Steve Strauss Oral History Interview, March 7, 2017

Title

“A Forest Scientist Navigates the Changing World of Genetic Engineering”

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Valley Library, Oregon State University.

Summary

In the interview, Strauss discusses his family background and upbringing in Brooklyn, New York, his interests as a boy, and his discovery of both science and a love for nature that emerged during his teenage years. He then turns his attentions to his undergraduate studies in Biology at Cornell University, describes his turn towards Forest Science as a discipline of study, and comments on his master's studies at Yale University, during which time he first came into contact with tree genetics. He likewise provides an overview of his doctoral studies at UC - Berkeley and reflects on the impact that these years made upon him.

The session then shifts focus to Strauss' career at OSU. In this, he shares his memories of his initial arrival in Corvallis and notes, in particular, the risk that OSU took in hiring a biotechnologist. He then details some of the reasons why poplars have proven so useful as model organisms for his research. He also shares his memories of what OSU and the College of Forestry were like in the mid-1980s.

The remainder of the interview is primarily devoted to Strauss' program of research in genetic engineering. Throughout this discussion, Strauss provides perspective on what it has been like to work in a controversial area during a period of cultural change. Strauss specifically notes ways in which he has been forced to adapt or reorient his research based on changes in the conventional wisdom as it pertains to genetically modified organisms (GMOs). Particular research projects that Strauss touches upon include his work on biosafety and sterile nursery plants, and carbon sequestration using poplar trees. He also shares his thoughts on his work with the Leopold Leadership Fellowship Program, and lends his opinion on the contentious issue of GMOs and food.

As the session nears its conclusion, Strauss comments on the future of forests and the hurdles that his graduate students face as they pursue careers in the field. The interview winds up with thoughts on change in the College of Forestry, and Strauss' perspective on OSU as it nears its 150th birthday.

Interviewee

Steve Strauss

Interviewer

Chris Petersen

Website

http://scarc.library.oregonstate.edu/oh150/strauss/

Transcript

Chris Petersen: Today is March 7, 2017, and we are with Steven Strauss who is a Distinguished Professor of Forest Biotechnology at OSU, and we will talk to him a fair amount about his career and his time at OSU. I'd like to begin by building more of a biographical sketch of your life and ask you where were you born?

Steve Strauss: I was born in Brooklyn, New York.

CP: Is that where you grew up?

SS: I was there until I was sixteen, and I left for college at that point and never went back.

CP: Really?

SS: [Nods] I went to various schools and places of employment, but not back there since I started college.

CP: Tell me about the Brooklyn of your childhood.

SS: I had a very simple upbringing. My parents did not have a lot of money. I was the fourth child, and by the time they got to me they were sort of done being careful caretakers, so I really had my run of the streets, as it were. I traveled around New York City on the subways and buses extensively and pretty much called the shots and came and went as I wanted, so I was a bit of a feral kid, so that was fun [chuckles].

CP: Tell me a bit about your parents and your family background.

SS: My father was a postal worker the second half of his life and worked evenings and enjoyed his job a great deal and had a great network of friends. I think he enjoyed being there more than he enjoyed being home with the kids and with my mom. My mom was a hard worker, but she was so overwhelmed by the depression and raising kids and was mentally rung out, I would say, by the time she got to me. Very humble, simple upbringing. My parents had good values instilled in me, ten times over, the value of getting an education and making yourself better and helped me all along the way once they realized I had a good academic potential. They kept finding money that I didn't think they had to keep my academic career going. So solid upbringing, but also not a great deal of mentoring, advisement—any of the things I hope I've given to my kids having a better situation.

CP: Can you tell me a bit more about community life in the specific neighborhood that you were in—what neighborhood was that?

SS: It was a neighborhood called Borough Park in New York. It was split roughly fifty-fifty between quite religious Jews, many of them Hasidic, and dressed in all the garb and refusing to associate, really, with what you may call mainstream society. And then Italians. Many of them were Sicilians who were first, or one and a half generations, off the boat. They were rough and tough and tumble and hated Jews as much as the Jews hated them. I grew up with most of my friends who—I had a secular-type of life. My parents were Jewish but very reformed—nothing like the Hasidic Jews. So I was something of an in-betweener where I played with these kids. I was out in the street playing stickball and football and just with Italian friends who didn't know what to make of me, because they were taught to hate Jews, and I was a Jew but not really a Jew because I wasn't like "those guys." So it was a strange upbringing in that regard. But some of these Italian friends are still very close to me, even at this stage in my life. They were struggling. Many of them were getting brutalized at home, and that was normal for the Sicilian culture they came from. They came in five minutes late and they were getting beaten. I had a very different kind of upbringing. It was amazing to see that—see the Hasidic Jews and see my in-betweener kind of growing up and figure it out from there.

CP: What were you interested in as a boy growing up?

SS: I was interested in sports. I was just a very active, sporty kid. I still run. I referee soccer. I follow some of the OSU teams. I'm still a sporty guy. These Italians were very athletic, so that was a real connection. Then probably the big change was as it got to teenage years and I met friends who were somewhat politically active in protesting the Vietnam War and being interested in recreational marijuana and things that were very common in the generation back then. I really moved away from these Italian kids. I moved further away after my Bar Mitzvah. I did get that done, because I felt like the family needed me to do that. Then I moved away from Judaism and moved away from these Italian, more rough elements, and found a group of friends who were more intelligent. They were a mix of Jews and Gentiles but more you would say progressive or left leaning. I grew my hair long; I had beads. In junior high school I remember that started, and became fairly politically active—I went to a bunch of demonstrations as a high schooler and then into college [0:05:03].

CP: At what point did science become something that was important to you?

