Dr. Pippa Malmgren: Knowledge Doubling Curve and its Consequences and Implications

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Erik: Joining me now as MacroVoices' final interview guest for this decade is Dr. Pippa Malmgren.

Pippa, you have been just on the leading edge of so many things. I think it was two, maybe three, years ago you first started talking about quantum computing. And nobody knew what the hell you were talking about. And of course today it's one of the hottest stories going. You were really on the leading edge of that.

Now, recently you've been paying attention to something called the knowledge-doubling curve. What does that mean?

Pippa: So there is a guy called Buckminster Fuller. He's the one who invented the geodesic dome.

He was a remarkable scientist who estimated that by the year 1900, the information, the knowledge of the human race was increasing at a rate of about twice every 250 years. In other words, every 250 years you would double the knowledge of the human race.

But by 1900, it was doubling every century. In other words, much faster.

By 1945, he said it was doubling every 25 years.

And by 1982, doubling every 12 to 13 months.

And then IBM did an estimate that by 2020, which is what we're right on the brink of, human knowledge would be doubling every 12 hours.

Now, just everybody for a moment think about how are you going to comprehend the world that you're trying to invest your hard-earned money into if the knowledge base of all humanity is doubling every 12 hours. What can you know?

You know, it's kind of that Donald Rumsfeld the "unknown unknowns."

You think you know because you've studied. You've practiced your field or your profession, your area of expertise. So you feel confident that you know something about, I don't know, call

it the shipping industry.

And yet, if this is what's going on, if we are having a knowledge doubling curve that by 2020 is doubling our knowledge of everything every 12 hours, you can't possibly keep up with that. So it raises, to my mind, a lot of questions about what are the handrails we currently hold on to that might not be sound anymore?

I like shipping as an example because over 90% of the world's commerce travels by ship and therefore we think it's a really good proxy for understanding flows in the world economy. You know, what's happening to GDP if the Baltic shipping index falls? We think that's a pretty good indicator that a slowdown is coming, for example.

But in recent years, it's become disconnected and the shipping numbers are not correlating with the outcomes in the way everybody expected.

And I think it's because – as a person who is in the world of manufacturing myself and 3D printing and laser sintering technology, I can send the designs and have them made anywhere in the world without putting anything on a ship. And does that mean that no business is occurring? No. It may mean that much more business is occurring than ever before and none of it is showing up in the shipping numbers.

So this is just one example of what kind of mental constructs have we created that we think are real? But if you're honest with yourself, if we're doubling our knowledge every 12 hours, they just don't hold true anymore.

I know everybody on this show, they're active investors. They're at the cutting edge of what's happening to price movements.

But I do think there is a danger at this juncture in history – if we don't step back for a minute and think about these dramatic changes on the landscape and instead we're all caught up in individual price movements because we're comfortable there, but in fact the landscape that it's based on is so profoundly changing – that we then get blindsided by what's coming.

Erik: Well, needless to say, Pippa, it's a staggering statistic that human knowledge is doubling every 12 hours. But let's talk a little bit more about what that means.

How is it doubling? Because we're not getting a new theory of relativity every 12 hours.

Now, I would imagine that a really big chunk of this must be the collection and monetization of personal data, a subject that you've talked about quite a bit in the past.

I was just reading an article the other day about how there are now these maps, these public websites that know every Wi-Fi network. You set up a little Wi-Fi network in your house, somebody is tracking you.

They know how many devices are in your house talking to your Wi-Fi network because there collectively are these apps running around on smart phones that are listening in and paying attention to who's got what number of devices connected to their network. It's really scary how much personal data is collected.

Another aspect of this, something I've seen in my work, is a few years ago the analysis, what people call big data in finance, was all about market data. What did the S&P trade at yesterday? What was the high print and so forth?

Now we've got entire companies being launched, like Refinitiv, that are expanding the base of this data that finance people process with their Python programs.

And it's got all kinds of data sets that's things like the voting habits of people in South Dakota, you name it. The data is being collected and saved and processed by somebody. And it seems like there are a lot of consequences and implications to what kind of data is growing.

So what are some other examples? What does this doubling of human knowledge consist of every 12 hours?

Pippa: Well, I think it's so interesting when you opened and you said we're not getting a new theory of relativity every 12 hours. And, actually, I have to tell you we are.

We are genuinely – what is happening in physics today is that we're getting completely new theories that are breaking apart our understanding of Einstein's theory of relativity as being simply not accurate any longer.

I mean, there is a fascinating new laser system. It's called LIGO. And it's focused on gravitational waves. I've been a little deep in this subject just because I find it interesting.

And what you find is that we're in a moment of history where the physicists are all having this fascinating discussion about all the new possibly theories of relativity to replace the old one that we now know doesn't work because our capacity to gather the data from the far reaches of the universe and at the nanotechnology level is so advanced.

