Nate Hagens (00:00:00):

You are 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):

Today's guest is my friend Tom Murphy, a professor of astrophysics at UC, San Diego, but perhaps better known for his longtime blog, Do The Math. Today we do the math on how continued growth and energy use is an impossibility, which at today's pace would result in more energy use than the entire galaxy in a short few 1,000 years, and other topics relating to the path ahead for humans living on a finite planet. Please tune in for Professor Tom Murphy.

(00:01:19):

Welcome to this podcast. Let's get started. I have a lot of questions for you. I've been a longtime follower of your writing on Do The Math, and of course we've been friends. So could you personally just say what is your current job and for how long have you been doing that?

Thomas Murphy (00:01:37):

I am currently a physics professor at UC, San Diego. I've been in that job for coming on 19 years.

Nate Hagens (00:01:43):

Okay. And during that time, what has been your main area of research?

Thomas Murphy (00:01:49):

So it's been astrophysics of various flavors. Started out as colliding galaxies and then moved into a project that's occupied the last 20 years of my life on measuring the distance to the moon to millimeter precision as a test of Einstein's general relativity.

Nate Hagens (00:02:04):

That sounds important. Is it important?

Thomas Murphy (00:02:08):

In some circles, it certainly is important because the fundamental disconnect between quantum mechanics and general relativity, they're fundamentally incompatible. So we thought we'd better test gravity as well as we can and maybe try to resolve this gaping hole in physics. So it was always easy to write proposals to get funding for because it's widely viewed to be a very important thing.

Nate Hagens (00:02:32):

Among other aspects of our society, that pursuit might be what we refer to as energy blind, but is that research important to you or is it still important to you?

Thomas Murphy (00:02:46):

Well, it definitely was when I started. I felt like I was really lucky to be doing something that had fundamentally consequential elements to it, probing the very foundations of physics, and I got to play on telescopes and build instruments and shoot a laser at the moon. Who can do that? I felt like I was really integrated into that world.

Nate Hagens (00:03:10):

You shoot a laser at the moon and then how long does it take for the laser to arrive at the moon?

Thomas Murphy (00:03:16):

It's 1.25 seconds there and another 1.25 seconds back. So two-and-a-half round trip.

Nate Hagens (00:03:23):

Dang. So shooting lasers at the moon and all of a sudden you started to write blogs and ultimately books about energy. So what's the change in your mind, your philosophy, your recognition from being a professor to being an educator on the issues of sustainability?

Thomas Murphy (00:03:44):

It was all in slow motion. Started in 2004 when one of my first teaching assignments was in a course on energy in the environment, and I went in very eager to learn what that landscape looked like. I had a lot of computational skills and just quantitative

physics skills and I thought, "I'm going to try to sort out what our future looks like. Solar, wind, geothermal, hydroelectric, nuclear, what's it going to be?" I knew that fossil fuels were finite but didn't really know much more than that.

(00:04:18):

What happened is I came out confused because it's a very difficult challenge. Fossil fuels are incredibly addictive and hard to replace, and I did my own experimentation. I built my own little solar set up with batteries and experimented and kept expanding it and learned a whole lot about the pros and cons. I'm a big fan of solar, but I also know practically how hard it is to be completely reliant on something like solar. And so over the years, I became more and more concerned until I eventually reached a breaking point and had to start writing this stuff down and that's when Do The Math started.

Nate Hagens (00:04:54):

And Do The Math eventually ended in a book which I have a copy of called Energy and Human Ambitions on a Finite Planet, which is probably one of the best energy textbooks I've ever seen.

Thomas Murphy (00:05:06):

Well, that's great. Thank you.

Nate Hagens (00:05:07):

So now what? What are you doing now?

Thomas Murphy (00:05:09):

So now I'm really transitioning away from astrophysics because I have come to the conclusion that so few people have their eye on the ball here, that we could really botch it. That if we just assume that things are going to work out and that we're transcendent as a species, we're going to fail and that looks like collapse. And in the worst case, that means that we lose all of our scientific knowledge, we lose everything I've worked for, all my colleagues have worked for, and that's very difficult for me to bear. And so I think maybe I should apply what talents I have toward this more existential predicament. And in the worst case, I'm wrong about all this. But every time I reevaluate that, which is almost constantly, I have a hard time believing that this is

not a serious issue. And so it just feels like the other stuff I did was playtime, it was recess, and now I need to step up and try to do something that I think is more important.

Nate Hagens (00:06:12):

That's how I feel as well, as you know. How many of your colleagues in the physics departments are moderately to extremely aware of the topics we're about to discuss?

Thomas Murphy (00:06:24):

Very few, honestly.

Nate Hagens (00:06:26):

Why is that?

Thomas Murphy (00:06:27):

That's a good question, and I ask myself that all the time. I think it's partly that they haven't needed to be more aware. We work in a society and a world that allows specialization and focus into minute little areas, and you can become the world's expert on some topic that's very esoteric and the whole system works for you and it's there for you. You wake up, it's almost as consistent as the sunrise. And so why do you need to be that aware? Because all the incentive structures are built around a continuance.

Nate Hagens (00:07:04):

Yeah, If I got paid a good salary to shoot lasers at the moon and write papers about it and I was knowledgeable on that, that would be a pretty good deal. So unfortunately, the story that you and I spend a lot of time delving into is not a pleasant, happy one because we're looking at two or three steps ahead, how the system of energy, materials, money, human behavior, the environment fit together.

(00:07:30):

So with that intro, thank you. I hope you'll be willing to engage in a speed round on topics of your expertise. I'm going to ask you eight to 10 questions, Tom, maybe just give short 15 to 30-second answers and then we'll get into a deeper discussion if you're willing.

Thomas Murphy (00:07:51):

Sure, that sounds great.

Nate Hagens (00:07:53):

All right, so you are an astrophysicist. Let's start with some core fundamental questions for our listeners that might not have a lot of expertise in this field. So first of all, briefly, what is the first law of thermodynamics and why should people care?

Thomas Murphy (00:08:10):

Well, the first law of thermodynamics is basically conservation of energy. That energy is neither created nor destroyed. It just can be sloshed around from one form to another. And so we don't create any energy. We just transform it from say a chemical form into a mechanical form or so forth. So that's the first law.

Nate Hagens (00:08:28):

And what is the second law of thermodynamics?

Thomas Murphy (00:08:30):

The second law is a little more subtle, and it's that this quantity called entropy is something that can never decrease in a closed system so that it's a measure of microscopic disorder at some level or how energy can be distributed in a system and it can't spontaneously decrease the entropy. It always has to go up.

Nate Hagens (00:08:52):

And why is that relevant?

