ability to make a more resilient version of that? This is where the difficulty becomes.

Nate Hagens (01:00:43):

I think we can agree, though we're still in the minority globally, that humans will not be able to maintain, let alone grow a 19 terawatt global society for much longer.

Simon Michaux (01:00:56):

No. Not even close.

Nate Hagens (01:00:57):

So that leaves us with two questions really. Can we create a more or less sustainable, lower throughput society technically? Can we do that technically? And then how to get from here to there socially and politically. So in your research, if it's not going to be 19 terawatts, forgetting about politicians and finance and geopolitics for the moment, technically, what do you think is a achievable given our energy and mineral situation? 19 Terawatts might technically move to what?

Simon Michaux (01:01:36):

If we're lucky, 10 terawatts. The smart money is 5 terawatts. So we have to do a few things. I know it's ugly. It's ugly. We have to do a few things. From a technical point of view, nevermind socially, our food production is going to be the biggest task first in the Maslow hierarchy of needs, where at the moment it's industrial agriculture and it happens on your six-continent supply chain fashion. That will have to phase back into small scale organic where most people are going to have to become involved with growing their own food again. Now of course they can't just do that and the land available to do that is simply not suitable. Let's say that happens.

Nate Hagens (01:02:16):

Well, hold on, I want to push back on that a little bit. So global agriculture is incredibly dependent on fossil fuels, both the gasoline and diesel for the tractors, but also the natural gas that makes ammonia and fertilizers and pesticides and everything else. But only a small amount of our current fossil fuels are being directed to agriculture. If we shifted things away from NASCAR and Disneyland towards tractors and ammonia, we could better use our depleting stocks of fossil hydrocarbons, direct them towards the highest use, which would be food.

Simon Michaux (01:02:56):

So I did a job a couple of years ago where I looked at the phosphate rock problem and I actually developed a work that I called Paul was Right. Paul Ehrlich, if you're listening to this, you were right. So what I was looking at was where does fertilizer come from? So you've got NPK fertilizer. The phosphorus fertilizer is made from gas, which makes ammonia and yes, you can get it another way, but they also use phosphate rock. And so phosphate rocks of finite resource, blah, blah, blah. Before we get to the problem of depletion, we've got the problem of arable land being depleted by how we're doing our industrial agriculture. We've lost about 40% of our arable land net since 1960 odd, right? So we are shrinking, our population's growing, but our arable land to grow food is shrinking and we're increasingly dependent on chemicals to make it happen.

Nate Hagens (01:03:52):

The soil that exists on the smaller amount of arable land is also much depleted of nutrients.

Simon Michaux (01:03:58):

Yes, correct. So the net position, when the green revolution took off in the sixties, they had a certain amount of people and they had a certain amount of arable land. Now we've got more people but less arable land. But the system that we grow agriculture on is now attached to non-renewable natural resources, which are a problem. So Paul was absolutely right. He was just 40 years late.

Nate Hagens (01:04:21):

Well, I don't know that you know, but I had Paul on as a guest and he told me stories about he knew Norman Borlaug and Borlaug, the father of the Green Revolution told Paul 50 years ago, "Paul, I've bought you a generation." Borlaug agreed with Paul's conclusions and said, "Use your time wisely because this bought us a generation."

Simon Michaux (01:04:45):

But the paragons of economic growth did not agree with them because it actually made life easier for them. I used to be a laborer on an organic farm and I was learning to grow organic fruit and vegetables and I learned how food was grown and in fact I'm going to use that professionally later to rehabilitate. And so we were learning about what does glyphosate, Roundup, actually do and why? We were able to unpack a lot of this sort of stuff.

(01:05:10):

So the solution to those problems is to go organic where we do small scale organic food where everyone grows their own food and anything like that. But if we have say, medium scale production of things like fertilizers using organic methods, if we applied our industrialization to making manure naturally, what would happen? And so it's an entirely different architecture to how we do it now. Whatever that looks like, it's going to be quite messy because it's going to be unplanned, but it's going to be something like Cuba, what Cuba did when in the late nineties when they were hit by the oil embargo. So first of all, food has to go.

Nate Hagens (01:05:47):

Food has to go?

Simon Michaux (01:05:48):

Food has to be transformed from what we do to what do now. Second thing of order is how do we maintain our fresh drinking water and our sewage and then it's energy for heating in the Maslow hierarchy of needs. We have to think in those terms. It's not about maintaining the latest iPhone. If we have technology, the technology will be required to meet sustainable targets in a Maslow hierarchy needs kind of way. So it'll have to be re-engineered.