Because of what? Because of this doubling of knowledge. It's the input of the data flow and the speed at which you can run the algorithms over it and therefore arrive at a discovery process. This is exactly what I mean.

And if it's happening to the theory of how does the universe work, you can imagine it's happening to every single other thing.

Now you talked about the internet of things, devices, and the general subject of surveillance capitalism, which is the business of gathering all kinds of data about every person, every place,

every thing, every (literally) motion and emotion.

And I think people are only just beginning to comprehend how much information about themselves is not only gathered but already present on the internet. And sold. And used by the companies that are trying to sell us stuff or even hire us.

Hiring decisions are increasingly made on the basis of your digital twin, not on the basis of the interview with you. And, in fact, you're not even getting an interview anymore because your digital twin has already disqualified you from the interview process.

So these have genuine implications, not only for our personal lives but, again, how do you invest in a world that's so driven by these algorithmic practices, by this business of data processing?

And I would argue that the answer is we have to be much more focused on patterns than on data points. And we have to get much better at not looking back in history for past data, thinking that it will tell us something about the future, and instead get much better at how to look at the future without the benefit of the data point.

But with other skills that humans have that we don't emphasize much. Like – it sounds awkward to say in a modern world economy – things like your instinct actually have meaning and value in this environment.

There was a great author writing in the 1960s called Marshall McLuhan who wrote "The Message is the Medium." And he always said the artists are the greatest radar of society. Artists always give you a heads up on what is coming.

I remember, just before we saw the yellow vests movement in France – the protests and the riots with French people putting on a yellow vest to symbolize that they were just a common person – the French fashion houses were showing riot wear.

Literally, the fashion that was being displayed (it was a few seasons ago), all of a sudden it was like flak jackets, camouflage, as if someone was in something like what happened in Hong Kong.

And I remember at the time going, oh, watch this space. The fashion designers feel conflict coming and they are designing clothes to reflect that. And, sure enough, three years later we see this live in the streets of Hong Kong.

So I'm really interested in what are artists telling us.

Now, most people in financial markets they're like, I have no time for art. Don't be ridiculous. I'm trying to be a serious investor here.

Now I'm telling you, to be a serious investor, you need to spend more time looking are art,

because if knowledge is doubling every 12 hours you can't read enough to keep up. But art is a way of conveying a huge amount of information about reality without needing words to convey it.

In other words, it's like a compressed symbol system. And what we wear is symbolic of zeitgeist.

I think people in financial markets are not typically very good at processing information in a non-numerical, non-linear, non-reading kind of way. But in this new 2020 going forward world with the doubling of information every 12 hours, you have to learn this new language and vocabulary.

Erik: Let's come back to that knowledge-doubling curve, because something I've always known you to be really good at, Pippa, is translating these high-level abstract concepts into actionable ideas that directly relate to financial markets and the economy.

So, when we talk about this idea of knowledge doubling, one thing you alluded to is, okay, all of a sudden the DOW transports index doesn't have the meaning it used to have because things don't need to be shipped in order to be used by someone else. You can send information over the internet and 3D print the part without shipping anything.

What are some of the other consequences? And particularly the things that investors should be thinking about in terms of how to understand what this means?

Pippa: Well the first thing is the most – it's like a foundation stone of finance, which is monetary policy. And I still struggle with what the heck is monetary policy if you have digital currencies and if they're sovereign crypto? Which is what the Chinese have announced, the EU has announced, the British are looking at that.

And fundamentally, look, we've already gone from paper money to electronic money. And everybody knows that. You don't pay for very many things with cash anymore.

But digital money, that's a different thing. It's not just that it's electronic. It's that it's no longer connected to volume, because you can create units of digital money with a keystroke.

So then what the heck is happening to the monetary supply when you can halve or double the amount of money in the system with a keystroke? Add to that your internet of things comment about the data that they take about every household.

If I think back to when I was in the White House, and we did this $300 tax break for every family in America at the time, and we send that. Now how do we send that? Well, at the time, the US government sends you, basically, a check in the mail.

Today, if I were working for a government which had the most sophisticated data systems –

which none of them do, but they will – if I could do it today with today's technology, I could identify specific households.

I could say I want to give a tax break only to households that earn between this much and that much, that only have two children, or have children but they are a particular kind of kid, let's say a certain disability or a certain gift that the child has.

And I only want to reward houses that are on my team philosophically, not on the other guy's team. So pick one side of the aisle, as it were.

In other words, the specificity and granularity with which you can target and then deliver that tax break directly into somebody's bank account, like right now this minute, and that ability to create a reward system that's so immediate and so at the will of politicians.

This is my question: What kinds of controls will we put in place on government policy makers? Because I think this is like Nirvana if you're a politician. You mean I can print money any time I want? Answer: Yes, actually.

And, look, we just recently had Alan Greenspan come out and say inflation is coming. And why? Because we've just added so much money into the system. Look at the deficit spending. Look at the federal budget in the United States (but, frankly, everywhere else in the world as well). Look at the amount of defense spending that's going on, which is kind of quantitative easing through the back door.