Thomas Murphy (00:08:53):

It becomes relevant in the quality of energy sources and it's also relevant in just dictating the direction of time and how things flow. Most videos that you watch, you can spot right away whether it was filmed backwards or forwards. And that tells us how deeply ingrained... Think of something splashing in the water or a coffee mug shattering on the ground. That entropy dictates the direction that time flows in a sense, and it's something that's actually very intuitive to us because we live in this world where entropy only ever increases.

Nate Hagens (00:09:30):

So the way that I think about it is every time we do a transaction, a good or a service or an activity, there's energy spent and there's waste heat dissipated, and there's always a loss. There's always a loss of the ability to do work with what we had before.

Thomas Murphy (00:09:48):

In terms of the second law, you'd say that the… Let's say organized motion of say the coffee cup sailing toward the ground, that's a very organized state of motion, and then it is going to turn into a much more disorganized state of motion and eventually as heat. All of that mechanical energy just ends up as heat in the environment and now it's a very diffuse form of energy that's got high entropy and it's practically useless to us.

Nate Hagens (00:10:13):

So how much of our energy is directed towards actual output and how much is wasted roughly?

Thomas Murphy (00:10:20):

Well, in the long term, all of it's wasted. We get some use out of it along the way, but okay, so a power plant might turn 35%, 40% of its chemical energy into electricity or a nuclear plant is very similar. A car driving down the road might turn 20% of the energy in the gasoline into useful mechanical, but let's take the car going down the road. All of that energy that we think that provides some utility for us ends up as waste heat because we're stirring the air, we've got friction on the brakes, friction tires in the road, friction in the car, your car gets hot, the engine is hot, but even the stuff that's useful propelling us down the road turns into heat eventually.

Nate Hagens (00:11:04):

And where does all this waste heat go?

Thomas Murphy (00:11:07):

Well, so if it just stayed on earth, earth would get hotter and hotter and hotter to the point where climate change is a laughing matter, but there is an escape from the earth and that's in the form of infrared radiation. So the earth cools off to the coldness of space by just radiating that thermal energy out to space.

Nate Hagens (00:11:27):

All right, so what is power?

Thomas Murphy (00:11:31):

Power is in the physics definition, simply the rate at which we use energy. So I like to think of it as a speedometer. So energy is the odometer and power is just the rate at which you're moving down the energy road.

Nate Hagens (00:11:45):

And why is that important?

Thomas Murphy (00:11:47):

Well, actually in some sense, my favorite unit is the watt, if I'm allowed to have a favorite unit, because many things are power limited and our society is somewhat power limited, our metabolism, the sun. So power is usually how much energy we use depends on how much time we're spending a certain power, but the power is the thing that is more a useful measure.

Nate Hagens (00:12:13):

So what does that mean, power limited? Am I power limited?

Thomas Murphy (00:12:17):

You are power limited.

Nate Hagens (00:12:18):

My physical body?

Thomas Murphy (00:12:20):

You are, absolutely. You can actually get a very good sense of how much power you're spending by your caloric intake. So if you divide the amount of calories, convert it to something more useful like joules and divide by seconds in a day, that's how much power you're spending. So 2,000 calories or really kilocalories per day translates to about a 100 watts.

Nate Hagens (00:12:43):

Like a light bulb?

Thomas Murphy (00:12:44):

That's like an old incandescent light bulb. And so when you are active in say performing a lot of labor or being athletic, you might ramp that up to maybe a few 100 watts. Now, horsepower is 750 watts roughly. So you would expect a horse to be able to deliver almost a 1,000 watts of mechanical power. We can't do as much as a horse, so we're not up to horsepower. Maybe for short bursts for a few seconds, we can manage. We're power limited.

Nate Hagens (00:13:19):

So the power limited means no matter how much food I eat, I'm still going to only be able to generate the power of around a 100 watt light bulb or a little bit more if I'm an elite athlete or something?

Thomas Murphy (00:13:32):

Right. And if you try to eat more than that, well, you know what happens.

Nate Hagens (00:13:35):

Yes, I am well aware of what happens, but in another sense, I'm not power limited because I can generate the power of a 100 watt light bulb with my own body but I have an exosomatic wand that I can use by ordering stuff on Amazon or flying to California or the embodied energy in my office here.

Thomas Murphy (00:13:58):

Absolutely. And that amplification factor is quite large as you well know.

Nate Hagens (00:14:03):

Yeah. Okay, let's keep going with the speed round. What is exponential growth as opposed to linear growth?

Thomas Murphy (00:14:10):

Well, exponential growth is what happens when something grows in proportion to the amount that it already has. So a bank account, for instance, gathering interest where the interest is computed on the balance in the bank will grow exponentially because as

that bank account grows, then the basis for which that interest is computed is growing. And so it tends to be a runaway process because the bigger it gets, the faster it grows and it's a positive feedback runaway.

Nate Hagens (00:14:40):

And when we talk about growth, there is the rule of 70, I assume you teach your students. What is the rule of 70 or the doubling rule briefly?

Thomas Murphy (00:14:50):

Yeah, the rule of 70 is just a convenient numerical thing where if something that grows at 1% per year will take 70 years to double, or if it's 1% per second, it'll take 70 seconds to double. So whatever the time unit is, it's a factor of 70. And then if it's 2%, well, now it's 35 time units, and if it's 10%, it's seven years or seven time units.

Nate Hagens (00:15:13):

So when our economy is growing at 3% a year, it would double in every 23 years plus or minus?

Thomas Murphy (00:15:22):

Yeah, something like 23.

Nate Hagens (00:15:23):

Got it. So thinking ahead to... Since you're the Do The Math guy, I want to ask you these questions. So what is the relationship between economic growth, which has been around two-and-a-half to 3% a year for the last 50 years, between economic growth and energy consumption?

Thomas Murphy (00:15:41):

Well, there are multiple ways to answer that question. One is historically they've been basically identical. Economic growth maybe grows a little bit faster than energy growth and some of that's improved efficiency. Now, the economists would say that it doesn't have to be a rock solid relationship. You can have things that are decoupled and you can have economic activity without a physical footprint. We haven't seen our global energy system do that as a whole, nor do I think we ever could. So I think that these are always going to be very closely tied concepts.

Nate Hagens (00:16:15):

Real briefly, why do you think we never could decouple economic growth from energy consumption?

Thomas Murphy (00:16:21):

Well, and here's where people can get tripped up because it's very easy to point to activities that are very well decoupled. The funny one I like is psychotherapy. You pay a therapist an insane amount of money and hardly any energy gets spent in that process, but trading art or a lot of things can be decoupled but the basics of life, food, transportation, thermal energy, heating yourself or heating your home, those things are just going to never be free from energy and can in fact exact quite a hefty toll on the energy front. And those things are always going to be a significant part of what we do. We can't go without them.

