**CRAIG:** Hi, I’m Craig Smith and this is Eye on AI.

This week, I talk to Tom Seibel, founder of the tech powerhouse C3.AI. He spoke about some of the fascinating applications C3.AI is working on, from military target acquisition to precision healthcare, and along the way talked about the potential dark side of our technological future. Tom is an outspoken man with strong opinions that he’s not afraid to voice, refreshing quality in a CEO. I’m sure you’ll enjoy the conversation.

Before we begin, I want to mention again [ClearML](https://t.clear.ml/eye_on_ai), an open-source MLOps solution, which is sponsoring the podcast. I really appreciate their support. ClearML allows users to easily Track, Orchestrate, and Automate ML Workflows at Scale. Signup for free, log your entire process, version data, build model repositories, provision machines, schedule containers, and deploy pipelines directly from code. If you're a Data Engineer, ML engineer, DevOps, or a Data Scientist, go checkout ClearML today at [clear.ml](https://t.clear.ml/eye_on_ai).

**CRAIG:** So, let's talk about artificial intelligence.

**CRAIG:** If you could start by introducing yourself, give your background how you got involved in artificial intelligence and deep learning in particular and how C3 AI got started.

**CRAIG:** And then we'll go from there.

**TOM:** Good morning. My name is Tom Siebel and I am the chief executive officer of C3.ai , and we are an enterprise application software company, and one of the world's largest providers of enterprise AI software applications. And I have been in the information technology industry now for four decades. I am a computer scientist from the university of Illinois. I did my graduate work in relational database theory, went to work for a little startup with about 20 people called Oracle Corporation, turned out to be a pretty good idea. And ultimately, I was one of the guys who ran that business.

**TOM:** About a decade later, I spun out, with a few people and started a company called Siebel systems, and we invented this market known today as CRM and this year that's about $120 billion software and services market.

**TOM:** We sold Siebel to my former colleague, Larry Ellison at Oracle in January 2006.

**TOM:** And then in 2007 and 2008, we started to think about what was happening next in information technology. And so, we saw the information technology business grow from about a $200 billion business in 1983, when I joined Oracle, to say a $3 trillion business, perhaps, in 2008, and we had seen information technology change everything.

**TOM:** By the time we went through mainframe computing and mini computing, personal computing to the internet, to the smartphone, we changed everything about the way we communicate, the way that we entertain ourselves, the way that we recreate, the way that we work so it really had a big impact on society.

**TOM:** Now, as we powered into the 21st century, we saw that there were some new vectors of information technology coming online that we thought were going to accelerate the growth rate of business and change things in very significant ways. And these accelerants included elastic cloud computing, big data, the internet of things, and predictive analytics.

**TOM:** So, we founded C3 in January of 2009. And the objective was to build a software platform and a family of application software that would allow governments and commercial, industrial users to deploy predictive analytics or AI at very large enterprise scale. Say, Smart grid operations, oil and gas, manufacturing, healthcare, financial services, defense, and intelligence, telecommunications, you name it.

**TOM:** And so, we spent almost a billion dollars building quite a sophisticated software stack and now, if not the largest, we're one of the world's largest providers of enterprise application software and platform for building enterprise application AI software. Through the cloud, we have got an infinite computing capacity available at very low cost, infinite storage available at very low cost.

**TOM:** These in turn enable us to solve classes of problems that were previously unsolvable in the area of predictive analytics where we can predict with very high levels of accuracy, things that haven't happened yet.

**TOM:** The addressable market for enterprise AI is suggested by IDC to be about, I think almost a $300 billion business this year, growing to close to a $600 billion business by 2025. So, this is an extraordinarily large addressable market opportunity that changes everything about the way that we compute everything about enterprise application software and candidly, everything about the way we run large organizations,

**CRAIG:** You started in 2009. That was before deep learning had been validated and was widely adopted. What kind of AI were you using in your predictive analytics at that point?

**TOM:** We started out with supervised learning and then unsupervised learning. There's a minority of applications where we use deep learning. So when we get into things like missile defense agency, and we're looking at predicting the trajectories of hypersonics, well, that's clearly a deep learning problem, in many AI applications say in banking or in healthcare, what have you, people are unwilling to do with a black box.

**TOM:** They want explainable AI. So, we deliver an evidence package to exactly, why we are making these recommendations, why we believe this heart will fail. Okay. Why we believe that this is what you need to do to optimize the integration of renewables. Why we're making a recommendation that this is a bad actor or an insider threat, or this transaction is fraudulent. And that's impossible to do with deep learning. And so, in many applications for both statutory and more importantly, ethical reasons we're constrained to supervised learning and unsupervised learning techniques.