Nate Hagens (01:06:17):

Well, one of the many questions is, can we envision that or something like that and be working on it in parallel to this Disneyland smorgasbord, Amazon 24/7 stimulation convenience supply chain world? Because it cognitively and emotionally... Cognitively, we can envision what you're saying Simon, but emotionally that doesn't feel like our reality. So can there be parallel paths of serious people working on this while the Disneyland band marches on?

Simon Michaux (01:06:55):

Yes. So when I was working on that organic farm on Mount Tamborine in Australia, I learned this very simple thing that if you were trying to manage a problem, you're trying to manage, for example, all the fruit trees had a fungus on them, like a mold and fungus. And so you could either go around cleaning the fungus off with a scrubbing brush and applying pesticides to try and prevent a problem. Or you could put some fertilizers into the soil to give the tree the food to flourish and then create the solution. You either fund the solution or you try and prevent the problem. Where do you put your effort? So instead of trying to stop the Disney, tell the Disney people that guys you're mistaken, leave them be, you can't do anything with them. I see the future breaking into three paradigms. The first paradigm was defense of the status quo.

(01:07:50):

The way things now is how things will always be. And a certain group of people will believe that and nothing else. You can't actually do anything with them. You can't actually talk to them, you can't reason with them. We've all seen that. Leave them be. The second paradigm, people who will recognize and realize that our existing system is now hitting practical difficulties and will now have to actually start making arrangements to actually look after the needs of society themselves. All the stuff you talk about, the growing of food, the forming of communities, we all come together on a different social unit called the community now or the village. And where our needs are scaled right back, what we do and what we need and what we want all become the same thing. But at the moment, most of the time what we do has nothing to do with what we need or want.

(01:08:47):

So we come into alignment. And so this is the social evolution of the social contract that we were talking about. That's paradigm two. Paradigm two is all about what's here and now and how do we manage things for the next couple of seasons, right? It's a relatively medium term thing, short to medium term. Whereas paradigm three is okay, the fossil fuel system is in trouble, but it's not gone yet. How do we actually create long-term for my children and for my children's children a system where we can maintain our levels of education and some sort of level of technological understanding that we have now? How do we do that? So that's paradigm three. But paradigm three will have to be interfaced with paradigm two to meet the needs in the short and medium term. So paradigms two and three will be able to talk to each other. Paradigm one won't talk to anyone.

Nate Hagens (01:09:47):

What percentage of our current population are thinking in those three paradigms right now? Just rough guess.

Simon Michaux (01:09:53):

So there is the public position and the private position. The public position, people are terrified of saying something out loud that might be seen as controversial, right? It's "Oh no, no. I can't possibly say that out loud." Right? But privately, I think maybe a third of the people around me understand paradigm two. Maybe 5% of the people around me understand paradigm three. Everyone else is paradigm one.

Nate Hagens (01:10:24):

So given everything that we've discussed both on this call and in our past correspondence, I'm curious what kind of advice would you give to young people who today discover and understand these energy and environmental risks and the general human predicament? What kind of advice would you give to young humans?

Simon Michaux (01:10:48):

The most important thing that motivates me to do what I do are my three daughters. I think of them a lot, but what's required of them? And I say, how do I talk to them? It's more important for me to know how to talk to them than to anyone else really. So what I would tell them is the world that's coming in is changing in ways that we simply don't understand in a historical fashion. We've not seen anything like this before. We've never been in a position where so much of the population is so unskilled with regard to understand what's coming let alone do anything about it. So my advice to them is learners will carry the day, people who can learn and adapt in the face of change. The learned, educated people, for example, will just merely be educated. It is much more effective to be able to do something useful in a changing environment compared to being able to recite how things used to be.

(01:11:43):

Someone like myself could stand up on stage, and "Look at the furrows of worry on my forehead. I've got this PhD and this physics degree. Isn't it wonderful? You should feed me." A lot of the things that we take for granted will simply be removed from us. So if you could be flexible, understand that what you think and you feel is flexible, and it comes down to a knowing, an emotional confidence of knowing what needs to happen with regard to the problems in front of us. And then taking on a positive attitude as opposed to a negative attitude. Right?

(01:12:18):

Have you noticed most of the environmental movement at the moment is all about punishing the existing system and punishing the people who support that system? They're not presenting a solution. Present a positive solution and then the old solution can just die a natural death, but the positive solution can grow. Be one of the people that can flourish in that system. So try not to think in fear and be flexible, learn.

Nate Hagens (01:12:43):

I like that a lot. But I'm going to add another question for you because you're both intelligent and wise. If you were running the global education system, knowing what you know about our energy and mineral and social and environmental situation, if you were the education czar for H sapiens, what sort of educational university, broader system for young humans would you advocate in a minute?