Nate Hagens (00:17:08):

So the psychotherapist has an office and a home and an education and a life and vacations and an internet and all those other things, and that makes the coupling of that person's vocation and the economic goods and service of the $300 an hour for psychotherapy contribute to almost a one for one correlation worldwide on GDP versus energy.

Thomas Murphy (00:17:35):

Right.

Nate Hagens (00:17:35):

Okay. So you are a physicist, to my knowledge, the first physicist I've had on the program. How are physics and economic theories similar?

Thomas Murphy (00:17:46):

I think they're similar in that they use math and I think that's it. I think that's the end.

Nate Hagens (00:17:54):

Okay. How are they different?

Thomas Murphy (00:17:56):

They're different because physics is a self-correcting enterprise that uses nature as the final arbiter. So you can theorize till you're blue in the face, but if the experiments don't back it up, then it's junk. So we have ideas in physics, not because we like them. In fact, we don't like a lot of our physics, but nature crams it down our throats. So it's constantly challenging its core assumptions.

(00:18:27):

Economics is a little bit too eager to follow its model. You had Herman Daly as a guest on this podcast, and I think he put it very well as, I think the fallacy of misplaced concreteness, I believe were the words to describe overindulgence in believing the model over the assumptions, not revisiting the assumptions that underlie the model

Nate Hagens (00:18:50):

But didn't the early economists try to mimic physics and apply physics to the broader human condition?

Thomas Murphy (00:18:58):

They did, and they were actually somewhat successful in the sense that they had a much firmer grounding in physical law and nature, and in fact thought about growth as a temporary phase. And then you have heroes or villains depending on your point of view, like Malthus, who really understood limitations. Now, he didn't understand the fossil fuel craze that was coming, but his basic idea will certainly be correct. It is correct that physical limitations will impose a limit on economic growth.

Nate Hagens (00:19:32):

Okay, so let's get into it. Thank you for the short answer part of the conversation. Now we'll get into the longer answer. So you are an astrophysicist. What can your work, your field, your expertise, contribute to this idea that the world is becoming more aware of that we are facing planetary limits?

Thomas Murphy (00:19:55):

I think a number of facets of being an astrophysicist lend well to this. First of all, we're used to looking at very vast tracks of time and space and understanding ourselves as in insignificant in the universe. We are really specks of biological matter on a speck of

dust around a star that's really just a speck of light in a swarm of hundreds of billions of stars in a galaxy, and that galaxy itself is a speck or a smudge among the rest of the universe. And so that really brings some humility to the story. So that's one thing, that the timescale is very important because if we talk about billions of years then what's happened in the last 200 years? What does it matter? It's just such a blip that we need to think longer term and it's very easy for me to think about the 10,000-year timescale of agriculture and civilization. That still is very short compared to the many processes that astrophysicists consider.

(00:20:59):

Planetary limits, it's got the word planet right there. That's an astrophysical concept. We understand the matter and energy interactions between the planet and the solar system and the sun. We understand the fundamentals of energy and light and I think astrophysicists are also accustomed to doing approximate calculations. These are not precise laboratory conditions. You're looking at messy systems in the sky that are far away and you have imperfect data quality and you're doing very approximate work. Those skills of quantitative fuzziness lend really well to some of these big societal scale messy problems because you just try to get an overall capture of the most important elements. And so that kind of fearless approach to let's tackle a messy problem and quantify it somehow, that comes in very handy.

Nate Hagens (00:22:00):

So one of your most famous essays, which when I was teaching at the University of Minnesota, I assigned in the energy section was called Galactical Scale Energy or Galactic Scale Energy. And in it, you teased out the concept that energy and GDP are tightly linked, and that contrary to conventional economic thinking, which basically says we can grow forever, you showed that at 2.3% per year energy growth, if I recall, we would within 2,500 years consume all 100,000,000,000 stars in the Milky Way galaxy worth of energy. So could you walk me through the math if that's possible, and how you arrived at that conclusion and why that's relevant?

Thomas Murphy (00:22:53):

Yeah, certainly. And one thing I will say about economic assumption is that if your model starts to be able to replace interchange labor and capital and energy and it's just all factors of production and you can just slosh them all around, then you can

understand why the model would suggest that any one thing like energy isn't that important. And so you can just replace it by something else.

Nate Hagens (00:23:20):

Wait, so hold off there. So an economist would say, "Yeah, energy is important, but in our model if we run out of energy, we can substitute it for labor or capital."

Thomas Murphy (00:23:32):

That's right. That's the effective thinking.

Nate Hagens (00:23:34):

Okay.

Thomas Murphy (00:23:34):

If you can call it that.

Nate Hagens (00:23:36):

Okay.

Thomas Murphy (00:23:37):

Yeah. So I wanted to focus on the energy story and then later tie this into the economic reality. And in terms of energy, if you look at the last few centuries of energy use, it's a fairly convincing exponential climb in terms of something like a two to 3% growth per year. So I picked 2.3 for the mathematical convenience that it's a factor 10 every century. And now I can think about it without using a calculator pencil paper.

Nate Hagens (00:24:06):

What do you mean a factor of 10 every century?

Thomas Murphy (00:24:08):

So at a 2.3% per year increase, the size of the system would increase by factor of 10, become 10 times larger every century. And this relentless-

Nate Hagens (00:24:21):

If we grow something at 2.3% a year, it doubles every 25 years or whatever. But in a 100 years it will go up 10X is what you're saying?

Thomas Murphy (00:24:31):

Exactly, exactly.

Nate Hagens (00:24:32):

Okay.

Thomas Murphy (00:24:33):

Right. So it's very similar to the law of 70. It's just another convenient handle. And so a factor of 10 per century, you find out that at the current rate of energy growth or the rate that's been present for the last few 100 years, we would hit the amount of solar energy that reaches the earth in 400 years at a 100% efficiency. So if your idea is that, "Oh, well, fossil fuels are finite, sure, but the sun is so plentiful solar energy that we can outfit the entire... All the continents and all the oceans with solar panels, and surely the efficiency will be at a 100% because we're just so clever." So even then, you're at 400 years.

(00:25:12):

And then the techno optimist would say, "But it doesn't stop there. We've got the whole sun. Why would we confine ourselves to earth? We're space cadets and so we can have a shell around the sun that collects all the solar energy and that buys you another 1,000 years." By the way, the earth, if you use the earth, if you destroyed the earth to make the shell, because where's the material going to come from? It would be a thin three millimeters thick surrounding the sun at the distance of the earth. And most of that's useless rock. It's not structural material that you want.

Nate Hagens (00:25:44):

Okay. So at 2.3% a year, we go 10x in a 100 years, which means a 100x in 200 years, a 1,000x in 300 years.

Thomas Murphy (00:25:55):

Exactly.

