Demetri Kofinas: What's up everybody? Welcome to this week's episode of Hidden Forces with me, Demetri Kofinas. Today I spoke with Jimmy Soni, a New York based author, editor, and speech writer. He's the coauthor of Rome's Last Citizens, a biography of the ancient Roman senator Cato and A Mind at Play, a biography of the late mathematician, [00:00:30] engineer and father of information theory, Claude Shannon, the latter, won the Neumann prize for the top book in the history of mathematics for 2017 and was named one of the best books of the year by Nature and Bloomberg. Jimmy has also served as an editor at the Washington Post, the New York observer and The Washington Examiner. Jimmy, welcome to Hidden Forces.

Jimmy Soni: Thank you for having me.

Demetri Kofinas: You wrote this book with Rob Goodman, right?

Jimmy Soni: Mm-hmm (affirmative).

Demetri Kofinas: You and Rob wrote one book before this?

Jimmy Soni: Mm-hmm (affirmative).

Demetri Kofinas: How do you guys know each [00:01:00] other?

Jimmy Soni: So we were debate partners at Duke in college, and we just became really good friends, and we loved a lot of the same things. A lot of the same authors, the writers. We both did a bit of speech writing in our past and when we did our first book, we were both early to mid 20s, and we're kind of figuring it out-

Demetri Kofinas: That's remarkable, man. Can I ask you something? Where do you get off? No, seriously, where do you get off? Like where do you get the idea in your head? First of all, it gives you, colloquially speaking, the balls [00:01:30] to think that you could write a book at that age, is my first question, two, how to maybe being debate partners help you accomplish that? How did that train you? And maybe also what does it reflect about your nature that made you do that?

Jimmy Soni: Oh, onto the second one first, which we're both huge, unrepentant nerds, and nerd then, nerds now. But candidly on the first question, when Rob and I started to do Rome's Last Citizen, which was our first book, I had come ... same sort of deal, I had gone on Amazon and looked for a biography of Cato because I had bought biographies [00:02:00] of Caesar and Cicero and all these other famous Roman figures and I just assume that someone had done one of Cato, and when they hadn't, I just kinda called Rob, and I said, “Hey man, look, no one's done this. We could do a proposal. Here's the best case scenario.” Best case scenario, publisher buys the proposal, and we get to do a book, worst case scenario, we spend two, three months writing a proposal, it sits on a shelf somewhere and that's it. There was very limited opportunity costs because we were essentially working on nights and [00:02:30] weekends on this thing-

Demetri Kofinas: During the academic year?

Jimmy Soni: Well actually we were ... we had just both sort of in graduate school and then I was working, and he was working, so this was while we were working full time. And this is how things are made, you see something that's an unmet need, you go out, you try to figure it out and sometimes you strike sparks.

Demetri Kofinas: Help me though because this is interesting to me because what you do when you write a book like that, you're on steroids doing what I do every week.

Jimmy Soni: Right.

Demetri Kofinas: You're exhausting and doing tremendous amount of research, and you're taking on a tremendous responsibility, and you've [00:03:00] incurred a huge future cost on your life, right?

Jimmy Soni: Yeah.

Demetri Kofinas: I'm just curious, where did you develop the skills to do that? And we're going way off topic, but I'm just a bit curious-

Jimmy Soni: I love talking about this stuff. So the skills ... So a lot of it is like you learn in college essentially how to write papers. Now, they're not exactly like writing a book, but you learn how to look up information, find information, source, and cite; basic skills. Then both Rob and I are avid readers and my favorite, favorite books to read are biographies. And so I always Kinda had it in the back of my head [00:03:30] like maybe one day I'll get lucky enough to do this, like I love biographies and so I just Kinda of had that in the back of my head, the topic came around, and then it was just a matter of like ... we had a whole stack of books, I still remember this, that were our models for how we did this, right?

So like you're building a company, you find a company that sort of looks, feels, and acts like yours, you sort of learn some things from them. For us, there were two or three really important books that helped us figure out how to write Rome's Last Citizen. It was a biography of Cicero by Anthony Everett and it was this book Rubicon [00:04:00] by Tom Holland. And I can tell you, I still have the copies of both of those books, and they're basically like husks of books, like their pages torn up, the bindings are-

Demetri Kofinas: Wow, amazing.

Jimmy Soni: ... because I had spent so much time. I mean to give your listeners a sense like I actually counted the number of words in the chapters, I counted the number of chapters, I put things together just to understand how it was done.

Demetri Kofinas: In a sense that's not random that your next book was on Claude Shannon in a sense. I mean, everyone else could have had the same epiphany, but you really

squeezed [00:04:30] as much as you could out of that text. You extracted as much meaning out of that information and we'll get to that defining the counterintuitive definition of what information is as we proceed through this, but that's interesting. So that's how you got the idea of the book, your process, I think in some ways for writing Cato, sounds like it informed your later interest in Shannon to some degree, and you saw the opportunity of course, and the fact that there was a gap in the market, which is a traditionally entrepreneurial thing to do.

Jimmy Soni: Well, it's also, by the way, it's incredibly in a way, it's almost stupidly simple to do because [00:05:00] if you go on Amazon, you can identify right away what gaps there are in the books you want to read. And ultimately for us this was just an act of, well, there's a book we want to read, it doesn't exist, let's create it. And we figured that there would be a market given that we knew that there were markets for books that were very similar.

So look, I am sort of ... I don't mean to be falsely humble, Rob and I knew what we were doing, we had written professionally for a while, at the same time, all books are acts of faith. You find something that isn't out there, you go ahead and try to put it together. And again, [00:05:30] there are book ideas that don't go anywhere, but these two happened to go somewhere.

Demetri Kofinas: Yeah. And I should also mention to the audience that they should check out any of Rob's interviews. You guys do them together, you're fantastic, we can't replicate that type of dynamic here. You're a great team, and unfortunately, he's in Montreal now, but we won't give his exact location out.

All right, so let's get the Shannon because this is why I brought you here. I wanted to talk about Shannon and really, I want to talk about information theory to the extent that we can. But you make a point very early on the book, and this is also ... it comes across in the title [00:06:00] of the book, A Mind at Play. You make the point that Shannon was a born tinker, that's lifted from your text. Why did you feel that that was an important thing to state outright in the book?

Jimmy Soni: Because he was the kind of person who wandered across so many different fields and every one of the fields that he's in, he doesn't have a precise sense of where his ideas, or his ambition are going to take them. He's tinkering, he's playing. We called the book A Mind At Play because in everything [00:06:30] that he does, you get the sense that this isn't a guy who's out to hit a certain threshold or capture a certain trophy or win a certain award or get a position at a certain university. He's just playing with ideas, with concepts, in some cases with objects.