If you really add it all up and now we overlay that with the capacity to double the money supply whenever you feel like it, clearly inflation becomes a bigger issue that we need to think about.

And yet, and yet, if knowledge is doubling every 12 hours, the compression on prices by innovation – the technology prevents prices from rising too much because it's constantly innovating – puts us in a very interesting narrow space where you maybe get more volatility and a lower amplitude than in the past.

You don't repeat the great inflations of the past where you've got 10,000% inflation. This might be a world where we get 2% or 5% inflation, but it's a more violent more volatile path from 2 to 5 than if it were a wider band.

I think maybe these are some of the things to think about.

Erik: Pippa, when we talked a little bit off the air about this knowledge-doubling curve, you mentioned a concept called ephemeralization. What does that mean? And what are its consequences and implications?

Pippa: This is this wonderful idea of Buckminster Fuller of doing more and more with less and less until eventually you can do everything with nothing.

And we've seen this in lots of ways. His original example was Henry Ford's assembly line where you could keep making products at a lower cost with no upper bound on the productivity. And what he was doing was just extrapolating that into the whole of the human development experience.

So, as an example, AirBnB. It's been a great story and everybody's taken advantage of it and saved money using it.

But imagine that brought to businesses. Not going on vacation or a business trip, but an actual business. Like a popup restaurant where now you'll be able to, instead of having to commit to one location for your restaurant and you have to sign a lease for a year, you could actually use an AirBnB type structure to say I want to be in Paris in this location for two days. Then I want to be in Tokyo in this location for three days.

And you create an ecosystem of businesses that only want a temporary position. And that gives them the opportunity to test out their idea. They get to see if there is a real audience. They learn a lot from that process but without having to have the massive overheads.

Now, I don't know anyone who's created that yet. But I can tell you that's coming. It's bound to happen. And that's an example of this ephemeralization that, instead of being constrained by resources, you actually have ubiquity as the outcome. And this is a very new way of thinking.

All of modern economics is based on the assumption that everything is driven by scarcity. The supply-demand curve is driven by volume. How much of it is there?

Well, now if it doesn't matter because you can have as much as you want whenever you want, including money being digital, you can just create it out of nothing, then what does that do to the value of assets, to the way we invest capital and expect a return on it?

So I think right now – this is the time of year when everybody's going, well, what do you think is going to happen in the new year? Should I be long short? Should I be this that? Which sectors?

I think this concept, ephemeralization, that's what we should think about.

And how are we going to make money in an environment where everything is becoming more ephemeral, less tangible, less easy to comprehend and to price.

And, by the way, Bucky Fuller, when he was writing about this, he talked about moving into – and this is a big leap in my thought process – but he talked about being able to perceive things that the human body can't normally perceive. That as you get more information and things become more ephemeral, you have to become more alert. And that means being aware of things that you can't visually process.

Like X-rays for example. We are all more aware of X-rays.

Everybody knows that now if you take a lot of long distance flights, especially over the North Pole, you're getting X-ray damage. I travel all over the world all the time. Everybody knows that there are health issues. When you go through one of these scanners at the airport, there are things happening. We are aware of them in a way that we weren't aware of them in the past. And even though we can't perceive an X-ray, we now know it's there.

We can't perceive, for example, the huge debate about 5G. The question is: What does it do to your health to have these waves passing through a human that have different characteristics than the kinds of data-transferring waves we've had in the past? And there is a big debate about this.

So this is the thing: becoming aware of things that you can't perceive directly but nonetheless there is content and meaning.

And I'll finish by saying I think one of the things we all need to learn is how to gather information without reading. And that means becoming more adept at using symbols.

Which everybody is already doing in the form of emoticons, which are really just a compression of information into a very narrow, highly efficient point. Because if you try to write out what an emoticon means, especially if you pick an obscure one, you'll find it will take you a whole paragraph. And, even still, you haven't quite described exactly what that one little picture conveys.

And also receiving information that's more haptic, for example.

This is the last on this subject, but an investable idea:

Everybody knows sports are huge. But e-sports are now much bigger than regular live human sports. And most people who are over the age of 30 don't even know what that means. They're like, Pippa, what the heck is e-sports?

And the answer is: This is when literally billions of people around the world get online to watch someone who is actually competing in an electronic sport over a computer console. This has become so huge that the sponsorships are bigger than they are for the NFL or the baseball league or any other human sport.

Now, in that world, haptics are coming, which means the ability to put on a jacket or a vest and you don't just get to watch the play. You get to feel what those players are feeling as they, say, smash into each other.

And you can set it. You can say I want to feel one-tenth of what they're feeling because I don't want to really take the full hit here.

Or you could be with your friends and getting a little drunk and say, oh, let's see if we can handle it. I imagine a few people are going to end up in the hospital this way.