**TOM:** We'll look at, say thousands of signals. And let's say that we want to predict when a device is going to fail. Maybe it's a pump. Maybe it's a component on an offshore oil rig. Maybe it's componentry on aircraft for the air force And we have thousands of 10 thousands of signals that are coming off telemetry from these systems, pressure, rotational, velocity, temperature, what have you. And, we can look at the correlation of the signals. We can look at the history of failures and of tens of thousands of signals, you might find a thousand that tend to move in certain consistent patterns prior to failure and so in n- dimensional space where, n might be a thousand or 2000 in n- dimensional space. We can build these machine learning models that are highly predictive of a fraud event of a failure. It could be a human organ, or it could be a transformer.

**TOM:** But the beauty of supervised learning and unsupervised learning, is with the prediction, you can provide the analyst an evidence package that says exactly why we think this is true. And while deep-learning can get higher levels of precision and recall the problem is you can't explain it. Okay. So, you can't explain why you think this is a money laundering event. We can't explain why we think this is a criminal activity. Or, we can't explain why we think this thing that's moving at hypersonic speed towards the earth it's going to land in Washington, DC. And people work need to make the decisions on the other end of that, they want explanations.

**CRAIG:** Have you run your system, your predictive system, against a deep learning system.

**CRAIG:** And if the deep learning system is showing higher accuracy, can you offer that as an add on or a validation to customers, that, look, you need explainable? This is a system that's going to give you explainable. We've got a black box deep learning system that over time has shown to be more accurate. So, you can factor that into your decision.

**TOM:** Yes, we have. So, there's no question with large enough sets of data - and these data sets do get quite large - that we can get higher levels of precision and recall with deep learning. Now let's take an application like object identification for military applications.

**TOM:** Is it a MiG or is it a 737? Okay. Now, we can demonstrate mathematically to four 9s that the deep learning prediction is accurate. And so, you can develop it mathematically to the point where the people feel comfortable with it. And it's just, over time it's a mathematical certainty that the deep learning system is more accurate.

**TOM:** And honestly, when we're dealing with the issue of is it a MiG or is it a 737, you don't have time to evaluate a lot of data. You gotta make a decision. Things are happening at nine times the speed of sound okay, when we're dealing with hypersonics.

**TOM:** So yes, we have, and there are applications where I think it is highly ethical and you can demonstrate mathematically that it's more accurate where people feel comfortable with it. However, when you're making a decision about, is this a crime taking place? Is this a fraudulent transaction? Are we going to intervene?

**TOM:** People don't feel comfortable with a black box. If you say, we think this transformer is going to explode in New York. Okay. They want an explanation whether they are going to roll a truck to replace the transformer and we can give them that explanation. And so honestly most of the commercial applications of AI that we're finding today, people feel much more comfortable and we feel more comfortable with supervised learning and unsupervised learning.

**TOM:** When we get into big data, big data means that we have all of the data associated with problems - we have all of the data and we're not doing computations based upon a sample. We're doing all of the data - we use a different computational model and there is no question that where these data sets get extremely large and we have the computational capacity which we do today, we can have much higher levels of precision and recall in AI.

**TOM:** I believe the largest commercial application of AI is precision health, and we will be able to take, we can today, take the genome sequences and the health history and healthcare records of a population say of the United States or France or Germany or whatever it might be.

**TOM:** And aggregate those data into a unified federated image. Now let's add to that, okay, that these, whether we're dealing with 60 million people in France or 330 million people in the United States, but these people now in the next few years will be highly sensored. Okay. Whether they have their Fitbit or whether they're wearing something on their heart, in the cerebrum, or whether they've taken a pill that is sensing the content of the gut in real time, and these will be emitting telemetry at various cycles. So, we can aggregate these data into a unified federated image, process these data in near real time and predict, say for the population of the United States or China or France, who is going to be diagnosed with what disease in the next five years.

**TOM:** And if we know that we can intervene clinically and avoid the diagnosis. This is huge. The social and economic benefit of this is huge. And then you couple that with telemedicine where we can reach largely historically unserved communities, social and economic benefit is staggering.

**TOM:** Let's go a little bit further with, okay, because this is also. I’m going to get to the dark side of this too. Right now, it's all goodness and light. So, then we will use AI for AI assisted medicine. And we will, for example, use computers to assist physicians in diagnosis. Whether it's reading radiographs or looking at blood chemistry, whatever. to come up with much more accurate diagnoses and then we'll have genomic specific medical protocols. Okay. So, what's not to like?