And so the tinkering, being a born tinker, is actually a reference to his childhood growing up in Michigan, in northern Michigan, where he's playing with broken radios and telegraph lines, he's making barbed wire, barbed wire communication [00:07:00] system for himself and a friend. So he's somebody

who at a very, very young age, is using his hands to construct things, to make things, and that's not every childhood. And so we felt like that was important enough to state outright. We also think that that tinkering instinct plays into what he does later. He's somebody who always is very gifted, not at just seeing ideas in his head. Einstein was brilliant at seeing ideas in his head, Shannon was also brilliant at bringing those ideas to life with physical objects.

Demetri Kofinas: Is it fair to say that the Midwest [00:07:30] at the time was in some ways the frontier of America?

Jimmy Soni: Oh, very much so. I mean, I don't know if it was the frontier of America-

Demetri Kofinas: The technological frontier of America.

Jimmy Soni: To some degree, yeah, certainly in the engineering sense. Now he's born in northern Michigan. He grows up in a town called Gaillard and his dad is a builder. His Dad's a tinkerer. He, in addition to being a judge, he's also ... he makes coffins. He makes furniture. There was actually a full page ads that we found in these papers from the 1800s that say, " [00:08:00] Claude Shannon, the furniture man, and he'll build things for you." Right. But where Claude Shannon grows up, it's actually at the intersection of a bunch of railroad lines, and so he is in a place that has a ton of industry and activity and commerce. He's also in an area that's packed with forests. So the first settlers moved to Northern Michigan because there's a lot of wood there, and that's very valuable.

And so you can imagine a town that's rural, that's building things, they're making wheels for [00:08:30] slaves, they're making 10 pins, they're making all kinds of stuff. And into this, you drop a boy who loves to play with things, to build things of his own. And so his childhood is really the story of taking these physical devices and making them better, improving them, playing with them, and for us that we feel like you can't have Claude Shannon, the engineer and information theorist without having Claude Shannon, the boy who grows up in northern Michigan.

Demetri Kofinas: That's a big statement. The other thing I'm thinking about as you're talking, because complexity theory, complexity of science comes up in the work of [00:09:00] Shannon; it sort of intersects like a lot of different fields. There's something about that that rings true in the sense that the east coast was heavily industrialized and so very structured. When you are sufficiently past the railroads, you're in the territory of the barbed wired farmers who were rigging their fences, and you're pretty much on your own. And what you're describing there is that culture, is what the culture in which Shannon grew up in, but he had the intersection of the railway lines, so the intersection of commerce and there was this sort of budding middle ground of complexity [00:09:30] that allowed him to ... that he was able to feed off of.

Jimmy Soni: Oh, 100 percent. I mean, this is the way I think about it. Let's say Shannon had grown up around the same era in a brownstone in New York, right? He would not have had a barbed wire fence into which he could have run a signal to communicate with a friend a half mile away. Now, he may have found other ways to satisfy those curiosities, but the fact is he built in a friend's backyard a makeshift barn elevator. In New York, he wouldn't have had a barn, much less the ability to build [00:10:00] a barn elevator. Right?

So I do think that people are products of that early environment in a way, and Shannon in a way is influenced by northern Michigan and everything in its building and everything that he gets a chance to build. And if he was living in let's say Boston or New York in the early 20th century, I can see him exposed to a wider range of ideas and people, but I can't necessarily see him being exposed to the same kind of practical, hard headed tinkering that he engaged in his childhood.

Demetri Kofinas: [00:10:30] Necessity is the mother of invention, as they say. What about his character, his personality, his disposition? Was he a quiet child? What was he like?

Jimmy Soni: He was introverted and he was for the balance of his life, he was not a social butterfly. He was someone who spent a lot of time in his own head. He loved games, puzzles, he loved code breaking even as a kid. His favorite poem or his favorite short story was the Goldberg by Edgar Allen Poe, which is actually the story of a very complex code. But he's somebody who [00:11:00] is very comfortable alone, and that's important. It's important because later he's not a frequent collaborator. His paper on information theory-

Demetri Kofinas: Fascinating.

Jimmy Soni: His paper on information theory, published alone. His famous master's thesis, published alone, no co-authors. He is not a co-author or co-founder kind of guy, but he's a loner. He's also somebody who loves music. So in his childhood he learns to play, I believe it's the French horn and he maintains an interest in the clarinet throughout his life in jazz music throughout his life. He grows up [00:11:30] playing music and it's an important part of both his boyhood and later his adult life; the whole family orients itself around music.

But he's the kind of kid who from the best we can guess, I mean you can only make estimations of this, right? We're talking about a childhood that was early 20th century, but from what we can gather, he was a smart student. He wasn't somebody that anybody said, “Wow, that boy's a genius.” Right? I mean there's was a ... funny enough, they used to publish grades like in the local newspaper because they had nothing else to publish. So they listed the students who are straight A students one year and Claude Shannon is not [00:12:00] on the list. I mean this is like one of the giants of the 20th century intellectually did not get straight A's. So for all you kids out there that's some hope.

Demetri Kofinas: Just to drive that point home about him being a tinkerer and being innovative, talked about music, didn't he create like a flame thrower trumpet? Like a fire-breathing trumpet?

Jimmy Soni: Yeah. It's much later in life. Let me just ... a small riff on this, this is much later when he's older, and his son Andrew has to perform at like a school musical or something, and Claude [00:12:30] Shannon, apparently ... this is the story we got directly from Andrew, he just looks at him and he says, “Wouldn't it be great if the trumpet that you played could also breathe fire.” And then he went off and built a fire breathing companies.

Demetri Kofinas: Amazing.

Jimmy Soni: And we've seen a video, a representation of it. Actually, we've seen the video of the thing being played, and no joke, you play the trumpet and it spits out fire from the belt.

Demetri Kofinas: You had pretty good access to his family?

Jimmy Soni: We did. It took three years to get access. We patiently had to communicate with them, send them tidbits we found out about their dad. If you guys will permit me, it's a great story [00:13:00] because basically what we had to do is earn their trust. So this is a family that was very private, just like their dad, they didn't chase fame, they didn't chase fortune, they were scientific family, they'd prefer to keep their own kind of counsels, they don't go out and advertise that they're the Shannon family. And when we first contacted Betty, his wife, who was in her 80s, we basically got the polite brush off. She said, "Oh, wonderful that you're doing a biography. Best of luck to you." And then we contacted the family and overtime we said, "Hey, look at this cool thing we found [00:13:30] out about your dad. Look at this cool thing we found out about your dad. Hey, did you know that he was profiled in Vogue? Here's a vogue profile of him." And over time I think they saw, wow, these guys are exhaustive, we want to tell the story the right way.