Nate Hagens (00:25:56):

But that's just the energy use. But the material use, which you just suggested over the last century or so is even more tightly linked to our economy than energy is. It's basically one for one. We double every 24 years in the amount of gigatons of aggregate asphalt, concrete, metal, wood, et cetera that we add to the system. So where are we going to get that from? Forget about the galactic scale example. Where are we going to get it from for the next three doublings?

Thomas Murphy (00:26:32):

Right. I think that's a huge concern and it's one that we can basically turn a blind eye to because it hasn't been fundamentally limiting so far. And so if that's what we decide that if it hasn't gone bad so far, then it won't go bad, then we deserve what we get. We can see the writing on the wall. We can understand that the first resources we grab are going to be the easiest ones, the low hanging fruit.

(00:27:00):

So yeah, you're right. The material demands on our planet have never been higher. We're already starting to have trouble meeting the current rate of demand, let alone a factor of 10. It's just inconceivable that we could go there.

Nate Hagens (00:27:14):

So if we do make a switch to either mostly renewables or partially renewables because we recognize our energy limits, we still have these material limits. Do you have any comments on that?

Thomas Murphy (00:27:29):

I do, and one thing I would say about it is addressing the idea of substitutability that, okay, well, when we run out of copper or something, we'll find something else. But the problem is the periodic table doesn't cater to our whims and doesn't expand just because we want new things. There are only so many elements and they all have their own unique properties and it's not a one-to-one substitution if you go to some other thing. We've optimized, we've found the best materials for many purposes, and what's left is inferior in a lot of ways. So the superior substitute story is just a limited time prospect.

Nate Hagens (00:28:11):

So my view is we optimize for the least available input, and if liquid fuel like oil starts to become scarce, we're going to make some decisions to rectify that situation. But then some other thing will become limiting and eventually there's a lot of things that are limiting and they interrelate. So what would an economist, and I know you've had both official and unofficial debates with friends of yours who are economists, what would economists say taking a steel man argument of the things that you've said so far? How would they reframe the discussion that we're having right now?

Thomas Murphy (00:28:50):

Yeah, that's a good question. And it's something that definitely deserves consideration. And I can't claim to 100% represent how they think, and maybe that would be damaging to my brain if I tried. I think one thing that they would likely point out is that even if you do run into material limits, that that will not stop growth because you can have growth in other domains that are not energy intensive. This is the decoupling idea. You can have more virtual reality so that you're going to Bali without doing the air flight. They would stress just utility in a generic sense and say that the real question is, let's say that you did stabilize in your material footprint, which by the way, how do we even stabilize? That still is a drawdown on non-renewable resources. That's just a relentless... Even if you're not growing, it's hard to maintain.

(00:29:48):

But that aside, even if you did maintain, so you've stopped growth materially and energetically, the question would be is life 500 years from now unambiguously, undebatably better in terms of the overall quality? So what you're getting out of those resources, is it better? And the answer is, well, probably. All of the things being equal and things being stable, yes, but that's a different kind of growth. That's not a quantitative growth, that's a qualitative growth, which is not precluded by this line of argument, but it's not the kind of thing that leads to loans and investments and Social Security programs and all of these mechanisms that we've built that rely on the quantitative growth.

Nate Hagens (00:30:31):

Well, if I make love more often with my girlfriend and I take my dogs for more hikes and I meditate out in the forest, all those things improve my qualitative well-being, but none of those things contribute to GDP. And right now GDP is our cultural

scorecard and some of that is our cultural choice, but some of it is the metabolism of biological species seeking power, not power like social power, although that's related, but power as in energy use per unit time. Do you have any thoughts on that?

Thomas Murphy (00:31:07):

Well, no, I absolutely agree that we're fixated on the wrong metric and happiness can be found in a very low tech, low energy, low material resource way, but that so many of our lives are dictated by how to gain enough money to buy ourselves the happiness that we're after. And in some sense, that's the wrong road and it's leading us to a bad place.

Nate Hagens (00:31:33):

It's a monkey trap. We can't let go of the banana. We're grabbing it too hard. Okay, so earlier you mentioned waste heat, and we had an email exchange about this, and I thought it was really interesting because I learned some things. So given your galactic scale energy example, setting aside fossil fuel emissions, which create a blanket around the earth that trap in heat via the greenhouse effect, every time we start our car or turn on a light or take an airline flight, not only is there the emissions, set aside those for now, but there's actually the heat that's generated. So how does the scale of our waste heat of right now is 19 terawatt global economy? The power of the global economy right now is 19 terawatts, which means we have effectively 190,000,000,000 100 watt light bulbs turned on all the time. So how much waste heat does that generate relative to the forcings that are happening because of the blanket of the greenhouse effect from our emissions?

Thomas Murphy (00:32:42):

Yeah, that's a very good question. And right before I get to that, I will just complete the galactic story that going from our sun to all a 100,000,000,000 stars in our galaxy would buy you a 100... So here's how the math works. A 100,000,000,000 is 10 to the 11. So that's the scientific notation for a 100,000,000,000. And so it becomes very easy at a factor of 10 per century, that 11 is how many centuries you have.

Nate Hagens (00:33:08):

So in 1,100 years, we're using how much energy?

Thomas Murphy (00:33:10):

We would go from the sun to the entire galaxy. So it would take 1,400 years to get to the level of the sun at our present rate, and then only another 1,100 years after that. So 2,500 years total to get to the galaxy. And that's physically impossible because it takes light a 100,000 years to cross the galaxy. There's no way that we would be able to capture the energy from all those stars in just 1,100 years. Physics says absolutely not. So basically, even though it was absurd when we had all continents and all oceans using a 100% efficient solar panels in 400 years, that's already absurd. And then we went one more level of absurdity to this shell surrounding the sun, but you can't say physically that's impossible. But by the time you get to the galaxy, yes, you can say physics will not allow it, and you're just shut out growth has to stop. On a timescale that's short compared to civilization, that's important.

Nate Hagens (00:34:03):

So we've grown at two-and-a-half percent a year since the 17th century on average, our energy consumption. So at that rate, we will use more energy than the entire galaxy in 1,400 years?

Thomas Murphy (00:34:20):

The sun in 1,400, galaxy in 2,500.

Nate Hagens (00:34:22):

Okay. And we stopped hunter-gathering and moved to the agricultural revolution 10,000 years ago.

Thomas Murphy (00:34:31):

Right.

Nate Hagens (00:34:31):

So our physical growth, our energy consumption growth will not continue for even a fraction of that time.

Thomas Murphy (00:34:38):

Right. We're closer to the end than the beginning.

Nate Hagens (00:34:40):

Of growth.

Thomas Murphy (00:34:41):

Of growth.

Nate Hagens (00:34:41):

Well, personally, and you know me, I think we're much closer to the end than the beginning.