Simon Michaux (01:13:15):

I would change the paradigm of how we educate and least have a stream within the education that involves problem solving and critical thinking, the ability to debate with people you don't agree with, and the understanding of situation awareness and embed that intrinsically into the education from day one.

Nate Hagens (01:13:35):

Yeah, we don't really do that. A lot of our education is teaching trivia of what mattered in the last 50 years and the next 50 years are going to require an entirely different set of skills. So I love your learning, problem solving and positive idea. So Simon, you and I have had a lot of laughs and we're Facebook friends and you put up some of the funniest damn cartoons and memes, but I don't know that I've ever actually asked you this. I just feel that we're aligned. But what do you care most about in the world?

Simon Michaux (01:14:12):

So the simple answer, the short answer is my three daughters. The longer answer is my three daughters and what they might have to do to live a happy and enriched life. Like your work, my work, where are we going? How do we make a better world? That's what I care about.

Nate Hagens (01:14:29):

Hear, hear. I agree with that. So speaking about the world, and these are questions I ask all my podcast guests, what specific issue are you most worried about in the coming decade or so?

Simon Michaux (01:14:42):

Okay, this is a long term one, but I'm worried that the people who control the ecosystem in all its forms across the planet, but also in each nation state will do something flamboyantly stupid just to remain in power. Now, you could say that they will just do something in an knee-jerk reaction to maintain power, but the worst answer is they understand the genuine consequences of what they're doing to humanity, but they do it anyway. We've got psychopaths in charge of things. I don't like that. I'm most worried about what they might do, which will complicate things for the rest of us.

Nate Hagens (01:15:20):

And in contrast, what gives you hope? What are you most hopeful about in the coming decade or so?

Simon Michaux (01:15:26):

This is going to sound a little odd that society is in a place at the moment where we can face certain problems that perhaps for the first time. 500 years ago, we didn't consider, for example, that we had a relationship with the planet environment. We didn't have education in the way we have it now. Most people around us believe in the law right and wrong. They believe in human rights. So we're actually in the best net position to face these problems. Now, these problems were always going to be so. Humanity is like any other animal. We're going to go after the easy resources first and we're not going to do any task that's hard or complicated if it doesn't give us a dopamine fix on the spot. So it was always going to be the case of we are going to do this the hard way.

(01:16:08):

So we have a narrow window of when action is possible and when action is irrelevant. That's the next 10 to 20 years. Well, it's actually started in 2008 and I think it will finish around 2030. So around that, it's a window around that. It was always going to be this way, but humanity is actually in the best place possible to meet these challenges. So it's possible that humanity could actually genuinely grow up and take its place as a sustainable species with an industrial or a technology civilization that has a genuine relationship with the planet. That is only possible in the current set of circumstances because the majority of humanity would not look at it any other way.

(01:16:55):

So I am hopeful we actually now have the opportunity to do it and it's a very nice time to be alive. I'm actually not afraid for the future. It's going to be tough. Someone's got to do it, right? But it was always going to be this way. It's a natural progression and the time is now. That's what I'm most hopeful for.

Nate Hagens (01:17:15):

I kind of feel the same way, Simon. As perilous as our situation is, we kind of had to arrive here to recognize it and respond to it. And this is the calling of our time. So I agree with you. Thank you so much for your time today and your continued yeoman's work on these issues. Do you have any other words of wisdom, advice, or closing thoughts for our listeners?

Simon Michaux (01:17:44):

I feel that humanity has actually been presented with a choice, both as a species, as a group, but also as an individual. This is back to the three paradigms. You can be part of the solution or you can be part of the precipitate. You can be part of the way forward or you can sort of dig your heels in and then hope for the best and complain when things don't go so well. The difference is what we do and also our perception. Choose to think positively, but what we do is defined by what's in our hearts, what's between our ears and what's in our hands. And it's a knowing. We've got to evolve first our relationship with ourself, and then we're going to evolve the relationship with natural resources and the environment around us. These are the terms that we need to be thinking in at the moment. Don't be frightened of it, don't be scared of it, if you can.

Nate Hagens (01:18:41):

Thank you, Simon. I will talk to you soon and I hope to see you in person in Finland this summer. To be continued, my friend. Keep up the good work.

Simon Michaux (01:18:51):

You too, mate.

Nate Hagens (01:18:53):

It's Nate.

Simon Michaux (01:18:57):

Nate, you're a mate as well.

Nate Hagens (01:19:01):

All right, Simon. Be well. Thank you.

(01:19:04):

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