And finally, and this actually, I've never told this story before, but the way that I got the long sit down interview with his daughter was that I had emailed her and I said, “Hey Peggy, I'm going to be in the Massachusetts area, in the Boston area sometime in the next couple of weeks. Any chance you're around?” She said, “Oh great, why don't we meet in Amherst at Blah, Blah, Blah.” And of course I had no [00:14:00] plans to be in the Boston area, I was just so [crosstalk 00:14:02] to see if she'll bite. And she was very gracious and she met with me for a number of hours and that's how we got a lot of the information.

Demetri Kofinas: Good job, man. That's fantastic. I totally relate with that. And it sounds like your sort of strategy, you and Rob, is just to share your enthusiasm; your genuine love for the material and to be straight open and honest and people respond to

that. People like when you genuinely care about what they're doing and you're not just trying to manipulate your way through to get what you want.

Jimmy Soni: That's right. And it's also ... with any of these projects or any projects, like if you're building a company, I mean if [00:14:30] you have that quality, I find that the world sort of organizes itself to help you. Along the way we've managed to even track down an ex-girlfriend, one of his closest friends, a running buddy, somebody he shared an office with who was a 101 years old when we talked to them. And so the world sort of finds a way to help you out as soon as you demonstrate you're actually doing this for the right reasons.

Demetri Kofinas: Who was it that said, man, the information gatherer? Who was that? I don't remember who that was. I don't think it was Norman. Maybe it was. So [00:15:00] let's get back to Shannon now because we'll never going to get through all the things that matter here, but let's start with Michigan. So we got through his youth to the extent that we have the time to get through that. He goes to Michigan and in Michigan he studies both mathematics and electrical engineering. First of all, an odd pairing, not by today's standards, but I wonder by those standards, how odd was that pairing?

Jimmy Soni: At the time, at the University of Michigan, the two curriculums were actually starting to overlap and part of the reason is because there's a [00:15:30] really enterprising engineering dean named Mortimer Cooley who essentially does a ... you can't call it a hostile takeover, but it was a takeover and a retrofitting of the engineering department. He's got a lot of bravado. He's a very confident guy. So he gets to the university to give them a lot of money to build out the engineering program, and he does. And what happens is the mathematics department and the engineering department end up overlapping. So when Shannon goes out to do both degrees, he actually jokes later that the reason that he did it was because it was really easy to get a dual degree; you didn't actually have to take that many additional courses. [00:16:00] But at the same time, what it exposes him to is engineers, who at the time were by the way working on very, very practical problems; how do you transmit a wireless signal? How do you build a ship that's better for the navy?

Then in mathematics, he's doing much more kind of theoretical work. He's exposed to Boolean logic, for example, which becomes important later for him. But he managed to get both degrees at the University of Michigan. It's this first experience publishing something, and he actually also manages to do reasonably well in his studies there.

Demetri Kofinas: [00:16:30] So let's talk about that. So he studied Boolean Algebra, which was essential to the formulation of information theory. First of all, give our audience a basic sense of what Boolean Algebra is, Boolean logic is, and how sort of important do you think that was for the later work that he did with electrical switching and information theory?

Jimmy Soni: So in the middle 1800s, 1847, George Boole creates an Algebra in which the values [00:17:00] that are concerned or sort of the true ... what are called the sort of truth value. So zero, one, true, false, right? So instead of using numbers or instead of using all numbers, he's using zero and one as stand ins for true and false. And it gives you the ability to do logical processes, right? So true, false, and, if, or, not. And so that study in the 1800s is taught to Claude Shannon in the early 20th century and it stays with him [00:17:30] and it becomes one of the foundations for a paper that he writes later; that becomes incredibly important.

Demetri Kofinas: Was anyone using Boolean logic for anything other than philosophical thinking? I mean, it's foundational in set theory, for example, Bertrand Russell did.

Jimmy Soni: No, not as far as I know. And again, I'm not an expert on the topic, but so far as I know no one was using it and it's why when Shannon saw the application of it to engineering, it was this astonishing thing.

Demetri Kofinas: Great breakthrough. Mental breakthrough.

Jimmy Soni: Yeah.

Demetri Kofinas: Right. I mean because we're talking about something that wasn't being applied in electrical engineering, [00:18:00] also, and we'll get into this, but I actually have some statistics here that by 1948 when he published the information ... and we're going to get to that, right now we're around 1932 to 1936 when he's in Michigan. In 1948, the same year in which Shannon published and mathematical theory of communication, more than 125 million conversations passed daily through the bell systems, 138 million miles of cable and 31 million telephone sets. So by the time he published that paper, there was all this stuff or even to call [00:18:30] it stuff would be a misnomer, that was passing through the lines, but how did you measure that, right?

And this is why his application of Boolean logic and the way he formulated information theory was so essential because it helped to make sense of this world that was emerging that we couldn't make sense of it. We couldn't wrap our heads around. But I wanted to make that point about Boolean logic and Boolean Algebra. So then he eventually moves off to MIT in 1936, there he forms [00:19:00] a relationship with Vannevar Bush. How important was that relationship to Shannon's life and how did that also take what he'd already learned and what he had studied in Michigan and the experiences of his younger life and build on it?

Jimmy Soni: So when Shannon is getting ready to graduate the University of Michigan, you've got to remember, this is a kid who now has spent his entire life in Michigan; parents are in northern Michigan, they expect him most likely to come back and join the family business making furniture. [00:19:30] And he's got an engineering degree, so that would be a plausible next step. He's walking

around Michigan and he looked at a Bulletin board and he sees a postcard tact to it, and it's a postcard that is looking for recruits to come to MIT and help to work on a machine called the differential analyzer; this is a room sized computer. And he decides to send in an application. And the person he's sending his application to is that the time one of the most important faculty members at MIT, a man named [00:20:00] Vannevar Bush, who later becomes probably one of the most important scientists of the 20th century; an advisor to presidents, a wide ranging lecturer, one of the true geniuses of the 20th century.

And he sees something, we don't know what, but he sees something in Shannon's application and he invites him to come out east to MIT. And I think of this as one of the seminal moments in Shannon's life for two reasons. The first is it takes them out of the Midwest and into a much more diverse, energetic, urban-

Demetri Kofinas: The big leagues.

Jimmy Soni: ... the big leagues. The other is that he connects [00:20:30] with someone Vannevar Bush, who is in many ways everything that Shannon is not. So van Bush, he knows how to network with presidents, he knows how to talk to people, he knows how to organize things. These are all things that Shannon has no interest in. But the other biggest thing is Shannon is now entering MIT to work the most significant computer of that day; an analog computer, meaning it's different than our digital computers, but the most sophisticated thinking machine of that time. And Claude [00:21:00] Shannon is there to learn from this machine and to learn from Van Bush.

Demetri Kofinas: It's analog in the sense that it acts out the algorithms of the world in a sense. Can you give us some examples or one example of what would be, let's say a algorithmic computation and I think the machine was called the brain. I think that's what they thought ... if you look at videos from back in the day, like the brain actually does this and that, and then it spits out this computation.