But what I'm describing is a world where haptic information has a value. And I am scouring the net and seeing every day more and more examples of technologies that deliver the data either through some kind of symbol or some kind of knowledge transfer that is not reading.

It's virtual reality. It's augmented reality. It's imagery. It's photogrammetry. It's visual or haptic or auditory. But what it's not is reading. It's not in a report that's written by words.

And I would ask this audience: How much of your information about the world we live in comes from words that are presented in a linear fashion on a page, whether on the screen or on paper? And I would venture that most people still are getting most of their information that way. Which means they are already behind.

Erik: Pippa, you called it. I'm not only over 30 but over 30 by a larger margin than I care to admit on the air.

So, if I understood you correctly just a minute ago – because you really caught my attention – playing computer games, something I discovered at the age of 12, back when it all happened on one little computer. In the '90s, that evolved to where you were playing computer games against other players over the internet.

If I heard you correctly, you're saying that has now evolved into a spectator sport which is bigger than the NFL as measured in dollars and cents spent on advertising.

Did I hear that right, first of all? And, if so, okay, who is spending all these dollars? Who is making money from this? Is it a public company? What is the ticker symbol?

Pippa: Exactly. You didn't mishear me. And this is correct.

They say that e-sports by 2020 (meaning now) is already a $1.5 billion industry, insofar as they can track it. The competitors are competing for prizes in any single sport for as much as US $24 million. So you can imagine the prize pools already are bigger than most real live sports.

And the advertising sponsorship has gone insane.

People are loving reaching young audiences that are truly global in nature by sponsoring visually. Because, remember, now we don't have to actually produce anything. You don't need a poster or even to broadcast on some physical electronic poster. No, now you're just in internet land. So you can put your Coca-Cola bottle wherever you want in that space.

So there are lots of different ways to get involved in that space. I'm studying it myself to really

understand it.

In London, where I live, there is this thing called the Gfinity Arena that holds tournaments of various kinds. And people go to physical places to watch this. So, like, in Beijing the National Stadium gets used a lot.

So imagine all these people go to a stadium to watch on VR goggles something that's not in the stadium. In other words, they're all going to watch nothing except what they can see online. And they could have stayed at home to do that.

But it's somehow more exciting to physically get together with all these other gamers, which means you get actual popcorn sales as well.

It's crazy getting your head around it.

There are platforms like Twitch which is where you can stream yourself playing video games and attract followers. And this is how this e-sports world got started.

And there's recently been the allegation by the United States that some of the platforms, like the Chinese platform called Fortnite, are actually not really about delivering cool sports to the audience. That's just the excuse and really what they're doing is gathering an immense amount of data about the users.

Including, by the way, your eye movements inside the goggles, which tell you a huge amount about your emotional state of mind, your propensity to respond to things in a particular way. And that's incredibly useful for selling you stuff.

So I don't know. I think it's a super-interesting, fast-growing, high-volume, big-value space. And if I were a professional investor, I would not want to miss what is happening here.

Erik: Pippa, I want to shift gears now and go back to something else you said that caught my attention, which is the world that we live in where these unelected central bank policy makers can literally conjure trillions of dollars out of thin air.

Ray Dalio has so eloquently described the market environment that we've been in for the last decade as saying, basically, what's going on central banks are buying bonds on the open market. That puts money into the hands of institutional investors who turn around and use that money to buy other investments, most notably the stock market. And that's the reason we've had the biggest bull market in recorded history over the last decade.

What Ray Dalio has predicted is that that era of central bank dominance over financial markets ultimately is unsustainable and has to come to an end. And the big question mark is, okay, so what is the catalyst that brings it to an end?

And it seems to me – and I'm so excited to ask you about this because it's so up your alley – it seems to me this is entirely about social mood and a change of public perception.

My prediction is what's going to change all of this will be the politicization of monetary policy where some politicians start to say, look, central bankers have proven over the last decade that you can conjure money out of thin air, trillions of dollars at a time.

And there were a lot of critics in the beginning that said it would lead to runaway inflation. And it didn't. You can do this. It's possible to create this money and use it for something. And all they've used it for is to give it to rich people.

We need to turn the tables and we need to create, essentially, helicopter money, QE for the people. We need to fund universal basic income, free college tuition, forgiveness of tuition loans, and probably a large number of other social programs by changing the game so that quantitative easing continues but is no longer used to buy bonds on the open market the way it's been used in the past.

First question is: Would you agree with me that this is the kind of catalyst that potentially could change the entire game for financial markets?

And, if so – you're the expert on social moods and feedback loops and so forth – what would it take to bring these kinds of things about. And how do you see this playing out?

Pippa: I entirely agree with this. And I think we really need to understand this new digital money will not exist in a vacuum. It will be immediately tied to individual people, individual addresses, individual GPS locations.