**TOM:** Here we have cheaper medicine, more available medicine, people live longer they are healthier,

**TOM:** Well, let's stand back from this because this happens. Okay. And this happens pretty quickly and it's big. Now, all of a sudden, the question is who has these data? Okay. And is this in the private sector or is this a single care provider? I'm not sure which is less benevolent.

**TOM:** And the idea that either one of them is benevolent, I think get over that. And so let's think this through whether you want to think about the United States or whether you want to think about China, let's think this through, the idea that who cares about pre-existing conditions when we know what you're going to be diagnosed within the next three or four years, I mean, get over it, and the idea that these data are not going to be used to set rates? It is going to be a set rates.

**TOM:** How about ration healthcare? Absolutely. It will be used to ration healthcare. The privacy issues. Do you want to know that you're going to be diagnosed with a terminal illness the next 30 years? Anyway, I'm not sure I do. Okay. And do you know how are these data going to be used? So the privacy implications and the dark side of this is very real.

**TOM:** And so, we have a largely unregulated industry. I think the idea that governments and private enterprise act beneficially. You can get over that. I mean see China and Facebook for details. And so, I think there are some very real and troubling, ethical issues that we need to figure out how to deal with.

**CRAIG:** And deal with through regulation or building safeguards into the AI systems?

**TOM:** It's a really good question, Craig and I know there's a wide range of points of view on this. it's arguable that our United States government, it's not particularly effective right now. So, the idea that these guys got to regulate anything in a way that makes sense is a little bit beyond me. That being said, I'm wrestling with it. If they don't regulate, I think we're in a world of hurt.

**TOM:** We have a human health crisis going on, particularly amongst young people and, teenage girls, body image issues, depression, a self-image issues, suicide. This is a tragedy that's playing out and absolutely driven by social media. And I don't know what the cure is. But there's no question that there are enormous social and economic benefits associated with AI, whether it relates to energy and energy efficiency and climate and energy security, health care. But you get into some of these privacy issues and you get into the intersection of social issues, look at social compliance, scoring, going on in China.

**TOM:** How scary is that? Could that happen in the United States? Yes, It will happen in the United States. And so, this is very 1984 Orwellian dystopian stuff

**CRAIG:** As C3 works with its client base and we, for example in Health care the applications that you're talking about, do you see that kind of convergence of data and telemedicine and sensors, do you see happening yet? Or is that still just in the offing, that it's going to arrive

**TOM:** I am confident that precision medicine will be the largest commercial application of AI.

**CRAIG:** Are you guys working with any medical software companies to develop that kind of thing?

**TOM:** Yes.

**TOM:** And there are people, for example, in the United States government who have talked to us, for example, about applications that I consider to be unethical.

**TOM:** For example, one of the branches of the military wanted us to apply AI to their HR system. And the purpose of this was to determine who to assign who to promote. We have this problem with data that you're well aware of known as cultural bias. And I was dealing with the secretary of this branch of the military.

**TOM:** He was in my office and we had done a lot of work with him on a number of important applications of AI. And I said, Mr. Secretary, we won't do this. And my advice is you don't do it either because the problem is cultural bias and we'll work for six months or a year.

**TOM:** And we'll build this application that addresses say a half a million or a million people or whatever it was in that branch of the military to decide who to promote. The answer is going to be white. Male went to west point in the 21st century.

**TOM:** That's not going to fly. And I said, Mr. Secretary, then we got to read about ourselves on the front page of the New York times. Then we got to go testify before Congress and I'm not going with you. So that would be an example of perpetuating cultural bias, that I would consider unethical.

**TOM:** We're not gonna touch that. We have been asked whether we would apply AI to help identify extremists in the U S population. And the answer is no, we won't do that. I consider that an unethical use of AI. What's an extremist Craig in the U S population. And again, it depends who you're talking to. Right?

**TOM:** Maybe it's you, maybe it's me, likely one of us, depending upon who's making the decision. And so there’s some very thin ice here on the ethical edges of this that we need to be very careful about. We are very vocal about it and unless we anticipate this problem, this could go to a very dark place.

**CRAIG:** How as a company, do you vet customer projects? Do you have a committee that looks at them or is it more a gut instinct?

**TOM:** Some companies that will remain unnamed, rely on staff ethicists, who will evaluate these things. Now with all due respect, what is an ethicist?

**TOM:** Okay. I think ethics is something you learn from your mother, which is the difference between right and wrong. And so, at C3.ai, it basically comes down to the executive team and we evaluate every one of these. And we look at it. And for example, where we're doing military applications where there's no human in the loop, we won't touch it.