Jimmy Soni: Yeah, it's actually, we call it an analog computer because it's actually an analogy, so it's analogy. So what it's doing [00:21:30] is it's actually acting out the answers to the kinds of things that it's being asked to compute. So if you put in a graph, actually the output is not a series of numbers, the output is a graph that's then interpreted by the people running the machine. So it has these ... we call it ... imagine a 100 ton giants foosball table, that it's this gigantic series of disks and levers and pulleys and it's actually writing out graphically what the answers to equations are. So it's acting out equations in trying to answer them. And so it's one of [00:22:00] the most unique machines of its time. This was the foremost computing machine of its time and Claude is very lucky to get to spend time in this room where these gears are humming and he does this for weeks and weeks and weeks.

Demetri Kofinas: In that state, it's continuous waves as opposed to discrete?

Jimmy Soni: Exactly.

Demetri Kofinas: And that's significant. You write in the book ... this is actually, I'm quoting you here, that quote, “In the midst of his work, he came to understand that he knew another way of automating thought, one that would ultimately prove far more powerful than the analog machine.” You [00:22:30] then site a quote by a certain logician at the turn of the 20th century regarding Shannon's insights about building a general purpose machine, and you say, "As a material machine is an instrument for economizing the exertion of force, so a symbolic calculus is an instrument for economizing the exertion of intelligence. Logic, just like a machine, you write, was a tool for democratizing force built with enough precision and skill, it could multiply the power of the gifted and the average alike." I love [00:23:00] that quote and I think it speaks to another insight which was this idea of moving from a special purpose to a general purpose machine, something that all our devices are today. This is what the personal computer is.

What was that process like from your research for Shannon while he was at MIT applying his ideas of logic, this analog computer, until these notions of computation in a sense, and how did he begin to arrive at this notion of discreteness in messaging [00:23:30] and information?

Jimmy Soni: So he is spending many months with a machine that has switches, right? Open, closed, open, closed, open, closed, and he's seeing that these switches actually control the flow of information, the flow of light-

Demetri Kofinas: The flow something. Something is flowing, right?

Jimmy Soni: Yeah. He then remembers his undergraduate study in Boolean logic and remembers that there's zero, one-

Demetri Kofinas: Remarkable.

Jimmy Soni: ... open, closed, true, false. And the insight [00:24:00] that he comes up with, which Walter Isaacson later called the underlying foundation for all digital computing. People have referred to it as the most important master's thesis of the century, which is really saying something, is that you can use this kind of logic to more elegantly and easily designed circuits. So you can break down what at the time was a really convoluted trial and error process into very, very, very simple math.

Demetri Kofinas: Did that not exist before?

Jimmy Soni: Nope.

Demetri Kofinas: That was a total breakthrough?

Jimmy Soni: [00:24:30] It was a complete breakthrough and it was ... also part of it is a product of happenstance. It was very rare to have somebody who was an expert in switching who had also studied mathematical logic and the logicians weren't studying switching. So you had somebody for whom actually engineering this room, this room sized computer, the differential analyze proved essential to this master's thesis. And even at the time when it was published, people recognized that this was something significant. Claude Shannon is invited to go to Washington DC to give a speech about it, he's [00:25:00] given the Nobel prize, and this is not the Nobel prize, but it's the most important prize for a young engineer. So he's marked out as somebody who is able to combine fields in really interesting ways.

And I think that for me, for somebody who doesn't come to this discipline as a mathematician, one of the most important things I learned from doing the life of Shannon is how important it is to study diverse fields, to look at like places that are completely unfamiliar to you to understand something. Because had it not been for the fact that he studied George Boole, [00:25:30] digital computing may have been set back, God, decades.

Demetri Kofinas: That's the single biggest value proposition of the show. This is why we cover so many different topics, it's exactly for that reason because there is no one field that's going to cover all the different things that might give you the inspiration you need to help you solve that problem; bring that creative approach.

Jimmy Soni: That's absolutely right, and I think that there's value in that, not just from the perspective of my understanding Claude Shannon, but in trying to improve ourselves. And I think some of the finest thinkers that I know tend not to be one trick ponies. Claude Shannon, certainly in that [00:26:00] field as well, that he's got a diverse array of interests and it leads to his best work.

Demetri Kofinas: So a few points to drive home. One is the paper that you're referring to as a symbolic analysis of relay switching circuits; that's his master's thesis. Remarkable. Even more remarkable to me, that paper, the fact that I didn't know about that paper other than glanced over it in Gleick's book, but even Gleick, I don't know that he made a big deal of it. It was a big deal enough that I didn't know about a mathematical theory of communication. The fact that I didn't know about this, I found this astounding. The fact that he wrote this back then.

Jimmy Soni: And by the way, he's [00:26:30] 21.

Demetri Kofinas: That's remarkable. I mean, it's absolutely remarkable, absolutely remarkable. It puts anyone at the shame. But then another point I really want to drive home here, which is that he's looking at this computer, this analog computer, and it's doing all this stuff and it's creating this output and what he's saying is that there is value in the in between and that the in-between carries the capacity for expressing computing and storing information and of course who knows if he thought of it as information at the time. How this was all coming together in his

head, I find astounding, but it just [00:27:00] shows you how many years it took between a clear articulation of some foundational ideas that were incorporated in his 1948 paper, how many years between that and that paper was published and so much else must have got into it and that baking and that simmering of thoughts and to that point about interdisciplinary approach to learning.

After MIT, van Bush put him at Cold Spring Harbor Laboratory. Let's just briefly sort of touch on that really to drive that point home [00:27:30] and he was studying mendelian genetics, I believe?

Jimmy Soni: Yeah. This is one of the least remembered parts of Shannon's life. It's ironic because it's actually the subject of his PhD dissertation. But Van Bush thought it was very important for mathematicians and for scientists that he was training to be flexible, to be open to studying new fields, so he urges Claude Shannon to go to New York to go to Cold Spring Harbor, which at the time is the world's biggest warehouse of genetic information-

Demetri Kofinas: It was the Rockefeller's Eugenics [00:28:00] experiments.

Jimmy Soni: Yeah.

Demetri Kofinas: In retrospect [crosstalk 00:28:03].

Jimmy Soni: It has unfortunate origins and some frankly some unfortunate destinations and it's a really ... I visited ... and you can actually still see the cards where they try to predict which genes will show success in chess or will show infidelity or will show a love of the sea. They still have these cards. They're bunk science then, bunk science now, but it's a really, really useful collection of data.