SS: I went to a high school in Brooklyn called Brooklyn Tech. In New York City there's three selective public high schools, and Brooklyn Tech is one of the three where there's an entrance exam. It's really a place for training engineers. In the old school, engineers were people who just shut up and calculated, and the teaching of science was rough—and for people that were gifted in mathematics I guess it was okay. But I was completely turned off to science. I wanted no part of it. All the teachers, the whole education system, was the opposite of sort of my somewhat progressive interests. So I graduated. I did take the engineering classes, I had to at Brooklyn Tech, and did fine. Then when I got to college I went to the State University of New York at Purchase, which is an alternative arm of the State University system in New York: it didn't have grades and had all kinds of experimental teaching systems. I majored in philosophy for a year—just trying to figure out what I was interested in and so forth—really because I was interested in the environment and wanted to save the world, and I didn't see how a degree in philosophy was really going to help me do that. I was concerned about my economic, the ability to survive, so I switched to biology at that point with an interest in the environment and some kind of a job.

Then I got into the science track. I had skipped a grade in middle school, junior high school as we called it. I was born at the end of the year, so I was almost two years immature compared to a lot of my peers, and I was really confused in college. I was going through these transitions—philosophy, environment, and science—and using a lot of marijuana and other things. Finally, I said, "time out" and took a year off. That was a really smart thing to do. I worked and saved money and did some great traveling—went to Alaska with friends and other things, and when I went back I was able to transfer to Cornell and become a serious science student. Cornell is very, very rigorous. Really from then until now I've just been busting my ass, if you will, trying to keep up with the incredible pace and demands of being a scientist.

CP: That's interesting. I was going to ask about how a kid from Brooklyn becomes somebody who spends his career in the forest, and it sounds like it emerged out of this political impulse.

SS: Yeah. Political impulse, and along with that I began to backpack some with some friends. I didn't know anything about the forest. I remember being very curious—"What's this tree?" "Who knows?" "What does it do?" I got curious about it. I loved the outdoors. There was an element of the use of drugs in there that made me just worship in a religious sense. I had some experiences with friends that I still think of this day—these friends of mine who talk about how magical it was to see the environment, love the environment, be out there, bond, try to understand it, and try to think about being a caretaker of the environment. It was inspirational, is what it was. That infusion of the youth and the feeling of the need to save the environment and then with sort of recreational uses and drugs and the comradeship—I just became passionate about it. I don't want to overemphasize the drug part of it, except that it gave a great sense of joy and sort of sharing that would have happened anyway, but maybe it was more intense.

CP: How did you select Cornell, or did Cornell select you?

SS: I selected Cornell. With my limited knowledge base growing up in Brooklyn and my parents working class and neither one of them had a college education, we always assumed that the next thing you do is go to Brooklyn College or some very affordable nearby place because you couldn't possibly afford to go to an out-of-town school, let alone Cornell. My sister was five years ahead of me and she had broken the thinking shackles that we could do better, that we could reach higher. She encouraged me to apply. One thing nice about Cornell is it's very selective, but it's a hybrid, really, between a state-supported university and a private university, and biology is actually split. I think it still is there. So if you get into biology and you're a resident of the state of New York your tuition's about half. So it made it suddenly affordable, whereas it wouldn't have been otherwise. Then I started getting a bunch of scholarships because I really worked hard and got very good grades and then, like I said, when my father realized I was getting A's at Cornell, "Who is this kid?" He started paying off debts and stuff [0:10:02].

CP: It sounds like this was an important moment in your life, Cornell?

SS: Yeah. It was the start of a whole new person that wasn't this kid in Brooklyn but was someone who was going somewhere, and I started working with an ecologist at Cornell. I was also taking all these courses in biology and evolution that would blow your mind and suddenly you were thinking about all this big, big stuff and also thinking about saving the world. I still never saw myself as a professor or scientist. I was really unable to do that, but I get a degree and then I'd think, "Great I have a bachelor's; now what do I do with it?" In the world of biology you are a technician for somebody. Then you think, "But well I could get a master's and it's really the same thing." So to really be a scientist, to be somebody who calls the shots, whose thoughts and intellect and ideas are what drive what happens, in science you need to move on to get a Ph.D. and even beyond—you need to get post doc. So I just never got off the train because I realized I needed to stay on. Although I never imagined myself being a scientist with my humble upbringing. So it just kept going, and I kept having success, and then from Cornell I got into the Yale School of Forestry & Environment, which is today much more a breeding ground for environmental activists and policy people. It's fully transitioned. Then I went to Cal Berkeley after that, which is similar. So I kept getting into these very challenging, very great academic environments that were even more and more environmentally as well as scientifically players in the world scene.

CP: How did you arrive at Forest Sciences as something you wanted to focus on from biology? I'm guessing biology was sort of an entree to you developing a scientific foundation, but then you focused your perspective a little bit from there?

SS: Yeah. That's a really interesting question. I think it was the fusion of backpacking and being out in the environment. I also remember when I was, I think, seventeen I hitchhiked out from the east coast to the west coast, and I was in Oregon just as a long-haired kid by myself. I remember getting a ride with a logger. I was up in the Oregon Cascades somewhere near Salem, not really knowing what I was doing. This was in May, and I thought I was going to backpack the Pacific Crest, or start backpacking it, and it was all under snow; I just didn't really know what I was doing. But I had this conversation with this logger, and I told him all the things I had read from this article about how bad forestry was in the Northwest and how clear cut is a sin that should never happened. He just said, "Now, son, let me tell you why we do it. Let me tell you what the safeguards are." I had no idea how one-sided and biased a perspective I was getting from the Sierra Club. That issue actually continues to this day, as I worked in biotechnology where you have organizations that I trusted as being truthful and telling the whole story, and now I realize do not. That's one of the steps in my evolution from "save the world," a "simple scientist, science will save the world," to the real politics and real information society we're in, which of course has exploded of late with all the fake news and everything. But that has been going forever, to one degree or another, just not at the presidential level quite so blatantly. That really opened my eyes and got me interested: "So what is really happening in forestry?" "What are you clear cutting?" "Can we do it safely and can you use intensive technologies of all sorts conscientiously and responsibly amidst all the noise?" So that's a place I've continued to work in for thirty years at OSU in the biotech controversy area—related to trees and agriculture in general.

CP: Back to Yale, I'll confess that I was surprised to find out that they had a Forest Science program.