Thomas Murphy (00:34:47):

I agree with that.

Nate Hagens (00:34:48):

But you're just pointing out that even if you would disagree with that premise, because we have trillions of barrels of unconventional oil and we have the technology to grow solar and wind, et cetera, there's still on a long time civilization timeline, we're still near the end of growth.

Thomas Murphy (00:35:09):

That's right. That even if you pull out all the stops and allow almost magic to happen, that's at least not physically impossible. You run into physically impossible before 2,000 years is up. Really just 1,500 years.

Nate Hagens (00:35:23):

And what if you tried that math on an economist?

Thomas Murphy (00:35:26):

I have, and they swallow hard, and this is not familiar territory to them, but they can't argue with it. And so they will accept, okay, but you are going to absurd extremes here. And maybe it's a bit of a straw man because they're not advocating galactic domination. But the point still is that, "Yeah, but you can't keep growing, right? Energy can't keep growing at this rate, right?" And they eventually have to say, "Yes. Okay."

Nate Hagens (00:35:56):

And if they agreed with you really, wouldn't somewhere that changed their models or not?

Thomas Murphy (00:36:04):

Well, so yes and no. By putting a timescale on it, that's centuries, they don't feel obligated to do anything.

Nate Hagens (00:36:11):

It's in someone else's problem. It's an economist of the future's problem.

Thomas Murphy (00:36:14):

That's right. It's not relevant to the here and now.

Nate Hagens (00:36:17):

Well, I think that that's been the problem all along because we're a biological species with an 80-year lifespan. And a lot of my Wall Street friends, I talk to them about all this stuff, and ultimately they don't disagree with any of the logic of the story, of the Great Simplification other than the timing. "You're right, Nate. But this is going to happen in my children's lifetime maybe, not in mine," which I disagree on but I think the math as you're an expert in is somewhat inescapable.

Thomas Murphy (00:36:50):

And what you just said, Nate, is that their kids must be jerks if they don't even care about what the kids have to go through or grandchildren.

Nate Hagens (00:36:59):

That's another issue, and it's one of the reasons that I'm doing this work on advance policy, that I've found that people between 25 and 65, this story is too emotionally potent to actively engage with because it's too threatening to their own status quo and getting paid to send lasers to the moon, et cetera. But younger people, teenagers, early 20s and older people who have grandchildren and have retired and don't have a status loss at risk from saying uncomfortable things, it's very potent to them in a way that they want to know what to do.

(00:37:42):

So I really think the world is converging on this story. It's somewhat inescapable. I used to think that telling the story better and providing more facts and more math like you've just done is what was missing. And I'm almost now thinking it's more fear that we don't have an answer and cognitive dissonance and denial about this because it's such a huge thing is why more people aren't getting involved in the story.

Thomas Murphy (00:38:15):

Yeah, I think that's hugely important.

Nate Hagens (00:38:17):

But I remember you wrote an essay back in the day about some of your readers on your blog that fit into a certain Myers-Briggs category, that you hypothesized that personality type was more conducive to these sorts of conversations. Why is it that some people gravitate towards the energy, climate, growth limits, thermodynamic, biophysical, ecological reality, and are energized and dedicated to it, and other people look at us like we just grew antlers? Do you have any hypothesis on that?

Thomas Murphy (00:38:54):

Yeah. Well, actually, when you say it like that, it reminds me that on my website, I've got this very old picture of myself, the UCSD website, in which I am actually holding up caribou antlers.

Nate Hagens (00:39:03):

Oh, I didn't know that.

Thomas Murphy (00:39:06):

So it's really fascinating to me that the things that worked for me, the things that got me into this were very quantitative, very physics oriented, and fear worked on me. I thought, "Oh my gosh, this is really worrisome stuff. How do we get out of this?" But for other people, fear is immobilizing and the numbers aren't really there for them. They're not fluent. They're not really quantitatively geared. So what works for me definitely doesn't work for a lot of people. One thing I found is that the people who were attracted to my blog, readers in my blog, so the majority came from two personality types in Myers-Briggs. Now, Myers-Briggs gets a lot of flack for some very obvious-

Nate Hagens (00:39:54):

It's a guide, it's a guide.

Thomas Murphy (00:39:55):

It's a guide and you don't take these things literally, but they can still be useful. And here the useful aspect is that when only 2% or 3% of the population is INTJ, but 45% of the traffic to the site is INTJ, whoa, that's saying there's something there to that metric, right? It's not astrology, it's real stuff. And the next biggest lump comes from the adjacent group of INTP. And those are classic physics type or scientists mentalities. The INTPS tend to be more theorists and INTJs tend to be maybe more experimentalist. It's not hard and fast, but 75% of the traffic were from those two.

Nate Hagens (00:40:35):

That's out of 16 potential combinations.

Thomas Murphy (00:40:40):

Yeah, out of 16. And those already are small. That's like a total of 4% of the population in those two.

Nate Hagens (00:40:45):

So what's the inference of that? What's your takeaway?

Thomas Murphy (00:40:48):

The takeaway is that the most important of those letters, the four letters is the N in INTJ, and T is pretty important too.

Nate Hagens (00:40:57):

I'm ENTP, by the way.

Thomas Murphy (00:40:59):

Okay. I could see that.

Nate Hagens (00:41:02):

But the E is just very mild. I'm like 51% extrovert, 49% introvert, and my extrovert manifests on this podcast, but then I'm going to go for a walk with my dog after this.

Thomas Murphy (00:41:13):

Exactly. Well, as a lecturer, I have to put on the extrovert thing to be an instructor.

Nate Hagens (00:41:19):

Right.

Thomas Murphy (00:41:20):

So you can morph a little bit into these different things, but the N is very important. That's abstracting. The N is the N in intuition.

Nate Hagens (00:41:28):

What's the opposite of N?

Thomas Murphy (00:41:30):

It's S or sensing. So it's how you get your information. Do you get it from direct sensory input? What you can taste, touch, see, feel, hear directly from your own experience, your own life because that stuff is important. Or do you prefer theoretical abstractions where you synthesize ideas and pull your stuff from ideas? And so the ends are idea people, and they are only 27% of the population.

Nate Hagens (00:41:58):

Really?

Thomas Murphy (00:41:59):

And so right away, you've got 73% who are in the S camp and just they look out the window, things seem fine to them. "What are you talking about? You're just rattling."

Nate Hagens (00:42:09):

And that's a real problem because a lot of the interrelated systemic risks that you and I are working on are in the future.

Thomas Murphy (00:42:17):

They are in the future.

Nate Hagens (00:42:18):

We don't see them until they happen.