So Claude Shannon is there and what he's trying to do is essentially do what he did with his master's [00:28:30] thesis, apply Algebra to genetics to see if you can figure out when would a gene show up in a population. To look at alleles and chromosomes very closely to say, “Is there a way to deduce mathematically what we are trying to look at biologically?” And so he's applying Algebra to genetics in a way that's never been done before. And while it's not quite as astounding a breakthrough, there are scholars later who said, “You know, he was about a decade ahead of the field.” And this is a guy who had never studied biology.

Demetri Kofinas: Remarkable. Well, I've told you as a kid, I did a summer camp there [00:29:00] as a ... I think in early high school or something like that, it's an amazing place and it's a beautiful little small intimate campus.

Jimmy Soni: Yeah, it's incredible. It's a right on the water and it's one of these places where you just get the sense that it's almost set apart from the world so that people can think about big and important things like population genetics. At the same time, that history is a little a shadowy as well.

Demetri Kofinas: That was a time when eugenics and eugenicism as a movement was really on the rise, both across the Atlantic, both in the United States and in Europe. And [00:29:30] speaking of that, this was during World War Two, now we're touching on ... this is exactly why this was happening at the time. This is in the middle of World War Two, right when the United States was getting into the war, right?

So this is an important thing I think to touch on, even though it's not ... to your earlier point, that knowing something, the biography of a scientist, the biography of mathematician of these intellectuals is important certainly in so far as informing us about the way that the person thought, the things that compelled them towards the breakthroughs [00:30:00] that they had. This was an essential time for Shannon and it would be good I think for all of us to sort of just take a moment and appreciate what it means to be a young man living in the United States, the Japanese have just bombed Pearl Harbor right after he went to cold spring harbor.

Jimmy Soni: It was after?

Demetri Kofinas: Right after. Okay. But it was while he was there.

Jimmy Soni: I don't know if it was while he was there because he only spent a summer at Cold Spring.

Demetri Kofinas: Okay. And then he goes to Princeton right after that.

Jimmy Soni: Yeah. So he finishes up at MIT and heads to Princeton on a fellowship.

Demetri Kofinas: Okay. And he had actually gotten that fellowship before he went to cold spring, right? That was like a kind of in-between that?

Jimmy Soni: Yeah. I think it was about the same [00:30:30] time that he was heading to Cold Spring is when they apply ... it was around that time when he was applying for it, and he wins what is NSF, national science foundation fellowship; prestigious then, still prestigious now. And he is able to go to the Institute for Advanced Study, which is located in Princeton, New Jersey.

Now, People will take great pains to remind you that the Institute for Advanced Study is actually distinct from Princeton University. They're on the same campus, but they're very different. But the institute allowed people to basically come and [00:31:00] work in a freewheeling environment. It also became a place where refugees from Europe, the most famous scientists of that day were going to the IAS, so Herman Wile is there, Kurt Girdle is there, Albert Einstein is there. And into that milieu drops Claude Shannon complete with a fellowship with a great list of mentors and a couple of papers that are pretty significant.

Demetri Kofinas: And interestingly enough, despite being dropped in that milieu as you appropriately call it, I think I draw this inference from your work as a [00:31:30] result of the fact that he was a partly as a result of the facts certainly that he was not a gregarious guy, that was not necessarily advantageous for him, and he was also going through a divorce at that time to his first wife who he was married to about a year uncharacteristic for the time certainly. The war, the uncertainty of what would happen to him. The real possibility that he might be drafted, that he might lose his life or lose a limb. And the uncertainty, the natural normal uncertainty of being a young person at the beginning of your career. All those [00:32:00] things come together and this person who was otherwise playful and lighthearted, it seems throughout most of his life, went through a period of melancholy.

Jimmy Soni: Yeah, you nailed it on the head. There's a dark period in Shannon's life. The time at Princeton is the dark period and one of the reasons is the cloud that's hanging over him and all young men from that period is the war. So it is just as he arrives at Princeton, that the draft order is given by President Roosevelt. And so all young men of a certain age or are eligible to be drafted. [00:32:30] And Shannon is in that group, and it is a source of huge anxiety. He believes that he is frail, he doesn't believe he will be well suited for army life, he is someone who believes that he could put his mind to use in the war effort, but not necessarily his body. And he's just afraid of being drafted and afraid of having a scientific life, which is now spent eight, nine years cultivating derailed by the war.

And so in a stroke of incredible fortune, his mentors find him a contract working for Bell [00:33:00] laboratories on the war effort. And he's not drafted, but he's put to work on what's called fire control, which is basically the science of how you shoot things down from the sky.

Demetri Kofinas: Anti-aircraft guns?

Jimmy Soni: Yep, exactly.

Demetri Kofinas: Yeah. There's an interesting passage about that ... I don't know that it who was in your book or I'm confusing it with something else where they actually went into specifics about the level of mathematical precision that went into designing the anti-aircraft weaponry, which is just fascinating to think about that. I mean, this is just remarkable. You want to talk about being on the frontier of ... again, [00:33:30] on the cusp of the transition. Actually not even really on the cusp, this is the germination of the digital revolution. The informational structure, the roadmap, which is what Shannon did, so he goes to Bell labs and in Bell labs there's a really interesting anecdote of him having tea time for about two months, is that right?

Jimmy Soni: Mm-hmm (affirmative).

Demetri Kofinas: With Turing in 1943. Now as I understand it touring, Am I correct, was in 1943?

Jimmy Soni: 1943.

Demetri Kofinas: 1943. From [00:34:00] my understanding Turing was essentially set to the US in order to kick the tires on the US cryptography team; the team involved in building the Cipher of Roosevelt and Churchill's or whatever other encrypted in communication across the Atlantic because the Brits were worried that the Yankees were gonna drop the ball on it. Tell us a little bit about this because these are two giants, obviously Alan Turing more notably known for his role in computing and computation, and of course Shannon is the father of information theory.

Jimmy Soni: [00:34:30] Yeah. It's an extraordinary moment in 20th century history and it's one that's overlooked. Turing is sent by the British to the United States to essentially make sure that communications coming from the US to top level leaders in Britain are going to be secure. You do this through the science and mathematics behind cryptographic analysis and cryptography. Specifically, how do you encrypt a phone call so that the Germans can't decipher it and then use that information again.

Demetri Kofinas: Can't you just do it in English?

Jimmy Soni: [00:35:00] They did. In any case they did use other languages.

Demetri Kofinas: They did the wind talkers with the Comanches; the Comanche language.

Jimmy Soni: Yeah. But basically what Turing is here to do is to test our systems to see will they be secure and safe. One of the places that he asked to go is Bell laboratories, and one of the people he meets, they're also working on cryptography, is Claude Shannon. And it's an extraordinary moment for a couple reasons. The first is they do end up getting together for tea every day in the Bell labs cafeteria, and there was something really remarkable about the idea [00:35:30] that these two giants of the information age we're having tea and talking together at a modest cafeteria at Bell laboratories. The other reason it's remarkable is because neither of these guys have a ton of friends, and so the fact that they made friends with each other, I like to think suggests that they recognized just how smart the other one was.