**CRAIG:** Have you been asked for military applications without human in the loop?

**TOM:** Yes, but it was a mistake. I'll be honest. It was a mistake. It had to do with a weapons system. We're one of the branches of the military, where they wanted to use AI, this would have been a deep learning problem by the way, for target identification.

**TOM:** Is it a MIG or a 737. A great deep learning problem. And then second target acquisition. Perfect application of AI. We could do it three orders of magnitude faster And then I got to page three of this thing and it said they wanted us to pull the trigger. I said, come on. There's 300 people around here making sure that something like this never gets to my desk. get this thing out of here. We don't want to touch it. And then they came back and said no, that's not what we want. we want to inform a human being, and we said, okay, we'll do that. So yes, I would say we're asked to do things that I consider the unethical.

**CRAIG:** China's doing target acquisition software. once you saw that there was a human making the final decision, did the project go forward?

**TOM:** Yes. Yeah. When we're informing a human being I think we're in the area of ethical AI. Now this is a real issue with China because we'll be in a war with China.

**TOM:** And one of the battlefields here is definitely AI. And these guys are very bright. They're very well trained. Their spendings billions of dollars and developing AI for military and defense applications. And they do have a different sense of ethics than we do in the West.

**TOM:** And you get to these guys in the Pentagon. And I spent a lot of time with them. I assure you, they're surrounded by lawyers to make sure that they're operating within the rails okay. Now we get to places like China and Russia, they don't have those constraints. So, we have asymmetrical AI going on and I'm not certain how that's going to work.

**CRAIG:** Yeah. Although you could argue that leaving the action to a human is a bit of a fig leaf because you don't need C3.ai to put that final step in. You or I could do it with a macro on our laptop.

**CRAIG:** What I'm saying is if you provide a system to the military that does target acquisition, but leaves the firing to a human, the military can take that and very easily turn that into a fully autonomous weapon.

**TOM:** But I do have the opportunity to interact with these people all the time. Craig, and I'm telling you they're, they're very careful and they're surrounded by lawyers and these guys are very thoughtful about this.

**CRAIG:** That's something that's been talked about a lot. If China is preparing target acquisition systems that are a step away from fully autonomous systems should the US be preparing the same thing so that there in a position to compete if China takes that step,

**TOM:** I assure you that the Chinese systems will be autonomous.

**TOM:** Okay. They have a different set of constraints that we do. And it may often really put us at a disadvantage

**CRAIG:** On the medical systems that you're working on. Can you talk at all about how much you see this convergence of sensors and prediction and individual data in precision health care, how much you see it actually being implemented into systems.

**CRAIG:** Can you talk about, without naming customers, about any of the systems that you're working on.

**TOM:** Just as we've described. We're looking at systems where we aggregate the healthcare records, the population of the United States and the genome sequences into a unified federated image, and that would deal with the telemetry coming from humans and build machine learning models that do disease prediction.

**CRAIG:** that's an active project.

**TOM:** Yes

**CRAIG:** wow. That's interesting.

**TOM:** And a solvable problem. Within the state of the art.

**CRAIG:** Yeah. And where is the genome data coming from? Would individuals submit their individual genome or I know for example, the China is collecting bio data on as many people, even Americans as say can.

**TOM:** There are large libraries of these data. We do not yet have genome sequences say of the population of the United States, but you can imagine that's not that far off and the time that it takes to sequence a genome today is a fraction of what it used to be.

**CRAIG:** And that project that you're referencing is that a government project or a private industry project?

**TOM:** Private sector.

**CRAIG:** So that would then find its way into a product, a public facing product that we guess.

**TOM:** Yes. I think that the kind of company that would be interested in that would be a large health insurance provider to reduce their cost of insurance or reduce their cost of payments or reduce the cost of healthcare.

**CRAIG:** These are fascinating examples. So, you're working on them on the target acquisition or on this precision healthcare. How far do you think before those systems are in place and active?

**TOM:** We have large systems in place today that do things. For example, like AI based predictive maintenance for the United States air force, we have most of the air force today.

**TOM:** We're using AI based predictive maintenance for say F15, F16, F18 and F35, Joint Strike Fighter, B2 B52 . And we can monitor all these systems in. I think we have 22 of these platforms live. And this is called RSO Rapid Sustainment Office has to do with readiness or availability of aircraft. And the idea is if you can identify device failure before it happens, then the system's not going to fail when you want it.