So, again, I come back to when I was in the White House and we wanted to give money back to the public. Today, my ability to know –

For example, if I were a policy maker, I could say I would like to reward all, say, Americans who run three times a week because I really think that this is the way that we're going to diminish the health-care cost burden. And so I want to incentivize people to look after their physical health.

And therefore this tax cut or this financial allocation from the government, whatever you want to call it, this will only go to people whose Fitbits or sports wearables are showing that they run three times a week.

This is now totally within our reach.

And if we add, by the way, blockchain to this picture, which inevitably is what's going to happen – blockchain technology is a little bit slow and unwieldy, but over time you'll be able to geolocate every person and all the motions and movements that they make in a particular place

at a particular time. So, even if you're not wearing a Fitbit, the fact that you're running and your phone is in your pocket revealing that you're running, starts to get counted.

So the question is: What the heck does this do to the structure of society when politicians can allocate those rewards and those penalties not just so freely (which is your point) that they can just (as you say) conjure forth money out of absolutely nothing and have no consequences? So of course they're going to love that.

But I'm saying take it to another level. Allocate it on the basis of your thoughts, your behaviors, your level of compliance or adherence to their particular political persuasion. That's what is really going to be happening. And I just think this part we haven't even begun to think about.

Because imagine – again, if I'm a politician, now I know I can double the money supply with one keystroke and have no inflationary consequences, or not enough for anybody to complain about. And I can target that money to go to everyone who I perceive to be a swing voter to pull them into my camp.

That is what we're talking about. That's a level of power and omnipresence in the economic life of the voter that we have never seen before.

Erik: You know, as you were talking it occurred to me that another potential ramification of all this is if you look at what's gone on with privacy. We've got certain protections; not a lot frankly. The constitution certainly still allows some things and after Edward Snowden's disclosures there was a little bit of a clamp down.

Well, what if they changed the game and said, look, we can't force you to give us all of your personal data. Some of that is still protected by the constitution and we can't force you to give it over to us. We're not going to make you do it.

But if you've got nothing to hide you've got nothing to lose. So what you really ought to do is voluntarily opt in to total surveillance and qualify for a tax break by doing so.

There's nothing illegal about that.

Pippa: This is interesting. And you're right. This is one possibility is you opt in to everything and you allow your digital twin to fully reveal everything about yourself because you have nothing to hide.

But my concern is that actually, in a sense, you may have something to hide. Let me describe.

It's a simple example. But, now that Google and MasterCard have a deal – so everything I buy on my Mastercard, Google gets to see what that was. And so if I'm buying Ben & Jerry's ice cream at midnight on a Thursday night on Uber Eats and it's clear that I'm sitting in my living room and maybe Googling at the same time, I don't know, Weight Watchers and thinking I

really need to get on the running machine, all of that is now visible.

And, at the same time, let's say your partner is in Las Vegas and they're buying, I don't know – as a really compelling example to get people to pay attention, they're buying lingerie for somebody in a size 4.

Now, suddenly, the algorithms can see that there is a mismatch there. And they will pick up and they will literally alert the bank that a divorce is becoming much more likely in this household and start cutting the credit limit of the lower-earning partner who then goes to apply for a job because the divorce is real.

And no one will interview – and it's usually her; it's usually not him – no one will interview her because all this same data is available and basically it shows that you're not emotionally stable.

So you say, I have nothing to hide. But the question is: How much are the algorithms presuming about what is "normal" behavior? And how much latitude is there?

And one of the things that scares the devil out of me is that we are blindly marching into a world where you have almost a kind of – we talk about genetic engineering, the people in the future – well this is social engineering, where you create a system that rewards people who are highly athletic and running three times a week but doesn't give any credit to somebody who writes poetry, because it's not valued by the system in the same way.

And this is a point that Yuval Harari makes in his book *Sapiens*. And it's a very compelling point. He basically says, look, who's got the money right now to develop all these algorithms and data-gathering structures and companies? That's Silicon Valley and it's the military.

And what are they going to focus on? What's the ideal human from their point of view?

Well, that's a person who is very physically strong in the military, highly efficient, very rational, responds to order without questions, this type of thing. Is that where we want our society to go?

Or if we look in the other direction, Silicon Valley rewards people who might have a particular political outlook or, again, a particular approach to health and well-being that maybe isn't shared by large parts of the population.

So it's got a social engineering quality to it which I think will have enormous implications for individuals and for society at large that we're just not thinking about.

And, again, as an investor this is important. Because if you don't understand this piece, I don't know how you can make money. Because you won't be able to tell which businesses are going to do well and which are going to do poorly if you can't understand that this is the construct that we're operating in.

Erik: Pippa, something else that you said a few minutes ago is in the future people will get more information, not by reading, but through other means of communication. And it made me think about another conversation we had in another interview a while back.

We talked about not VR, virtual reality, but something else called AR, augmented reality. I know you've been following that and probably other trends.