Claude Shannon even later would say that he was blown away by Turing's intellect. They stayed friends. Claude Shannon also invites Turing over to his home in the West village, which Claude Shannon invited no one over to his home in the West village. [00:36:00] So again, it is saying something that they became friendly, they would reunite after the war and without missing a beat, the Shannon's are visiting Turing at his home and Turing invites Claude down to go see a computer that he's building downstairs. And so this is like one of those greats bromances in technological history.

Demetri Kofinas: So I think this is an appropriate moment to talk about the bomb as you ... Well, I think that's actually lifted from a quote of one of his colleagues-

Jimmy Soni: John Pearson called and he [00:36:30] said it came as a bomb is the way he described the [crosstalk 00:36:32]-

Demetri Kofinas: The paper, the 1948 paper that he wrote. And then I think that's actually the title of your chapter on that. Why the bomb? I think you've sort of illuminated us a bit about that by referencing how he works in solitude and it just kind of came up. But why the bomb and what was the immediate sort of reaction when it dropped?

Jimmy Soni: Yeah. So in the book we talk about how the paper, the 1948 paper, which was called a mathematical theory of communication; Claude Shannon's most important work. It's why he's called [00:37:00] the father of information theory. It was stunning in how surprising it was. And part of that is Shannon didn't talk about the paper with anyone before it was published in 1948, which was just not done. I mean in scientific circles, you're constantly trading ideas, you're talking to other people, but he worked on this paper in private, essentially for 10 years before he ever let anyone else have access to some of the ideas.

He was always in limited discussion with a couple of other very smart people, but nothing like the collaboration that other [00:37:30] academics and researchers were engaged in. The other reason we called it the bomb, not just that it came as a surprise, but the scope of this work. It not only asked, but roughly answered all of the significant questions within the field of information theory. So he invents a field and then answers all the questions. And so it's an incredible stroke in technological history and this paper is even today regarded as one of the true masterpieces of the 20th century.

Demetri Kofinas: Okay. I want to nerd out with you right now.

Jimmy Soni: By all means.

Demetri Kofinas: And I want to get totally unstructured [00:38:00] right now. Okay. Because this is an area that I've amateurishly read about and thought about for the last number of years, maybe three two, I rarely get to discuss it and I think the nature of the subject is such that even brilliant geniuses, mathematicians, philosophers who understand this field and have studied it far more than you or I, still probably struggle with it in some sense. And perhaps in the same way that physicists struggled with the notion of quantum theory as sort of [00:38:30] what is it; we can understand it mathematically, but what is it.

I want to try and ... for our audience to get some sense of what it is that we're talking about. You and I, we mentioned James Gleick. James Gleick refers to this in his book as a fulcrum ... that the 1948 paper was a fulcrum around which the world began to turn. I like that expression because there is a sense in which

things really began to change. When we look back retrospectively, [00:39:00] the way we think about the world, the way we think about information, right? And mentioned before the number of electrical lines that ran across the United States, the telephones like 31 million telephones, the conversations. Our world was beginning to transform in terms of where and how it was happening.

How would you explain ... I know Rob has talked about information as being ... well, I think he cites someone that a or a statement from Shannon, Shannon said, [00:39:30] information resolves our uncertainty. I think that's a good way to approach it. There are many ways to approach it. Talking about it in terms of entropy, talking about it in terms of randomness, talking about it in terms of computability. How do you try to explain this to people who have, let's say, no idea of what we're talking about here?

Jimmy Soni: Yeah. I throw out a few things. So this is one of the more incredible papers in the 20th century, so I'll do my best to give the sound bits that are most helpful for people to understand it. But I do [00:40:00] think it's actually worth going back and reading it yourself. Even as a non-mathematician, non-engineer, you can actually find it to be a very readable paper. That's one of the things that makes it most remarkable is that even a lay person could get a rough sense of what the heck he's talking about when he talks about information.

The big thing to think about is at this time, our understanding at the time that Shannon's writing, our understanding of information is very immature. There's a sense in which the only way that you can make a signal go [00:40:30] from one place to the other if it's a little unclear, it's a little noisy, it's just by shouting louder; by increasing the power within a message, so you would just yell.

Demetri Kofinas: In these analog systems?

Jimmy Soni: Yeah. And what Shannon shows-

Demetri Kofinas: And the repeaters.? The way you got a message across this you need it ... it was the distance it had to travel and the boosting it.

Jimmy Soni: All you would do is just try to boost the power so it got louder so that you could make it clear and you'd accept that noise was just an inevitability.

Demetri Kofinas: And you created more noise of course in terms of boosting it, that was the thing; you amplified the noise?

Jimmy Soni: Right. What Shannon does is a few [00:41:00] things. The first thing that he shows is that you can actually quantify information. So Shannon is responsible for inventing the bit, so everyone knows what eight bits, 10 bits, 12 bits, Shannon invents the bit. It's short for binary digit. And it's a way of measuring information, which turns information from something ethereal and a little hard to pin down into something that mathematicians, physicists and engineers can

actually use, can actually compute. So that's sort of big breakthrough insight number one is let's quantify information.

Demetri Kofinas: Boolean Algebra, boom, right there.

Jimmy Soni: Yeah. [00:41:30] Then he has a diagram, a famous diagram that the different components in any kind of information source. So this is like the transmitter, you sort of have it in front of you obviously, but it's a famous diagram that shows any kind of information, has an information source, a message transmitter, a signal noise, a recipient and a destination. And so he actually makes it so that anything like a radio signal, a telegraph signal, a photo, a song, bird song, they're [00:42:00] all the same; they can all be brought under the same rules, which is really important. One of the things that defines field is when people can actually bring rules to bear on those fields. So Shannon finally brings information he can govern information with these common Law's.

One of his other insights is that information is probabilistic by which we mean that when he says the information is the resolution of uncertainty, what he means is that you can predict with some accuracy how much redundancy there is in a language. So a good example of this that I [00:42:30] like to think about is the letter Q in the English language is almost always followed by the letter "U." The letter "E" makes up something like 17 percent of all the letters used in any kind of English writing, right? There are these sort of rules, these predictable patterns within a language.

Demetri Kofinas: And words as well. The, proceeds, let's say subjects or something analogous.

Jimmy Soni: Yes. And what that allows you to do if you're Claude Shannon, and if you're trying to think about the transmission of information, is if you want it to communicate a sentence, you could strip away all the vowels [00:43:00] in a sentence and still have someone understand it. So let's say a sentence out of 100 characters, and you stripped out all the vowels and now let's say it's 70 characters. Well you've actually just compressed that message without losing any of the meaning. Why is that important? Because that means you don't have to shout louder to get those hundred across. You actually just have to say less, you have to say it more economically. So that was one of his big breakthrough insights is because of how redundant languages are.