**TOM:** And those systems are in production today. Very large scale production.

**CRAIG:** But specifically target acquisition, for example. is that a research project or is that an implementation project?

**TOM:** That's plain vanilla stuff. That's easy stuff and that happens to be a natural and I would say highly ethical application of deep learning

**CRAIG:** yeah. But the project that you're working on has been delivered and the U S has that capability.

**TOM:** We are actively engaged in bringing a system like that live. It is not live today.

**CRAIG:** Do you have any idea how long before a system like that would be live ? The system that you're working on?

**TOM:** I'm certain that the department of defense has applications that are, that do this, that are live**.** Okay. This is not a difficult AI problem

**CRAIG:** And on the precision healthcare, how long do you think before that genome based precision health care for the population of the United States is online.

**TOM:** Three years

**TOM:** Really? Wow. And that's according to C3.ai’s timeline.

**TOM:** yeah. That's my opinion that's my well-informed opinion, based on the people that I'm dealing with, the conversations that are happening.

**TOM:** It's within the state of the art. It's a solvable problem. The economic and social implications are staggering. And I think it's probably a three-year problem.

**CRAIG:** You were talking about the addressable market when we started. So for enterprise, for predictive analytics, do you have a sense of where we are on the penetration of the economy, how much of that addressable market has been addressed?

**TOM:** I think we're in like the first half of the first inning and maybe we might have the first guy up at bat. We're just scratching the surface of this one.

**TOM:** So, this is expected to be, I think a, almost a $600 billion addressable market, according to IDC at 2025. So, this looks like an entire replacement market for everything we've done in enterprise application software in the last four decades. This is a big one.

**CRAIG:** And to that point it will in effect remake the economy.

**CRAIG:** There's so many areas of the economy that frankly haven't been disrupted even by the Internet yet that will be completely remade once you apply AI. I mean, certainly in predictive analytics, being able to foresee equipment breakdowns or employee churn rates or things like that.

**CRAIG:** So how do you view the future? These are pretty disruptive technologies. Take me 10 years into the future? How many of these things will be impacting our daily lives.

**TOM:** A hundred percent of them will be impacting our daily lives every day.

**TOM:** All of the systems will be predictive systems that will be around you in your house, in your business, in your car and your healthcare system. Okay. And then we have this other issue of social media which is a very scary thing. It's possible that social media might be the most destructive invention in the history of mankind.

**TOM:** So, where that goes, I don't know Craig. So, some of it's very scary. Some of it's very disturbing and a lot of it's really good. We're going to deliver safer, cleaner, more reliable energy with less environmental impact, hard stop, at massive scale.

**TOM:** Say at the scale of Shell. And we're doing it for the largest utilities in the world. So that's all goodness in life, but we get into some of these issues associated with health and privacy issues.

**TOM:** We get into issues associated with social media, get into social compliance, scoring. Craig, this is scary stuff. You're familiar with what's going on with social compliance scoring in China. It is hugely scary. Okay. Now let’s open the cyber security door. How scary is that? That's existential, right?

**TOM:** And , you have this guy in Moscow, you put him in a corner and he can shut down the power system in the United States and everybody knows it. How scary is that? You shut down the utilities infrastructure in the United States, like nine out of 10 people die. How far is this guy from being cornered? Your guess is as good as mine, but looks to me like he's getting cornered and we can have a problem. There are bad actors. AI – there is this hard intersection with what's going on with InfoSec and cyber security.

**TOM:** The intersection of AI and what's going on with their ability to secure critical infrastructure is existential. And right now, I don't think we are able to secure critical infrastructure.

**CRAIG:** Is that something that C3.ai is working on, those kinds of defenses hardening infrastructure?

**CRAIG:** Because certainly AI plays a role in that.

**TOM:** Absolutely. Natural role for AI to use predictive techniques, to identify zero-day strings. They all come down to phishing attacks, right? And so we should be at identify something as a phishing attack and we shouldn't have to hire Kevin Mandia to spend three months to tell us which building this thing came from and Shanghai. We should be able to figure that out in milliseconds. And yes, I think that is a huge and important application of AI. We'll be taking a hard look at that in the immediate future

**CRAIG:** C3.ai, you mean when you say we.

**TOM:** Yes, yes.

**CRAIG:** That’s it for this episode. Again, I want to thank [ClearML](https://t.clear.ml/eye_on_ai) for their support. Please take a moment and visit [clear.ml](https://t.clear.ml/eye_on_ai) to see what they offer.

I want to thank Tom for his time.

In the meantime, remember, AI is about to change your world, so pay attention.