Thomas Murphy (00:42:21):

That's right. You need abstraction to understand things that haven't happened ever before. And now you can see that there's a lot of adaptive benefit to having mostly S types because usually the world is the same today as it was yesterday. And so if you're a hunter-gatherer group, relying heavily on that experience is much more, I think, relevant than listening to the idiot in your group who's talking about things that have never been seen before in generations. You can understand why that person should be laughed out of the room.

Nate Hagens (00:42:54):

Dude, I think the climate is going to warm in the future because of our behaviors. Okay, that was helpful. Let me get back before I forget because this is something that I learned from you that I didn't understand. So we are burning fossil fuels in our airplanes and our factories and our commerce and our global system, and that is creating a blanket of heat over the earth that many of the models and our daily realities on our sensing of the world, we can see that things are already changing, let alone 50 or a 100 years from now, but that's from the greenhouse gas effect. But you're also saying that our burning of these things is generating waste heat. So how is that waste heat quantified relative to the forcings of the emissions?

Thomas Murphy (00:43:46):

Yeah. So right now, if you put an apples to apples comparison to... The primary thermodynamic input to the earth system is from the sun. And so the sun is intercepted by disc, that's Pi R Squared as the area of the projected earth where r is it's radius, the surface area is 4 Pi R Squared, but what the sun sees is just this flat projection Pi R Squared. And so we compute the sunlight that hits the earth divided by that Pi R Squared is about 1,300 watts per square meter, a little over a kilowatt per square meter.

(00:44:20):

Now, the climate change problem right now, the imbalance that we're facing is at the level of about one watt per square meter. So that's what we're all in a tizzy about, is

that there's this 0.1% modification to that solar input, which is not something you should dismiss. It's a real concern.

Nate Hagens (00:44:39):

And the one watt per square meter is projected under the real grotesque emission scenario RCP 8.5 to 8.5 watts per square meter or around eight times what it is now.

Thomas Murphy (00:44:54):

Yeah. And so today it's at one, and that's already a problem. Now, if you take our 19 terawatts of global industrial power and divide that by this Pi R Squared, you get about 0.1 watts per square meter. So right now, this waste heat, and I want to also clarify that even though some of that energy is being used for what we think of as useful purposes, it all ends up as heat. So all 19 terawatts is heat after we've used it.

Nate Hagens (00:45:23):

Oh, so just some fraction of it is immediately wasted, but the rest of it gives us some dopamine in the interim and then turns into waste.

Thomas Murphy (00:45:32):

And then it's waste heat. So don't go off thinking, "Oh, well, we just make some things more efficient and then we don't have waste heat." No, it's all going to heat.

Nate Hagens (00:45:39):

So if we continue to grow at 2.3% a year, our energy, in a century from now, just the heat from our activities alone, forget about the greenhouse gas effect, just the heat will be the equivalent of what the greenhouse gas effect is today.

Thomas Murphy (00:45:58):

Exactly, because it's 0.1 today. In a 100 years, it's one, and a 100 years after that, it's 10. And absolutely dwarfs our current concern on global warming.

Nate Hagens (00:46:08):

So forget about the energy and material limits to growth. We have heat constraints on the planet to growth, like absolutely urgent ones.

Thomas Murphy (00:46:18):

Yeah. I'm not out there holding signs up saying, "Worry about waste heat," because this is just a way to illustrate that if we wave magic wands and get past some of our current troubles, we would ultimately run into this as a real problem. I don't think we ever get there. I don't think you think we get there either. Growth is going to end and we're going to have all kinds of other problems on our hands before waste heat actually becomes a serious issue.

Nate Hagens (00:46:44):

No, I agree with that, but I'm just trying to create the boundaries of the problem that a lot of other people who think we can just continue... Well, look at the International Energy Agency, British Petroleum, a lot of these international entities think we will continue to grow throughout this century at 2% or 3% a year, but will do it by using renewables for one example. So I don't think that's going to happen, and that's a whole 'nother podcast. But even if that were to happen, you would still have this heat generation issue, which you just brought up.

Thomas Murphy (00:47:20):

Yeah. I use this as a tool to say, "Hey, I don't care what your assumptions are. You can't just keep growing." There are thermodynamic consequences that I don't think are what's going to get us, but they're there and they closed the exit of saying, "Well, we're just going to imagine sailing off into this glorious future." We can't just do whatever we want just because we think we want to.

Nate Hagens (00:47:45):

So broadly speaking, Tom, is human civilization in its infancy or near its end than the beginning? Setting aside the growth, because we can't have a civilization without growth. So are we near the beginning or near the end? What do you think?

Thomas Murphy (00:48:01):

Well, when I think about that question, I think civilization is 10,000 years old. As you said, that's when we started agriculture and started building cities. And so that forces us to think in 10,000 year timeframes. And so the question becomes what can we be doing in 10,000 years from now? And it helps define what I would call success or failure. So success would be an uninterrupted continuation of our civilization so that

we preserve our knowledge and the things that we've... The hard-won truths about science and the universe and life and that we prosper in some form for 10,000 years.

(00:48:37):

So that's success, and when we think on those timescales, almost nothing that we do today can continue. Obviously, the growth is long over because we're talking about just century timescale for that to end or sooner and in practical terms. But even things like mining, you can't tolerate deforestation or resource depletion or anything that's non-renewable just cannot be part of the story, period. Unless it's at a 0.001% per year growth rate or something, it's out. And almost nothing we do today is in that category, which means that almost everything we do today is pointing us toward failure and not success. So success really means sustainability, and we don't even know what sustainability means or what it looks like, but if we're not pursuing that, we're just piling on the failure and making it come sooner.

Nate Hagens (00:49:34):

Well, the Chinese at least have a five-year plan. That's better than we have.

Thomas Murphy (00:49:37):

Yeah, five years. Great.

Nate Hagens (00:49:39):

No, well, the issue is we are not optimizing for sustainability. We're optimizing for the dopamine and experience of the eight billion people alive and aspiring to more right now. And if truth be told, those people, most people don't care about the upcoming bottlenecks. They want to avoid them and they're not even aware of them. So this gets to governance and cultural oversight and values and why I'm doing this podcast.

(00:50:14):

So do you think our species is capable of leaving some of earth's goodies on the shelf, including ecosystems, low entropy resources, other species that right now we're just grabbing because we can, generation after generation under some sort of global cooperation? Is that possible?

Thomas Murphy (00:50:36):

Yeah. That question also is one that makes my head explode a little bit because no, but we don't know what global cooperation is. We're always in global competition. We don't know what it's like to leave things on the shelf within easy reach. I happen to be someone who I get a large chocolate bar and have one square per night and it drives other people crazy that I have the discipline to do that and make it last a month. It's within easy reach and even then, I'm depleting it. Right?

Nate Hagens (00:51:07):

Were you that way when you were a kid or a teenager?

Thomas Murphy (00:51:08):

I'm not sure. I think to some extent that's always been a part of me, but just a moderation instinct and don't do it just because I can. Ask if I should.