And he actually estimates that English is like 75 or 80 percent redundant. [00:43:30] Just kind of funny when you think about it. But he estimates that because of the redundancy in language, we can say less, we can say things with economy and thus transmit them with more accuracy. So that's one of his big insights.

Demetri Kofinas: I was going to say also wouldn't the corollary of that be that if you want to say things with more certainty, that instead of amplifying the message you would increase the redundancy in the message in order to account for packet loss.

Jimmy Soni: Yep. So that was the next big breakthrough insight, it wasn't just that you could compress, it was actually that you could use redundancy to [00:44:00] create what are called error correcting codes. So for example, if you wanted to make sure that a certain message like let's say the letter A is represented with ... let's say A is 01, so first letter in the alphabet 01, it's one. In order to make sure that that's transmitted with 100 percent fidelity, you could add a zero and add a one, so 0011. Meaning that if like you were transmitting and across the channel and one of the zero's got lopped off or one of the ones got lopped off, you would still have the fundamental essence zero and one.

And what [00:44:30] he realized is that you could redundancy, this kind of redundancy, to protect messages that were being sent. And his big breakthrough insight is that you can send any message with almost perfect accuracy over a channel that that is actually theoretically possible-

Demetri Kofinas: The Shannon limit?

Jimmy Soni: You can achieve the Shannon limit. The thing is that was not an idea that anyone had. Everyone assumed that noise was just a problem that had to be dealt with and that the only way to do it was to shout louder. Shannon realizes you can both compress [00:45:00] and encode messages to transmit them with perfect fidelity and that is something that is the underpinning architecture for everything. It's the reason that you can watch a YouTube video on an iPhone and it doesn't take seven years to watch the video because it can be compressed and because it'd be communicated with error correcting codes that allow it to be presented with accuracy.

Demetri Kofinas: Well, that third thing you mentioned, so we talked about Boolean Algebra, we talked about electrical relays and switches. The third one was the statistics. Statistical structure, understanding that [00:45:30] there was a statistical structure that underlay, I don't know how he would say that, everything in terms of information the way he was thinking about it. There are many of the things I want to say, but before I do, I want to actually pull it, I just pulled out the paper here in front of me, there's this paragraph, I think it's the second paragraph from the paper. It's like the most cited sentence, and I'm going to actually add a couple of sentences to it.

This is Claude Shannon speaking now, introducing information theory in his paper. The fundamental problem of communication is that of reproducing at one point, [00:46:00] either exactly or approximately a message selected at another point. Frequently the messages have indentation here, meaning they refer to or are correlated according to some system with certain physical and conceptual entities. These semantic aspects of communication are irrelevant to the engineering problem. The significant aspect is that the actual message is one selected from a set of possible messages.

I mean that capture so much right there. Not only is she talking about [00:46:30] the statistics, but he's also talking about the physical fact that information does

not metaphysical. We have this metaphysical notion of information, but it ultimately resides in a physical reality, which lays the groundwork for the work that's been done in information theory and entropy and thinking about information theory in terms of the physical sciences, which it is entropy. It is this sorter in a physical system.

As the universe expands from the Big Bang, if we take that theory, the universe generates more information. And that a fully [00:47:00] entropic universe at completely sort of thermal death universe has the most information and it's captured in a sense, and this also, I'd love to ask you, Jimmy, what you think about this, because this is all over the place now, but I told you I was going to geek out, I warned you here. It's the Laplace demon, right? There's another great quote by Henry [Poincare 00:47:21] here and I've mentioned it before, "Chance is only the measure of our own ignorance. Fortuitous phenomena are by definition, those whose laws we do not know." [00:47:30] This idea of do we live in a deterministic universe or do we not, and is complexity science and complexity theory is complexity. Just simply the reflection or the theory created by a mind that doesn't have the capacity to compute the universe, doesn't have the full level of intelligence to be able to see all the causality in the world, which generates this sort of ... I hope I'm not glazing you over here?

Jimmy Soni: No.

Demetri Kofinas: I don't know, if you think about [00:48:00] all that. I just threw a mishmash of ideas here.

Jimmy Soni: Those are a series of big and very related questions. I'll offer a couple of insights. The first is that there was a reference, someone called Shannon's paper Copernican. Copernican in the sense that before Copernicus, it was just assumed that the sun orbited the earth, and after Copernicus, we know that the earth orbits the sun.

In the same way, Shannon's findings were Copernican. He turned the entire idea of information on its head, [00:48:30] and took it from something that we couldn't measure to something we could measure, something we couldn't manipulate to something we could manipulate, something that had very few physical properties or ideas that seemed like physical properties to something that could be very carefully statistically calculated. So that just gives your readers a broad sense that's why this matters is because before Shannon, information was not this kind of hard science. Engineers did not have the conceptual tools to think about communication like this.

The thing I'll say about entropy and about the probabilistic [00:49:00] work, the best analogy that Shannon uses in his paper is the flipping of a coin. And he says, a fair coin that's weighted equally to heads and equally to tails, if you flip it, it actually communicates a lot of information. You don't know what's gonna happen, you're uncertain about what the outcome is going to be. So when the outcome is either heads or tails, you have one bit worth of information. He says

a coin where both sides are heads, communicates no information because it's entirely predictable because it's 100 [00:49:30] percent predictable, it communicates zero bits of information. And that idea it can be a little complicated to think about, but if you just say it that way-

Demetri Kofinas: Information is choice.

Jimmy Soni: Information is choice and it makes a lot of sense. It means information is the resolution of uncertainty. It means that something like a coin that's weighted with both sides or has two sides of heads is actually communicating nothing. It's communicating utterly nothing. It has no bits of information to it, whereas uncertainty, not knowing, is what we're trying to resolve when we communicate something.

Demetri Kofinas: Also, I [00:50:00] think another way that's interesting, there's so many examples that are useful, and I think all of them are useful in something like this because redundancy in the message. You want to get this redundancy in your head. Is music, jazz, if you have an hour of jazz, if you want to compress that, that takes up way more information, and way more space on a hard drive than let's say one hour of ... I don't know, what's that song from the south, like Dixie, my Dixie or something? Some simple mundane percussion of [00:50:30] a drummer or something because there's predictability, there's statistical structure in that other hour. And so you can compress it, there's far less information.

Jimmy Soni: Yep. It's appropriate by the way that you chose Jazz because this was among the things that Claude Shannon cared a lot about when he would get into friendly debates. He cared nothing about politics, but he would argue with you to the bone about who is the best jazz musician and he would go to clubs in the West village and just sit there and sort of nurse a cigarette, and nurse a drink, this was when you could smoke indoors, he would sit there and just [00:51:00] watched jazz musicians for hours on end lose himself inside the music. And so it is actually, we think it's important and interesting that jazz is a central part of his life because there is so much uncertainty and complexity in that kind of music that maybe there isn't another styles. And again, I'm not making a judgment about the music, I'm simply talking to you about the order or the chaos within jazz as compared to other styles of music.