SS: Yeah. Most people don't know about it.

CP: Tell me about that environment for you.

SS: Yale was—I went there first because when I was at Cornell and I was interning doing undergraduate research with an ecologist he was grooming me to go work with his Ph.D. supervisor, a brilliant man named Herb Bormann an ecosystem biologist. I was all set to go there, and then my graduation was delayed a year because I overlooked a requirement, me and my advisor. So I had one more year to figure out who I was. I took a class in forestry, and I just got a little more interested in application, in the newer-term sense. So when I got to Yale to be an ecosystem ecologist and worked with Herb, and I did work with Herb Bormann some, but I sort of veered off and became more of a physiologist-practitioner as compared to an ecosystem ecologist [0:15:05]. But I also discovered that Yale, was a place where the number of scientists —particularly the number of practitioner-type scientists—is very small. I mean it had really transitioned [in the] '60s and '70s into a training ground for environmental activists, environmental lawyers—a lot of the people who populate the national and international organizations come through places like Yale—and Duke forestry has done a similar thing and Cal Berkeley forestry has done a similar thing—where really to survive and be a college in those institutions that are not land grants—or if they are they are mostly not; in Berkeley's case they're kind of a split one—they really had to become really working on big issues of environmental science in a global sense. So they transitioned. And there is still some science there, in all these places, but it's relatively small, or its highly environmental.

In Oregon State still we have a lot of that too, but we also have a much bigger—because we serve, we're in this region where there's this incredible forestry sector, whereas New Haven is not in such a region anymore. There's a little bit of forestry but very little by comparison, so we, here, try to serve both: training students just to work in the industry, work in the land management agencies very actively as well as do science and being on the cutting edge of the environmental issues. But being at Yale was very much a step into that world, which is a world I wanted to be in my whole life. But I also realized that I was a little naïve maybe in thinking that science had more of the answers, and in reality I found that science has a lot of answers, but mostly the laws and social perceptions make it difficult to have those answers be used, particularly in genetics, which we can talk about at some point.

CP: What was your research focus at that point?

SS: At Yale I did, I think, two or three projects. Yale doesn't have a master's thesis requirement, so I got involved in research projects. I went out to the U.S. forest service in California, in Berkeley actually, where they had the Pacific Southwest station. I worked with scientists there. My first paper was on the inheritance—so pines have these terpenoids that make them smell so nice and the resin that comes down and tries to protect them from bark beetles and so forth. Well the chemistry of that resin varies widely. Sometimes you have one chemical, sometimes another, and it's important to the ecology and the organism. So I figured out how it's inherited. Some scientist before me, Bill Critchfield, a very, very great man, had made these hybrids between different species and the progeny then had high alpha-Pinene, low alpha-Pinene, myrcene—all these chemicals. We did this basic meeting work, crossing species with different chemistries, and then you could map the genes in the progeny. So he basically said, "Here's the progeny, do you want to map the genes?" So I went out and measured them with the help of a scientist, and that was my first paper. Then there were a couple other small projects like that. Really what it was was very much being an apprentice, and science is like that a lot, where people do projects over many years and then students and post docs come in and figure it out, add value to it, tweak it - particularly with trees - but in science in general, where experiments take years to decades. So I came into this stream of science that the forest service scientists were doing in Berkeley. I was able to publish some papers and that set me up for getting into grad school in Cal and success from there on.

CP: Was that your first exposure to tree genetics?

SS: Yeah, really, and when I went to Yale it was not—as I told you, it was to be an ecosystem scientist and I started working for a geneticist there that put me on a couple of projects and then he set up this opportunity with the forest service in Berkeley, California. His name is Tom Ledig. He passed away from cancer a couple of years ago, but very well known internationally. He was at Yale, and then he moved to the forest service and so they set up those opportunities. So I went to Yale. I had no particular interest in genetics—I was open to it, then the opportunities, the people. Then I went to Berkeley too. That was partly to work with Tom Ledig, but I still was open to being a physiologist, a silviculturist managing forests on a larger scale, maybe an ecologist even of some kind, and then again opportunities: the forest service there—also one other theme in all this, one thing that's frustrated me about ecology, and still does a lot, is it's hard to measure things precisely. A lot of scientists, they want to get to the bottom of things [0:20:03]. They don't want to have a conclusion that says, "Well, could be this, could be that, could be this. We have data, we have models, and it looks this way. That's just the nature of the beast." In genetics you tend to get much closer to hard answers. That was appealing to me. Then all the genetic technology coming along continues to just—[motions expansively with hands], my whole career. The field of genetics has exploded five times. It was attractive. First it was terpenoids and the chemistry thereof and then gas chromatographs, and then it was these enzymes. You were doing collective genetic variation in a way that we never did. Then it was DNA. Then it was genomics—so doing DNA on a massive scale and then genetic engineering. There's been this progression of incredibly powerful and intellectually exiting and potentially very important technologies. That also pulled me out of ecology some. These technologies are now being used in ecology quite a lot, but it's taken a long time to get there.

CP: It sounds like it was a fairly seamless transition to Berkeley for you.

SS: You know I had been there before. I knew the place, and I loved it. I just loved being in Berkeley the five years I was there. It was a great environment for a young person, and definitely a very artificial environment. The reason I say that is one of my memories from there is, I think the first year we were there, this would be 1980...I hope I have the story right, Reagan was running against—I think it was Jimmy Carter, maybe for Carter's second term or something like that. You could be in Berkeley and think that Carter was a shoo-in. Of course I think he won no state but Massachusetts, or something like that. So again you're in this little bubble of Berkeley, and everything's very progressive and you don't realize where the country's at. We saw that a little bit this last election.

CP: Tell me bit more about this time—how you progressed through your Ph.D. years.