So I'll broaden it to generally, if it's not reading, how is it that people will receive information? How is the world going to change in terms of how we all process information?

Pippa: One of the things in my robotics business, where I'm making aerial drones and autonomous vehicles that gather data, we've started working with a company called Epson that provide augmented reality glasses. And they are so interesting.

You can have your regular glasses on and these will go over them. Or you can just wear them straight. And if you're on a construction site, let's say, you can now be standing in the construction site, you can see that construction site crystal clear because it's right in front of you.

But you can also see the data overlay. You can see all the measurements of all the piping. What is the material that it's made of? What's the volume of fluid that's passing through pipes already in that building? What are the stresses and tensions on the building that are already beginning to cause cracks in the infrastructure?

In other words, it's this – what I've talked about is the fourth dimension. You know, 3D is one thing. To see your asset in 3D is one thing. But I'm talking about where you extract the data and now you can look at that asset strictly through the data lens. And that's like a different universe.

You know, Einstein talked about the fourth dimension as being time. Well, this is what I'm saying. You now have the capacity to break the linear arrow of time because you can go back to a moment in the past and look at that same building and see exactly where those micro-fractures were happening that led to a beam collapsing, let's say. You don't have to guess when did this start. You'll be able to see exactly when it started.

And, similarly, you can jump into the future because you can probabilistically begin to predict when is the fracture likely to result in the shearing of a beam. And in this way get in front of accidents and prevent them before they happen.

But the fourth dimension is also where –the Victorians used to think of it as where ghosts and spirits resided. And, in a sense, this is what we're seeing is the fourth dimension data is the digital spirit of the person or the place or the thing or the building. And so all of that information is being gathered visually through images, not through reading a report about the

building.

And what I envisage is people will sit in the boardroom at headquarters in New York and they will literally pick up – instead of picking up a board report that's written on A4 paper and printed, they will pick up these glasses and they will look at their assets all over the world through glasses.

And all the data will be accessible to them on their mobile phone where they can bring up a deeper dive into that site and everybody will start to confer without ever having looked at a report that contains words.

That's what I mean.

Erik: And I just want to encourage our listeners who may not be familiar with this, because it's very hard to conceptualize without being able to see it, go to YouTube and type in "augmented reality" and take a look at some of the demo videos that they have on technology that's already available and shipping today. Because it is either amazingly impressive or amazingly scary, depending on your perspective.

And just to sort of describe what this is like, if you imagine some of those – like the *Terminator* movies where the terminator, who is supposed to be a robot, is looking at a human being and they see these data blocks coming up next to them. This is who this person is, their date of birth, their current heart rate, their whatever.

That's real now. That technology exists.

So if I go to a meeting with you to negotiate with you, I look at you. And coming up next to your head is a little data block that says this guy's last 12 deals, this is how many points of negotiation he made before he caved to the deal. It's looking at your facial expressions, running them through an artificial intelligence engine and figuring out when you're lying, when you're at the truth.

When you tell me, look, this is the bottom line, this is as far as I can go, I know whether you're telling the truth or not because I've got a huge amount of computing horsepower that is analyzing your facial expressions.

And I might be doing this wearing some covert kind of device that you're not even aware of that I can see through. Who knows? Right now it's eyeglasses, but it could be contact lenses in the future. It's scary stuff.

What are some of the other consequences, good and bad, of what this technology could mean for society?

Pippa: Yes, one of the things I've been following is how the Chinese are using it with their

social credit system. And one aspect of it that I've found particularly intriguing and potentially worrying is linking all of this data that's required as a citizen – and now they're saying you have to have facial recognition to access the internet in China, so you really can't get online unless you properly identify who you are.

Linking all that data to dating apps. So, literally ,when someone is going to do internet dating, which is how most people do this these days, they can see – Do you pay your bills on time? How do you behave in relationships? What was the length of your last relationship? What kind of divorce did you have? Here are the publically available papers about your divorce.

Literally, this is where we're going that the depth of information about – again, how many times did this person order Uber Eats baked Alaska ice cream after the divorce and how did that trail off in the following few years?

This stuff is already accessible. And all that's going to happen in the coming decade is it's going to become easier for regular folks like you and me to access that kind of information about each other.

And so, again, I come back to: How do you invest in a world if you don't really understand this piece of the puzzle? Because this is where the profits are going to be made. This is where the juice is extracted and comprehended.

But it's also where your personal life is going to be driven by these things. The hiring, the firing, the marriages, the dating, the interfacing with any kind of organization. Where you're now carrying your medical records with you everywhere, which in many ways is a massive advance that's going to save lives.

But it's also a world where your medical records are more visible to – it's hard to keep them as contained and private as they have been.

So what do we do with the folks in society who do have real medical problems? Who can't keep a relationship going? Does make them not worthy of spending time with? What kind of judgment calls have we made?

And that's one thing that just worries me.