Nate Hagens (00:51:19):

Well, you're a rare individual because I teach steep discount rates and I teach transcendence and the agenda of the gene, but the reality is I probably would eat the whole fricking chocolate bar, Tom.

Thomas Murphy (00:51:32):

Well, and I think that's the reality for the human species, and I'm not singling us out. I think most species would behave that way too. We're not exceptional this way and it's just that we have the ability to destroy whole ecosystems and run other species extinct in large numbers. And so-

Nate Hagens (00:51:50):

That's how we're exceptional.

Thomas Murphy (00:51:51):

We are exceptional in that way and that's almost the only way that we're exceptional it turns out, and that's a problem in our mentality of who we think we are, but one of my colleagues who's another astronomer put it in a very nice way that if we really want to preserve a good outcome for the far future, we have to care about the future. And as to the extent that we're a transactional species, "What can you do for us?" There's nothing the future can possibly do for us. It's just physically causally impossible.

And so if we are transactional in nature, then we can't, we can't prioritize the far future.

(00:52:33):

Now, I'd like to believe that that's too pessimistic and that we could adopt a different model. The model that we need is one where humans are not the dominant species, but we're a partner to the rest of nature, a subordinate partner in fact. And we need to learn to treat nature at least as well as we treat ourselves and stop thinking that anything that's good for humans in the short term is something we should do because that is the road that leads to failure.

Nate Hagens (00:53:05):

So all of my guests so far, and probably almost all of them in the future are going to agree with that statement, but still, we're a tiny minority of people. How does this happen where we subordinate ourselves to nature and is it a long term cultural value change? Do we have to start teaching ecology to four-year-olds? What's possible?

Thomas Murphy (00:53:32):

Well, I don't know what's possible. I think that if you tried to do that on the educational front, you're going to get a lot of resistance from the people who don't see the things the way you do and, "Why are you inculcating our kids to care about newts not about human rights?" By the way, all things human can lead to a bad end in the sense that if we prioritize human rights and equity and liberty and all those things, they put us first and that fails. That destroys ecosystems. We have to put the ecosystems first and then see what we can afford after that. And that might sound inverted, but we are a part, to think the opposite is almost insanely inverted to think that we're above somehow the life support machine we live on.

Nate Hagens (00:54:19):

And yet most people, if they were asked that question, probably do believe in human exceptionalism.

Thomas Murphy (00:54:26):

Absolutely.

Nate Hagens (00:54:26):

That somehow we are different. And that on top of that, technology will figure it out. And I don't understand everything that Tom Murphy just said about galactic scale energy, but technology will find a way because it always has.

Thomas Murphy (00:54:40):

Yeah, that's the religion, if you will, and it's got a good basis. We've got a good track record and it looks like that's a really good model for the way the world works. But you step into the astrophysicist mindset and that few 100 years is nothing. That is just a tease and there's nothing to it.

Nate Hagens (00:54:58):

So conceptually, understanding galactic scale energy, understanding that humans are exceptional primarily in their ability to produce waste heat, and destroy ecosystems and become technologically clever in the near term, as an astrophysicist, if you were able to, or any astrophysicist to be benevolent dictator, what would be some of the decisions or directions that you would advise our society to go in?

Thomas Murphy (00:55:33):

I suppose, and it's not something I've really thought deeply about because I'm not in that position, nor will I ever be, but I think we need to appreciate nature. And if I just look at the way I approach the world, I'm still a part of this modern system. I'm living completely unsustainably and it's really hard embedded in this system to do otherwise. I really try to cut down my resource use. I think hard about buying any new thing and is it really something I need? It's not that I can't afford it. I can afford plenty of things, but can the earth afford it? Money is the wrong metric. Money is an amoral system that misses a lot of very important pieces. It doesn't have any real long-term vision. And so when you make decisions based on money, which is 99.9% of the decisions that are made in this world it seems, you're going to have bad decisions. So by discounting the future, you're almost guaranteeing a worthless future.

Nate Hagens (00:56:32):

So you've arrived at your own personal ethos and hygiene of your daily behaviors. I envy you and I'm very happy for you. I wish there were tens of orders of magnitudes more people like that. But applying that to the broader circumstance, do you have any practical things that our society might be able to do in the coming decades that

would be able to prioritize nature and either prepare us to use less energy or allow us to use less energy once we hit a wall on our current model?

Thomas Murphy (00:57:10):

Yeah, and this is something I've definitely thought a lot about because I have made a lot of personal choices in terms of how much energy I use with thermostat setting in my house, travel. Everything is in consideration of that, but when I confront anybody else on similar topics, they say that, "Well, individual choice is just a waste. It's great that you're doing that but unless everybody does it, it doesn't amount to anything." And my response is, yeah, well, then everybody should do it. But why would they do it if they don't understand the mentality? If they haven't seen, if they haven't stared into the abyss, why would they do this? It just seems like punishment.

Nate Hagens (00:57:51):

Well, it's a collective action problem. If no one else is doing it, you are receiving less benefits than you could because everyone else isn't doing it.

Thomas Murphy (00:58:02):

That's right.

Nate Hagens (00:58:02):

However, in your case, you're probably getting more psychic benefits from your behaviors than the actual pecuniary dopamine benefits from eating the whole chocolate bar because you've constructed your life around your ethic.

Thomas Murphy (00:58:16):

Right. And for me, it's personal and it's a personal journey and it's rewarding because it's my personal journey. But if it's imposed from somebody else, "You should do this, you should do that," then it's not fun. But I think about voting as an example of a collective action that your individual vote really, let's face it, it never matters. It's never down to just one vote or almost never down to just one vote, but you still vote because you understand that that's part of your civic duty. I'd like to see a similar mentality that your individual action, take it or leave it, it's not going to make a difference, but it's part of your responsibility to our world, to nature. The fact that we have so much

power and we can do so much damage gives us great responsibility, and we're not using that power responsibly at all.

Nate Hagens (00:59:01):

I do think that, a new religion is too strong of a word, but a new culture, a new tribe, a new meme or way of living around what you just said is just around the edge of our current cultural conversation. You've got organizations like Extinction Rebellion and Fridays for the Future, and some of those things are energy blind, but I do think there is a higher ask for many humans alive today following the logic of this story that they want to play a part of, and they're willing to sacrifice or change their behaviors. It just needs to be organized a little better because I feel a terrible, shame isn't the right word, but you're right. I have my foot in both worlds. I'm part of the energy hungry superorganism, and I'm part of, at least the N part of my Myers-Briggs is conceptualizing the abstractions of what sort of future culture might be in more harmony with our one living blue planet that is slowly experiencing massive metabolic impacts from one species?