SS: The Ph.D. in Berkeley was really good for me. I really enjoyed Cal Berkeley a lot. It had a lot of what I was mentioning about Yale—the environmental stuff, the foment, the science. It also had, still, a lot of the traditional stuff, some of the older economists and silviculturalists, very, very famous people: Hank Vaux, John Zivnuska. My main mentor at Berkeley, Bill Libby, very charismatic guy, very much, really in the mold that I've taken on in my career. I've kind of been a spokesperson, if you will, for the use of genetic engineering as a technology in forestry. Which is a difficult thing. It's difficult biologically. It's difficult socially. A lot of the incredible power of the environment groups around the world has exploded during my life. They're almost all opposed to it, either unilaterally or extremely negative. Bill was a proponent of cloning in forestry. So you go out to a wild forest—now every tree is a unique genotype, like humans mostly are with the exception of the occasional identical twin. He said, "What if you could pick the very most productive one out of this mass of variation, not just one but the top ten, the top hundred for production purposes? For wild forests, you'll maintain all the diversity you possibly can. But for production forests—if we could clone it, the benefits could be cloned and the benefits would be huge." So he argued that his whole career and had some success. Some of it was used. But he was very much pushing against the tide at that point. The industry was very traditional, and then the environmental tide as well.

I, in a sense, followed in his footsteps, which is interesting, being a good biologist, I think, but being also outspoken on some of these policy issues and using innovative, new, [air quotes] socially novel genetic technology. Me in the GMO area and him in the cloning area. He was a very outspoken guy, and he was very influential to me. But the whole intellectual environment of Berkeley was very stimulating. I TAed in forest policy, so most scientists I would say have a limited notion of how policies are made and how laws are passed and what they mean. They just figure you learn how it works in nature, and then you do it smarter and better. The notion that there's all these layers of rules and regs, and perceptions, and vested interests—we're just kind of naïve. It's just that simple. So being at Berkeley was a time where I really got my eyes opened up—taking and teaching about forest policy, just realized that if scientists really want to change the world they really need to be out there. They can't be naïve, in their labs and their little field sites—they have to be out there interacting with society [0:25:00]. I think I've done some of that—not as much as some of my colleagues, and I think today you see a lot of activity on campuses. Scientists need to do it even more. You have this march for science coming up in April, and I think it's scientists saying it's just not going to be okay to be quiet. You have to get out there. But speaking for science is also—I'm rambling here a bit [smiles]—but speaking for science is also really complicated, because scientists are all biased and ideological, like everybody else. So it's a really messy thing.

CP: Your dissertation was still on genetics, is that correct?

SS: It was. Back in those days they had these enzyme technologies, called isozymes or allozymes. It turns out that you have thousands of proteins in your body, trees do too, and due to genetic variation the forms of those proteins vary. They do what they do, but they do it a little bit differently. So back in the '60s, '70s, '80s scientists realized that instead of measuring genetic variation, say based on variation in height of people like ourselves that are influenced by the environment, how well you eat, as well as your DNA, you could look right at the products of DNA, these proteins. We weren't able to look at DNA itself yet. So that whole allozyme genetic diversity technology was very, very big for thirty years. And that was what my thesis was about: trying to see if you could look at the amount of genetic polymorphism—variability in these enzymes in trees, and could you predict their productivity." Are trees that have a greater diversity of enzymes, are they more productive in a natural environment? Using the materials that were available to me that was the question that I tried to answer. I had some success in the sense that I got some publications out about it in good journals, but by no means did I resolve it at that level. That question, actually a bigger question, in science still continues.

CP: So you finished up at Cal in 1985 and then you arrived at OSU. How did that come about?

SS: That was an amazing thing. I did this thesis that was really about genetic polymorphism and whether it predicts productivity, and environmental stress tolerance was another element of it. It had experimental connotations, but it really wasn't about production, and it wasn't about biotechnology by any means—that wasn't called biotechnology, you didn't have that word, really, back then. Back at the time in the '80s when I was at Cal the field of what came to be called biotechnology—so recombinant DNA, cutting and splicing genes—was starting. It had started in bacteria a few years earlier, and scientists were beginning to use it to study diseases, to study cancer, to study human pathogens of various sorts. Then it started percolating into plants were people were using it the same way, and scientists figured out how they could transfer genes from one organism to another. They could do what people had done to bacteria years earlier; they could now do it in plants. So the possibility of genetic engineering plants for enhanced trade suddenly was there, and everybody was taking about it.

I remember I think it was '84, a year before I graduated, my mentor Tom Ledig, the guy I mentioned from Yale that went to Berkeley, held a big conference about how should we be using biotechnology in forestry: what are the opportunities, what are the constraints? I'm watching this and I'm not a biotechnologist. I didn't really know what DNA was per se, apart from—and suddenly it's like this is the next big thing. It's coming at us. And then the year '84/'85, depending on exactly how you date it, the first genetically engineered plant was created. And then two years later the genetic engineered tree—a poplar tree that I've actually continued to work on mostly in my career—was created. The forest services were working on it, and it just seemed like this is just a big, wonderful thing and a big scientific ecological challenge.

I remember when this job came opened at Oregon State it was somewhere around December or so of '84, maybe January of '85, and I remember seeing it when somebody pointed it out to me. We always had at Oregon State really strong forest genetics, a sub discipline of forest science, and we've been strong, at OSU, we've been strong in the forest service right across the parking lot. We had a geneticist, Kim Ching, who was retiring. They said, "Well, what should we do? Should we hire another Kim Ching?" Kim worked on cytology, meaning chromosome-level genetic biology of trees, Douglas fir. Or should we start going down deeper? Just go down to the DNA level [0:30:02]? That's where the science is going, there's all this foment is going on. So he said, "We're going to take a risk and hire a biotechnologist." I don't think any other forestry school had done so yet. About that time there were two or three that did it, so I don't remember if it was us or NC State or who was actually number one. But we were right there in taking this risk to invest in this new area.