I know I've quoted this on your show before, but I love that line from Frank Zappa, the rock star who said progress comes from deviating from the norm. And if we're going to create a society where we're really asking everybody to comply with whatever rules of the road that we think are appropriate, the fact is compliance is antithetical to innovation and progress and disruption and creation, the act of creation.

So, for these reason, yes, you're quite right to point out the person you're talking to can read you now in a way that they never did before.

By the way, facial recognition technology is already being used in regular retail high-street shops. Not just to recognize who is a thief and who has a record of stealing from shops and then they get an alert saying that you're in the shop and you usually get surrounded by bodyguards who make it uncomfortable for you stay.

But, in addition, they can pull up your whole purchasing history. What did you buy in here when you came last? And that way, the person comes up to you and says, we have some amazing new scarves. And you're like, well, actually, last time I was here I bought a scarf. Funny that.

It completely changes the relationship between companies and customers, and between states and citizens.

Erik: Pippa, a final subject I've been dying to ask you about, because I know you have been very closely following the way that different generations are evolving and the way that they think very differently about society and about the future. And I know you've been very, very optimistic about the way that younger generations are going to maybe solve problems that our generation didn't know how to solve, by taking new approaches.

Something I've noticed, though, just in the last six months, this phrase "OK Boomer" has come into vogue with young people. And basically what I see it as – and I think it's justified in many respects – is Generation Z is waking up to the fact that their parents' and grandparents' generation was not particularly responsible with not funding all of these entitlement programs.

So, all of a sudden, the fact that we've got baby boomers retiring and there's not enough money to pay for their retirement, that's something that baby boomers have been following that trend and the fact that social security is underfunded and so forth for many years.

But what we're seeing now is teenagers, people in their early 20s, are looking at this and saying, wait a minute, these people voted for all these benefits where they get money that I have to pay for and they didn't do any saving during their working years to pay for it. It all has to come out of my working years. I don't think so.

Where is this headed? Are we headed potentially for – you know, I think back to the late 1960s, the generational divide in society where people under 30 and people over 30 didn't get along with each other that well. Are we headed toward another version of that or maybe for different reasons another generation gap in society?

Pippa: Yes, and I think these generation gaps are, again, hugely important for investors to understand because you can make a lot of money once you comprehend them.

So one aspect of this is – I'm a boomer and so I get that "OK Boomer" means you guys are just so clueless that I just can't explain this to you. Like, even if I tried to explain it, you won't get it. So I understand.

And part of that is because the younger generation, who have had smart devices in their pocket since they were tiny, they are literally able to access more computational power than we needed to put a man on the moon in the '60s. Because that's what's in an iPhone today. More computational power than we had to put a human on the moon.

So the old notion a boomer has, that knowledge and wisdom are a function of age, it no longer applies.

Again, back to the doubling of the knowledge curve, who is at the front end of that doubling process? That's younger people because they're more adept at extracting that information, finding it, being aware of where it is and where it's occurring.

So now the young don't equate age with wisdom. In fact, quite the opposite. They think the old people are clueless. And now it's a different thing. They want to displace them.

So they bring a lot of knowledge. But is knowledge and wisdom the same thing? I would argue, no. It's not.

So we're going to find out in the coming years amongst the younger Gen Z and millennials how they learn to discern the difference between having a lot of knowledge and big data and wisdom. And I don't know if that's a function of age or not. But that's definitely one fulcrum on which this generational argument turns.

Another one, which I find super-interesting, is what I would call holistic versus Cartesian.

The Cartesian way of thinking is what we've had ever since Descartes said, basically, if you keep cutting reality up into ever smaller bits, if you ask ever more precise questions, you divide in order to find answer.

You make everything quantitative so it's mathematical and subject to computational analysis, quantitative analysis. And if you just go deeper you'll find the answer. So the origin of being highly analytical is to buy into this Cartesian notion that, if I can't put a number on it, it's not real.

Well, that's a very boomer idea.

And the younger crowd, they're going in the other direction. They're saying, you know what? There may be answers when you go down into an analytical thought way, but we have to think holistically about the whole planet. And, actually, every decision that you make here has a consequence there.

So a boomer can say, let's make iPhones. And we don't really care about the folks in Africa that are extracting some of the metals that are required that's really toxic and kills them at an early

age and makes their environment awful. And then we dump those iPhones when we're done using them in some place that creates all kinds of new health hazards for the people who never even had a chance to use them. Boomers are okay with that.

Younger generations are not. They are thinking: What are the consequences of this decision to use an iPhone? Who gets hurt along the way? This is way beyond the stakeholder thought process. This is a holistic way of thinking.

And I do find that this gap is so big it's just almost impossible to overcome.

In fact, you know, Thomas Kuhn who wrote that wonderful analysis of scientific revolutions – Kuhnian thinking was that, when there is a paradigm shift, the people in the old paradigm can never make the jump to the new one because they are so constrained by the thought processes they already have they can't break free enough to see what is the new paradigm. And I wonder whether this is one of those issues as well.