Demetri Kofinas: Again, I'm thinking of Brownian motion. I'm thinking of Heisenberg's uncertainty principle. [00:51:30] I'm thinking about, to take the opposite side of that, our capacity to see patterns where patterns don't exist, and to infer meaning where none exists. All of these are so interesting. You and I were speaking before we went on air about what is a random number. Well, to choose a number by inherently means that it's not random and there are actually have been books written that produce random numbers that were created by Algorithms, which is like sin, high sin. So these notions of incomputability, incompleteness, [00:52:00] uncertainty, randomness, intelligence, these are so interesting to me, it's at the intersection of so many different fields.

I guess what I want to do with this, I took it as far as I could take it because you get kind of lost when you try to mention Brownian motion, that has to do with again, entropy and the random motion of particles in a fluid. But there are so many interesting ways to approach the subject, it's so valuable to study. And I do implore anyone and everyone to kind of look into it and to begin to [00:52:30] get into it. I didn't even mention girdles and completeness there, there's some aspect of that as well that feeds into it. You can feel it when you study these different theories.

And Turing talked about an algorithm being a way of expressing information, like the shortest algorithm is the shortest way of expressing that. Anyway, it's all part of that. So I wanted to make that point. We're not going to have a chance to get into his later years, which are fascinating. I think from the standpoint of how much of his life [00:53:00] happened after he published his paper and he of course he went back to MIT and he taught and I think he retired in 1978, but he died in 2001, right?

Jimmy Soni: 2001.

Demetri Kofinas: It's really wonderful. Jimmy, I'm remarkably impressed by not just your coherence in being able to talk about this subject, but the extent to which you understand it is I think remarkable, especially given the fact that you're only, what?

Jimmy Soni: Thirty two.

Demetri Kofinas: I just think it's ... I mean, it's remarkable.

Jimmy Soni: Let me just say that [00:53:30] I'm 32 now, but you look at what Shannon had done by the age of 32. By the age of 32, he published the most important master's thesis of the century and then it's when he's 32 that he publishes the information theory paper. I've written a couple of good books, I haven't invented [crosstalk 00:53:43].

Demetri Kofinas: [crosstalk 00:53:43] humble you.

Jimmy Soni: It humbles everyone.

Demetri Kofinas: Of course, so that's cool, that the fact that you studied that. But it's really great, but I want to really emphasize that point because it's valuable for anyone who's going to be reading your book to understand that you understand this stuff, you've thought about it to this degree because you're not just writing about a life, you're writing about a scientific life, and [00:54:00] I think these things are relevant.

Jimmy Soni: I appreciate that and it means a lot to hear you say that. I think the other thing about it is that I think I'm not a scientist, don't play one on TV, my math studies

ended in high school. And part of the reason I think non-experts could approach this book and read it and not get bogged down in the terms of the equations is because neither Rob nor I were experts when we wrote it, so we had to learn this stuff from the ground up and then communicate it as learners, [00:54:30] not as experts. And so for your audience and for other people, it's actually one of the virtues of scientific biography in a way is that if you read, for example, I don't mean to just brag on our book, but there's a really wonderful book called A Beautiful Mind and it's by a woman named Sylvia Nasar. It was one of our models for this book.

And one of the things that's great about that book is you don't have to be an expert in game theory or in economics to read that book and get a lot out of it. And we like to think that part of our book, yes, it's an introduction to Claude Shannon, the man, it's also an introduction to information [00:55:00] theory, the idea, its introduction to circuit design, the idea, its introduction to how to program a computer to play chess, which is one of the things that Shannon did. So I hope and it sounds like we did get to a place where the ideas and the life balance each other out because I think one of the virtues of studying someone like Shannon is figuring out how did someone like this come up with these ideas.

Demetri Kofinas: Yeah. I love it, man. I appreciate you writing it. And Rob as well. He's here in spirit though not in physical body. Tell our audience your Twitter handle and how they can learn more about you. The paperback is coming out [00:55:30] in like a month, right?

Jimmy Soni: It's coming out in July. Yeah.

Demetri Kofinas: And which is the anniversary, the 70th anniversary of the Shannon [crosstalk 00:55:35].

Jimmy Soni: It's very appropriate. Yea, it’s the 70th anniversary of the information theory paper this year. And actually the other thing your audience should know is there's a movie coming out.

Demetri Kofinas: Really?

Jimmy Soni: So it's called A Bit player and it's by a filmmaker named Mark Levinson, who's other film was a film called Particle Fever, which was all about the search for the Higgs boson.

Demetri Kofinas: I've seen that. That was a great documentary.

Jimmy Soni: So his next documentary is Claude Shannon.

Demetri Kofinas: It's a documentary?

Jimmy Soni: Yeah.

Demetri Kofinas: Oh, he worked with you guys and that?

Jimmy Soni: Yeah, he did. So it's actually a mix of a documentary in a biopic. [00:56:00] He got an actor to play Claude Shannon and this actor looks exactly like Claude Shannon. And then part of it is interviews with experts. Rob and I are both in the movie, a bunch of others, people from his family et cetera-

Demetri Kofinas: It's amazing.

Jimmy Soni: ... and it's so good. I mean just as good as Particle Fever, if not better.

Demetri Kofinas: I'm so jealous. When is that coming out? That's fantastic.

Jimmy Soni: He's debuting it at a conference in a couple of weeks and then he's going to probably look ... it's going to go to film festivals, it's a whole process I don't know anything about.

Demetri Kofinas: That's amazing.

Jimmy Soni: But it's the first feature length look at Claude Shannon's life, and I think it'll introduce a lot more people to them.

Demetri Kofinas: Why [00:56:30] don't we get you, Rob, and him, the director here, we'll do a Charlie Rose [crosstalk 00:56:33] situation.

Jimmy Soni: I love it. I'll gladly come back. Any podcast that's talking about Brownian motion-

Demetri Kofinas: Do our audiences. We're such geeks, man. I really wished that they could meet Rob as well because he's such a geek. He's such a geek. So, I really appreciate you coming on, man. Thank you so much, right?

Jimmy Soni: Yeah.

Demetri Kofinas: It was great to talk to you.

And that was my episode with Jimmy Soni. I want to thank Jimmy for being on the program. Today's episode [00:57:00] was produced by me and edited by Stylianos Nicolaou. For more episodes, you can check out our website at hiddenforces.io. Follow us on twitter, Facebook, and Instagram at @HiddenForcesPod, or send me an email. Thanks for listening. We'll see you next week