At that point there were not a cadre of forest biotechnology Ph.D.'s and post docs around because the field didn't exist. There were a couple just starting who had done work in other species, barley—a colleague of mine, Dave Neale, an OSU grad, very great scientist, had done a post doc in barley, learning some of that stuff, but it wasn't trees. These were some of my competitors for this job. Anyway I asked some of my mentors, I just said, "What's with this biotechnology thing—is this like a flash in the pan? Should I apply for this job? I don't have back—," and they said, "Yeah you should apply for it. You're as qualified as anybody, given how young this field is." Then I did. I went on this crash course of learning about biotechnology. I applied, and they basically hired me on the notion that I had potential to grow with the field. I would say in retrospect that turned out to be a pretty good guess. That's how it started. This is really a new venture for me. It was a new venture for forestry at OSU. It's had a number of turns that no one predicted, but from a science point of view, and from a career development point of view, it's been very successful.

CP: It sounds like a nice piece of strategic thinking or visionary thinking.

SS: I think so. I think they knew they were doing that. They didn't know where it was going to go. I got here and I said, "So what do you want me to do?" They said, "I don't know. What's biotechnology? Figure it out and do it." Actually the first five, seven years I realized that genetic engineering had been done once in one place—a tree was engineered, but it wasn't ready to go. So what could I do? What I realized I could do, and I was also very successful and made a name for myself early, was I could use these DNA techniques to figure out the evolution of some of our major tree species. I think I had the most important paper at that time on pines and how they evolved. I had the most important paper at that time on Douglas fir and its relatives and where it came from in relationship to all its relatives around the Pacific Rim and beyond. So there's a lot of insights—you know when you get to the DNA level when you get an insight about relationships in evolution they're often very, very strong. This is this thing—this precision you get when you sequence or analyze DNA at that level. Suddenly people say, "Well it's not just his opinion about whether the size of the cones or the thickness of the bark's the most important trait. It's this random look at the DNA," and it just shouts at you which trees are most related to which and who the common ancestor is and so—what I did the first five or seven years is I did a lot of this genetic evolutionary analysis.

I did some really high quality science and the people at OSU, even though my dean in the department head would have loved to see me help the forest industry right then and there, they said, "This is the right thing to be doing right now." So they did have a very open mind about it. But then eventually, and perhaps I'm getting ahead of myself, but I'll mention it briefly—what happened in Oregon and in the Northwest is people started worrying about sources of wood and pulp, because we had the spotted owl wars, we had rising environmentalism, and the people were afraid there wouldn't be enough wood. So they started investing. The department of energy made major investments in growing these poplar trees and plantations, like the ones along I-84 that we talked about. Those are products of that, and some people started doing some serious research on that. There was a big project at the University of Washington on that.

I realized I had the expertise, or develop it, to add a genetic engineering element to it. That started late early '90s, late '80s, early '90s, and I started working with the industries and developed an industry cooperative-consortium, basically, of public-private partnership. Our college of forestry has a bunch of those, and still does, where they provide money, not a lot of money, but enough to sort of help guide it toward things of interest to them. Then we at the university use our resources and go out and give grant dollars to make good science of relevance happen. Working on poplars—I mentioned the first tree that was engineered was a poplar—and suddenly people are thinking about growing poplars on a major scale in Oregon in the northwest: "Let's use this technology to do it even better." So a lot of my career has been I took that step, formed this consortium, started working on poplars and genetic engineering, and I quickly got involved also in some of the social and legal issues of it [0:35:04]. Like I said earlier, those are big, and they've continued to be big. That was the reason I made that shift early in my career at OSU into genetic engineering per se and also helping to deal with the social elements—working with industries, forest industries, and biotech industries. That's been the big middle of my career and still continues.

CP: What is it about poplars that make them attractive to this work?

SS: From a science point of view, they're much better model organisms. So everything about Douglas fir and pine, you can imagine when it comes to doing genetic manipulation, is hard. Those terpenoids I mentioned earlier well, they mess up getting your DNA out and analyzing it. People have gotten over it these days, but it's just one other thing. The genomes are huge. In poplars we figured out pretty early on— in fact the number one tree—how to insert a gene or modify a gene and then grow the progeny and see how that one gene affects them. In the conifers that's still incredibly difficult to do, very expensive and very difficult. Something about them [poplar] makes them easier to engineer. Their genomes are small. They grow faster. It's very powerful in genetics when you make a genetic change or you have a genetic variant of interest to make copies of it, just for replication, so you have high-quality science. Poplars in nature clone themselves all the time. These aspens—you may have read about these groves of aspens—their kinds of poplars can cover many, many acres in one single genotype. That doesn't happen much in conifers. They're easier to make copies of. So there's a bunch of reasons: easy to transform, small genome, easy to make copies of, faster growing that make them very good genetic models.

Also, the industry was already looking at making hybrids between different species to increase productivity. They were already cloning them for plantations. So the genetics was very intense. Then adding genetic engineering as another kind of genetics made sense, because the industry had already brought it, and science had already brought it, to this level; "Let's take that a level further." When you look at Douglas fir or pines, even today, the genetics is primitive compared to any crop species—compared to poplars, so it's much harder to say that genetic engineering is what we need to do now. We're still sort of Neolithic with breeding so it doesn't make as much sense; with poplars it does. So you have all these reasons: the biology as well as the state of breeding. Also, if you're making a particular product with poplars, like pulp or particular kinds of wood or biofuels, you can optimize it much more. That's how the industry came about. Whereas in the generalized forestry we're making all kinds of things under all kinds of conditions—we don't control the environment as much, they're growing on steep hillsides, and poplars are more agricultural. In fact, they're regulated as agricultural crops by Oregon and Washington. Everything about the social and biological environment made it sensible to consider trying to add in genetic engineering as the next genetic technology.

CP: Backing up just a hair, I'm interested in collecting a little bit of institutional knowledge about the university, you know, the college. What do you remember about your early impressions of OSU and of the college of forestry?