I don't know. Personally, as a boomer I am making a very big effort to break free of my predetermined notions of reality. But I have to say it's a lot of work. A lot of work.

And you have to read and you have to – not just read but, as I was saying before, experience. I have to say, if I hadn't experienced virtual reality and augmented reality as a business tool – not as a fun thing to play with but as something that genuinely changes how you perceive and find value in things – I really wouldn't be able to comprehend half of what's going on out there.

So it's, again, how do you improve your sensory perception capabilities?

I have a couple of recommendations on that I'll just finish with.

And one is find music that you – really modern music, like something that's happening right now that you really don't like. And then study that. Listen to it. Listen to versions, different variations of it. Try to understand what is it that other people are moved by.

And I think what you'll find is, as you do this, your sensory perception is actually a remarkable tool and it does like novelty. And it will start to absorb something like a song that you couldn't bear because your teenager was listening to it and you're like, do we have to listen to this? Can we turn this off? That song could become your most favorite song.

But it's a thought process that you have to engage in.

And this is just a reminder to us that, when the ancient Greeks invented the term technology – tech – it was originally the word *techne.* And what *techne* meant was not a thing but a thought process.

And I think that most of us boomers need to widen out our thought process. And the way you

do that is by trying things that you genuinely don't like. Music is an easy one.

Trying food that you just thought there is no way I'm ever going to like this and suddenly begin to understand why there is such a big business in vegetarian food these days. Well, when you try it, actually the quality of vegetarian food has become so remarkably good that even people who are not vegetarians are going, hey, there's something happening here and I'm buying it.

And, boom, now you've got an investment story into the whole vegan vegetarian space, which boomers are hugely dismissive of. And young people are like, OK Boomer, how can you not get this?

So those are some of my thoughts.

Erik: Pippa, one final topic that I want to mention. You of course, I think most of our listeners know, went from being a presidential advisor to entrepreneur. You run H Robotics. You actually manufacture not the toy drones that you used to take pictures with, but commercial drones that are used for surveying mining sites and all kinds of industrial applications.

And I know that you're engaged in thinking out of the box. So I want to get your vision of the future.

How are remote controlled or even self-controlled unmanned autonomous vehicles going to change the future? What are the things nobody's thought of yet that are maybe over the horizon that you're looking forward toward?

Pippa: Totally. Yeah, I'm so deep in this subject. And what's so interesting is when people say – when I say we make autonomous vehicles, everyone immediately assumes that means you're making cars. But, actually, no.

I make autonomous vehicles that are for transporting cameras and sensors and devices, things like lights, not about moving a person. In fact, the whole point is to remove the person and get them out of dangerous tasks and out of repetitive tasks that humans don't really do very well.

And I think this notion of autonomous vehicles are not about people. They're not people-moving equipment, they're sensor-moving equipment.

And what's the purpose? It is this business of entering this fourth dimension where you have this extraordinary data-based view of reality which is more precise and accurate than any view of reality that you'll ever have with your own eyes.

So I see extraordinary things happening in the business community as they move in this direction. From being able to do everything from secure their properties by literally having better-quality security against theft because of autonomous vehicles operating on the property

all the way to being able to construct buildings in entirely new ways because you have this data to work with.

Doing things like managing remote assets. You know, I've talked about the tailings dams on mines, which are so horribly toxic and so dangerous. And never again should there ever be a failing of one of these tailings dams because now you can know exactly what is the volume of fluid? What is the shape of the basin? Are the liners coming unstuck? Is there a leak?

All of these things are completely crystal-clear visible with autonomous vehicles sending sensors in and which a human can't detect with the naked eye.

So I'm very keen to have a conversation with people on the net, social media about what are we talking about? This fourth dimension world, this world of autonomous vehicles that are gathering data. This world where quadrillions of data points are gathering to create almost like a crystal ball that we have to learn how to conjure forth answer from this new data space and to do so effectively and correctly.

And I think that's an entirely new skill set that people of every age and every background are learning from scratch. I mean, in this new data space that I'm describing, in a sense we're all illiterate.

And so, to that end, I'm very keen to have a chat to people. I'm @DrPippaM on Twitter and Instagram. I've been a bit quiet lately, but only because I've been so busy building this company. But I'll be very active again in the new year.

And also as @H_Robotics because we make helpful robotics.

I'm very happy to talk about this whole process of automation, robotics, and why all of it's going to create more jobs than it destroys. And it means that our future economy is actually going to look much better than most people are currently anticipating.

Erik: And, again, for any listeners who may have ideas that they want to share with Pippa about how autonomous vehicles might be used in the future, the Twitter handle is @DrPippaM.

We're going to have to leave it there in the interest of time.

I want to wish all of our listeners a safe and happy New Year's holiday. Patrick Ceresna and I will be back next year – that's also next week – right here at macrovoices.com.