Thomas Murphy (01:00:19):

Well, and you asked what we could do to actually get people… Could you educate them? Could you start early at four years old? And I think really, what it's going to take is it needs to become evident to a lot of people. So you need to get the S people and you need to have a crisis, and it needs to be serious enough.

Nate Hagens (01:00:38):

By the time the S people are aware of our planetary limits, it's going to be too late to change anything in a large way. Yes?

Thomas Murphy (01:00:44):

That's why I think we should collapse now and avoid the rush. Really, it's going to be better for us if we get a taste of what can happen early. I don't know how to engineer that, but that would help.

Nate Hagens (01:00:57):

Well, that's a whole 'nother conversation. I don't know that we can have a mini collapse now. We should have collapsed in 2008 and the central banks did everything possible

perfectly to keep the system going. 2020 was another example. Now the Russia, Ukraine, that's another potential risk to the system, but I hear you. So moving into the typical closing questions of my guests, Tom, what kind of advice would you give to young people? And I expect you do give advice to young people because you're a college professor. What advice would you give to young humans who today discover and understand that they're alive during the time of the energy economic limits and that risk to nature, climate change, and the general human predicament? What advice do you give to the people that are figuring this all out and come into terms with it?

Thomas Murphy (01:01:53):

Well, I think it's three-pronged, and you're right, I do talk to a lot of young people. And so one is to be an early adopter, not in technology. We're used to thinking of being early adopters of technology, but an early adopter of dropping the technology dream, dropping that false sense of salvation through just more of the same. It's not helping us. And this leads to part two, which is keep your wits about you. If the dream collapses around us, the people who have already given it up will be in much better shape psychologically, and everybody else will be out of their heads. And you're going to be able to say, "Yeah, of course, this is what's happening and I understand the way the currents are flowing and I can position myself to be resilient in the face of this."

(01:02:43):

And then the third is along those lines as well, is to develop a plan for your future that is somewhat resilient to various outcomes. None of us can predict what's going to happen, and I could be completely wrong in my worries or the timescale. And so pick something that will be valuable no matter which way things go. So don't pick a career that only makes sense if the world continues as it does. Pick some basic skill that will still be useful today, but also useful in a much changed world.

Nate Hagens (01:03:17):

I use different words, but those three things you just said are exactly what I tell my students as well. What do you care most about in the world, Tom?

Thomas Murphy (01:03:26):

Newts.

Nate Hagens (01:03:27):

Seriously?

Thomas Murphy (01:03:28):

Half jokingly. I'm in an area that has a lot of newts around Washington state.

Nate Hagens (01:03:32):

You're in Western Washington, yes?

Thomas Murphy (01:03:35):

That's right. And just splitting time right now, but there are newts around and they're absolutely adorable and fantastic. And my wife thought I was crazy when I first talked to her about it, but she has fallen in love too because they're just amazing little creatures. And I don't spend all night and day thinking about newts, but when I see them, it gives me great pleasure and other wildlife. And so that's just a placeholder. When I say newts, I really just mean biodiversity. I mean life. I mean that this planet as an astrophysicist, I can appreciate how rare this planet is, and we've got this thin shell.

(01:04:11):

If you took all the biomass on earth and collapsed it into a uniform shell around the earth, it's four millimeters thick of wet mass. That is really thin and it's really precious and it's diverse. The fact that life could spring up and this self-replicating organism and all its variety, I just think the universe is amazing, physics is amazing, the wildlife is amazing, and notice I'm not saying humans in that. Human is one of those life forms and that is amazing, and I could admire some of our skills and our intelligence, but let's not put that above into the exclusion of all those other things. So that's what I care most about is the non-human world.

Nate Hagens (01:04:53):

Well, I now better understand why we get along so well. I totally agree. So of all the things we talked about or didn't, what are you most worried about in the coming decade or so?

Thomas Murphy (01:05:05):

At some level, I've gone through all the stages of grief, and at this level of almost just being a spectator, I'm not really worried about how things are going to go because at some level, I can't control whether there's going to be a nuclear war or anything like that. So I don't bother myself with that. I guess I worry most about inattention, that the denial that we tend to exercise, that we think that things can't really go bad, can't really go wrong, that is our biggest danger.

Nate Hagens (01:05:34):

That we just say shrug and say meh?

Thomas Murphy (01:05:38):

Right. And so if we took these ideas seriously and started gearing our lives around a different approach that didn't depend on growth, didn't depend on exploitation and non-renewable resources, at some level, as I said, the sooner we collapse, the better because we're going to have more available to pull ourselves out of it. The more successful, as you say in 2008, we're extremely successful and incentivized to avoid collapse, and if we continue being that successful, it's going to be the most devastating possible outcome. So I think I worry about that most, that we're not going to get the message until it's far too late to recover gracefully.

Nate Hagens (01:06:17):

In contrast, what are you most hopeful about in the coming decade or so?

Thomas Murphy (01:06:21):

I think it's almost the flip side of that, that I'm hopeful that we can have enough shakeups and that say, the younger people will get that this is not normal, that this life that we live is not normal, it's a blip, it was the wrong path. And so just a waking up to breaking the spell, that's what I'm hopeful can happen. Now, the young people, I deal with a number of young people in classes and so forth, they tend to get that growth can't continue. So they're on board with that, but they direct their energies elsewhere. It's the billionaire's problem, not their own habits. It's not their own place. It's not their own demands that they place in the system. And so that's still a barrier.

(01:07:10):

But long-term hope, yes, for a decade, but if I think longer term, the plasticity of humans is rather amazing as adaptable as we are. So somebody who's born in say, a post collapse situation will just see that world as normal, absolutely normal, couldn't imagine a different scenario. And so that human will probably do fairly well for themselves. And if nature is forcing that existence to be more sustainable, then that's not a bad outcome.

Nate Hagens (01:07:38):

I happen to agree with that. Thank you so much, Tom, for your time and your continued work on these issues. Do you have any other words of wisdom, advice, or closing thoughts for our listeners?

Thomas Murphy (01:07:50):

Yeah, thanks. I think I said before that we need to learn to treat nature at least as well as we treat ourselves, that we need to learn to be a part of nature. I like the phrase that we're not apart as a single word from nature, and let's not ruin it all. We could ruin the whole thing for all of us, not just other species but ourselves. So we need to step out of this weird anomaly that we're in and understand that we're in some sense, a victim of bad timing, that we were born during this period when we're at the apex of just a phenomenal fireworks show and fireworks shows end, but we have a hard time seeing that. I would encourage people to step back and realize that what we've been doing for a few generations is very temporary.

Nate Hagens (01:08:39):

I agree with that. Well, thank you so much, Tom. I expect I will have you back again and to be continued, my friend. Thank you.

Thomas Murphy (01:08:46):

Great, thank you.

Nate Hagens (01:08:47):

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