SS: The things that stand out over all these years—Dean Stoltenberg, who hired me, and successor George Brown—just this incredible sense of "go out there and make an impact. Serve the state. Serve the nation. Serve just"—this incredible ethic of service. I came in here still somewhat young, still very much wanting to do science, and wanting to survive also in academia. I was very nervous—am I going to be able to get tenure? They really wanted much more. They weren't interested so much in am I going to survive and get my next grant, but what am I going to do to change the world for the better. Also they had a sense of how am I going to serve the Oregon industry better and make Oregon more productive and economically more vital. I just felt that, and I felt the pressure of it, but I also felt that it was wholesome and real and good. So that was another reason for the transition to poplars. I mentioned I did this genetic work early on—on the evolutionary relationships of different species. That was a great way to use biotech methods to advance science, but it wasn't really going to advance Oregon forestry, except at a very fundamental level. So when poplars came along, and I could use genetic engineering I could do great science, and it can have an impact on the industry and on society maybe tomorrow [0:40:08]. If we can really grow trees 10%, 20% better by using genetic engineering methods, and we can do it in poplars in my lab and get it out there, that's exciting—that conjunction of application.

One thing that we've worked on too for many years that tied into my environmental background, was it was pretty obvious to me that genetically engineered trees, poplars, were going to be controversial for a variety of reasons. We had already seen it in agriculture and medicine. It was not like society was going to say just "Rah, rah, rah, let's have more of it." They're going to say, "I don't like this," or they're going to say, "Who controls it?" and so on and so forth, and "How should we regulate it?" "What should the role of the EPA be?" and "Should we have really strict regulations?" So it was obvious to me that was all going to happen, and was happening, and the biggest issue that science can deal with about that is the release of propagules into natural environments. I think cognitively you cross a line when you say you're going to genetically engineer something. Then you're really saying that humans are really taking control of this organism and changing it to their needs. Of course we do that with conventional breeding—all of our crops, corn or whatever it is, look nothing like their wild relatives.

And we've made that cognitive leap, but I think now we're even more conscious of that then we used to be, and genetic engineering—because it's unnatural [air quotes], mostly unnatural technique, it does happen in nature but not commonly—you cross this cognitive line, where it's obvious to me that people might say, "Well I'll accept in these intensive poplar plantations that look nothing like a natural, that genetic engineering can have a place, but I don't want the pollen and seeds spreading out into wild riparian cottonwood areas where really what we value is biodiversity and all the ecosystem functions." That's going to be a problem. Indeed it is. So we said, "We need to, for those plantation trees, we need to shut down flowering." We think the trees will grow faster as a result, but the main thing is that even though poplars do vegetate and spread a little bit we can manage that, but we can't manage pollen floating miles and miles in the air.

Another exciting thing was in addition to developing the gene transfer methods and working with industries to test things, we said we're going to develop the genetic containment technology so society accepts it. We've continued to make that our focus all these years, and that really tied into my environmental consciousness coming in: let's use advanced technology but let's do it right. That's probably what I'm most known for around the world—developing this containment technology and putting it into practice. It takes a long time [smiles]. The science takes a while. Getting the genes in, and then if you're studying flowering you have to wait years, because trees don't flower right away. So it really is, I didn't realize it so much at the time when I made that decision in the early '90s that I was committing to two or three decades of experiments, and that's what's happened. That's what's going on. They're still in the field outside of Corvallis.

CP: At what point did you start to receive some push back from various outside entities. Was that pretty much from the get-go?

SS: In the beginning there really has been, I don't know that anybody's measured it—I'm sure they have measured it, I should probably go find the papers where they've done it—but I used to mock some of the media coverage, including OSU's own public relations, that: "Here's biotechnology. It's the answer to all our problems. It's going to feed the world. It's going to revolutionize. We're going to make square trees that just go right into boards." All this crazy stuff that I knew was not going to happen and not going to happen in my lifetime. So it was hyped. And society—they were sort of giddy about it. Then over, I think it was the late '90s, when various things happened in agricultural biotechnology, then the media coverage became pretty negative and big environmental groups, like Greenpeace, with hundreds of million of dollars in funds - essentially environmental corporations - decided they were against all of it everywhere, whether you were making vitamin A to deal with blindness, whether you were trying to treat—they were against all of it. It was an ideological thing. Partly because organizations like that with a lot of power and money changed, things shifted. Things became much more negative.

Again, in the later '90s where you start to see a lot of vandalism—first in agricultural biotechnology and then a forestry [0:45:02]. So in 2001 was a big year. Here at Oregon State, in Corvallis, we had vandalism—somebody came in during the middle of the night in Corvallis and cut through a wire fence and damaged about 1,000 trees. It was at night, and you can't tell the ones that are genetically engineered from the ones that aren't, so most of them they actually didn't get what they wanted to. It was an indication of just the intensity of the issue. That I think was in March, and then in June there was arson against a collaborator of mine at the University of Washington. His building was almost completely burned down. A collaborating industry in Clatskanie had a million dollars in farm equipment damaged, so it really ramped up. It really got intense. I was the chair of an international society for tree biotechnology and we were having a meeting at Oxford in, I guess it was, 1999 a couple of years earlier. The one field trial of a genetically engineered tree in England was vandalized the evening of our international scientific conference. All these things told me that, "Holy cow—society's not with us."

Then in Europe in particular, which was violently reacting against Monsanto and bringing in genetically engineered soybeans as animal feed into the country and blockading them and all that. When these trees were damaged outside of Oxford, these trees were trees that had, without going into the technical details, they were engineered to be easier to pulp, they take less energy and less chemicals to produce the same amount of pulp. So it's something that we all thought as scientists the environmentalists were going to love and that we'd have strong support for, but no—the bigger narrative in society really dominated that. So when these trees were destroyed the science of what we were doing was irrelevant and the storyline and the major media—*The Guardian* and others—was "Monsanto—now they wreak havoc on the food supply and now they're going to wreak havoc on our forests." We were all like, "Holy cow. What are these guys smoking?" That's how big the social narrative is about genetic engineering and GMOs. The details of the science really don't matter much, and that's a hard thing to remember. But 1999, 2001.

Also in 2001 we had 9/11 in the United States and the government called ecoterrorists terrorists and they pursued them the same way they were pursing people who were bombing the World Trade Center. So that kind of stuff stopped. The guys who did the stuff in Oregon and Washington were mostly caught and put in jail. In Europe in continued and in the U.S. it stopped. That was a big marker that things were just crazy out of hand. But society's reaction continued to ramp up after that.

One of the conditions we have today is that Green Peace and others who are very against this stuff have created conditions where forest industries really can't use genetic engineering, period. They're own certification organizations don't allow it, even in research. So field trials and collaborative work I did with industries years ago doesn't happen anymore, or happens outside of the Northwest in very special conditions because the social conditions have become so hostile. Just like in organic food you can't have any GMO in it no matter what. Even though scientists will say, "There's good uses of it in addition to the ones that are questionable;" it's an all-or-nothing thing, and that's where society's at with forestry uses right now. One of the things that I've done in my career is tried to argue that we need research to find out what are the good uses and what are the not-so-good uses and how we can make a not-so-good use and make it good. That's really not gone anywhere, even though I've tried to, what I would consider, to have a more middle of the road, more reasonable science-based agenda.

The environmental community, the marketing arm of it in particular, feels like this is the way they have to be to get the consumers to buy their products, to charge more for it, and maybe do the right thing in their view. It's become a hostile world. I'll be able to finish my career using this technology but by and large in forestry around the world the amount of interest in genetic engineering as a method has really gone—[downward sweeping motion with arm]. It's not zero, but it's really gone way down. The social pushback has been bigger than anybody could have imagined.

CP: How have you been able to navigate that, or how have you been forced to adapt or compromise?

SS: It's a reality and it's important to recognize—it's sort of a 12-steps thing—recognize what you can change and what you can't [0:50:03]. I've written a bunch of papers about how what a smarter way would be to regulate, what a smarter way to be to market it. I had a paper in *Science* magazine last year, I'm about to publish in the very best journals putting forward ideas. I've collaborated with lawyers and economists to get the social stuff right, being I'm a biologist. There's larger forces, larger social, economic forces. Big companies profit from avoiding GMOs. They're not going to stop doing it. It's not just philosophical. There's a huge profit margin to saying that you're cleaner than thou, and I call it green washing. It's everywhere in the marketplace now. I can't buy a loaf of bread that I want without a no GMO seal, even though I'd like to avoid it because I know it's meaningless. So it's a bigger thing. So what do you do with that?

From my point of view—we had at OSU an outreach in biotechnology program, mainly funded through the College of Ag, probably funded through forestry, that I was the chair of, the director of, for about eight years. It was kind of a soft program. It used to be something that was a hard program, an extension, and it got softer over the years. We had a website, and we hosted 40 public lectures. We got amazing scientists from all over the world to talk to the public in Corvallis about all these issues. That was one way that I thought I could really help change society, or make society smarter about this. I think it was super successful. But I think OSU, the College of Agriculture, has sort of tired over this, and there's only so much science can do, and they've backed away. They don't want to alienate their more organic elements that are anti-GMO. Most universities, not all of them, the large majority have said that this is bigger than we can deal with. Our state funds are being cut. We'd rather have somebody who is breeding berries than nobody breeding berries and have somebody fighting this wave of anti-biotechnology because it's very complicated. It is. If you do a responsible outreach about it, it's not just "Rah, rah, rah;" it's "Here's the tradeoffs. Here's the pros and the cons, etc." It's a complicated story.

From my own point of view I've wrote scientific papers, talked to regulators, I still give three, or four or five talks a year about it—I talked at the public library in Salem to the environmental educators consortium up there a few weeks ago. So I still do things occasionally, but basically I've said that I can do research to advance the science and the technology, and when society's ready, if they're ever ready, it'll be there. So that's where I've put 95% of my energies, is doing the science. It's hard. One thing, the conditions are sufficiently adverse in both Europe and the United States for applied biotechnology in the public sector that it's very hard to go to a USDA or Department of Energy grant panel and say "I have an idea for a better genetically engineered tree. We're going to tweak this and that." They're gong to say, "Well, it's a GMO, right? So it's going to be really hard to get regulatory approval. Companies are going to have trouble growing it. So we're not going to fund that." That's happened the last 15 years. It's very hard.

The one kind of funding you can still get a little bit of, if you want to say, "Well, we need better safety technology. We need to not worry so much about getting better trees but getting safer trees." That little niche has allowed me to continue doing the research I do on genetic containment and so forth. That's one of the ways I've been able to keep doing what I believe is interesting and important: getting the science done and testing it in the field. To me it's very important not just that I do laboratory work; when you go out in the real world most laboratory ideas don't actually work because the world is complicated [smiles]. But I have stuff out; I have 10 acres growing in Corvallis now that are testing ideas in the field from the laboratory. At any rate—but it's this safety orientation that's allowed me to keep productive, keep doing good science even though the social milieu is extremely adverse and funding is very hard to get.

CP: So the work on biosafety and sterile nursery plants has almost been a survival strategy on your part.

SS: Exactly, yeah. It's survival but it's also something I'm interested in. When I started that consortium and started working on poplars and I said, "We need to figure out containment." I'm still doing that, and luckily that hasn't dried up. It could anytime, but it hasn't so far [0:55:02]. I do work that is state of the art. It's competitive throughout science and throughout agriculture: the panel that funds this is mainly a USDA panel called Biotechnology Risk Assessment. That one, the ERS thing that you just mentioned, was a separate thing related to it, but that's funding all of agriculture. So we have to be doing work on trees that is competitive with the very best work on corn. That's hard because they have a lot more money, and they're a lot more advanced genetics. I'm proud that I've been able to do that. I compete with those guys because the science we do is just as good. If I did it in Douglas fir I probably couldn't. But I can do it in poplar [laughs].

CP: Something else for you that caught my eye was the project on carbon sequestration using poplar trees. Could you talk about that?

SS: It's interesting. If you decide you're going to grow trees seriously for some purpose, meaning they're going to have a dominant dedicated use, what nature gives you is okay and you can tweak it further but often you want something very different. A lot of people who do ecological modeling started saying, "If we produce trees that have more roots and less stem," which is contrary to what people do in forestry—they tend to want the fastest-growing, tallest tree. And I said, "No maybe we don't want the tallest one, maybe we want the fattest one with lots of roots and the roots will add to the carbon and the soil and decay much slower than stem material would, maybe. Maybe we can even make the roots so that they decay more slowly and enhance the amount of terpenoids and phenolics, these compounds that slow down decomposition so that the carbon stays around in the soil longer." So it's those ideas, that we can change the allocation between tops and bottoms and change the chemistry of roots that would promote carbon sequestration. That was the idea.

We also thought if we have a tree that has more roots it will survive great stresses, it will bioremediate soils better. We also have a problem in industry that sometimes when you select the fastest growing trees, and this has happened in the Northwest with poplars, they blow down. We get these giant windstorms every now and then and they just blow over. Also we have in agriculture the green revolution, which is not a biotech and GMO thing, but it's a bunch of technologies starting in about the 1960s. The key one is that a scientist figured out that we don't want taller wheat, we don't want taller rice; when you just select for productivity, everything gets taller. Then when you have a storm they blow over, they lodge. You've probably seen this around Pendleton. That happens occasionally. Then the crop is lost and rots. The quality goes.

What these scientists did is they found a dwarfism gene - semi-dwarfism - that keeps the wheat, instead of being [reaches towards the ceiling] way over your head, it keeps them about here [motions to height of chest in sitting position]. Most of what we see around Oregon is like that. That's a particular gene brought in from an Asian variety that constrains them from getting tall. So it gets more roots. So it gets more seeds on it, and it doesn't lodge. So it was also that thinking—that maybe we can sequester more carbon, have a tree that is more drought-tolerant and bioremediates better by having them be shorter. I'm not talking about three feet tall—I mean, this is a tree, so instead of a hundred feet you might be sixty feet, or whatever. You would slow it down and change the distribution and the quality of the bio mass. That's what that project was about. Trying to tweak these trees for these particular goals. We were successful at it.

Some of the genes we tested were genes from the Green Revolution in wheat [smiles]. Because the mechanisms are very fundamental, they work quite well. So we were able to get shorter trees with more roots. But was anybody going to use them? No. because they're a GMO and because it would change the industry. The industry doesn't work that way. Breeding would have to be radically different: we'd have to get a GMO probably into the breeding program. Because one of the things you're doing and don't grow as fast—well in nature those trees die because they can't get light, so you'd have to change the whole way you breed trees and evaluate them. Anyway, it would be very disruptive to the industry. But with the GMO element of it, it was a non-starter. So we did the work. It was successful. There it is. The science is done. Does somebody every want to pick it up? I don't know. But that's what that was about. The short of it.

CP: That was a project that had an association with the Sun Grant, is that correct?

SS: That's right, yeah. That was a Department of Energy, USDA funded, those were a couple of them. The biggest funding we got was from the biofuels section of the Department of Energy. That was a big one. Then we had some supplementary funding from other places [1:00:07]. We've also got funding from the Sun Grant and a couple other places on trying to make a tree that would have some valuable coal products. So one of the problems with growing bioenergy is that energy is cheap in the world. Unless we tax fossil fuels really aggressively, which we're not almost anywhere as aggressively as it should be, they're not competitive. So how do you make them more competitive? One of the ways is engineering some product that is high value, a new biochemical that would have some other higher use in industry. So we try to get trees that produce bioplastics. Things that we can use. We're already using similar versions from bacteria—these cups that decompose that you can put in the compost. We tried to make the same kind of thing with poplar trees, and we did it, but we couldn't make enough to make it economic. So we need a major engineering leap to make that work—there's just no funding for it. It's also a hard problem. That's what one of the Sun Grant projects was about: was trying to figure out how to make those biofuels, and we collaborated with companies who were doing it with different crops. It's a hard problem. I still have a student who is working on an element of it, but it would require a pretty serious effort.

CP: Has any of your work intersected with the cross laminated products at all?

SS: The short answer is no. I was at a conference—the Panco Foundation is this forestry foundation funded by this, I assume, rich guy who really wants to infuse advanced engineering technology of all kinds to make better wood products, including the laminated products for Oregon and for the industry. These, "Why aren't we doing genetic engineering?"—He's looking at all the amazing things in engineering in the traditional sense, why not genetic engineering? I went to this conference with other engineers and I told him why—it's the broader social element and it's also that the industry is not ready for it because we're still sort of in the Neolithic breeding-wise. It would just be like trying to teach a baby to run before it's able to walk. It just didn't make sense. He didn't want to hear that but that's the reality of it. It could be done.

Before we did that, for example, if you're going to have the precision of genetic engineering to get the fibers to be bonded in a way that would be better for CLT, or glue better, or whatever it might be, the first thing you want to do is just homogenize the wood. As an engineer you want to know it's going to be a certain thing and then you can tweak it, right? Right now in our forest the variability in wood properties is incredible. So you first want to be able to probably clone trees. The problem with that is that it's not affordable in the industry right now. So unless you get to that—that's again a crawl, walk before you run—we're not going to get there. And so I also told him that—the industry, until we get to those barriers we're not ready for it, and that's a matter of economics and probably also social acceptability. "Would it be okay to have cloned Douglas fir all over the landscape?" I don't know. What would the Sierra Club say? They'd probably hate the idea. Due to economics plus concerns, it's just not happening.

CP: Tell me about the Leopold Leadership Fellowship program. I got that was something fairly important to you.

SS: That's a great thing. It resonates today. Jane Lubchenco at OSU, distinguished professor, president of AAAS, national academy member, amazing scientist and person—she and some colleagues said, "Scientists don't have the skills and the network to communicate with the media and decision makers like they need to." Her interest was in getting more environmental science, and science in general, into policy. Most politicians don't have science backgrounds. Almost none of them do. So you need to talk their language. You need to know how decisions are made. You need to know how to talk to the media, how to talk to science journalists, non-science journalists. So she created this program that was funded by various foundations over the years. It's still centered at Stanford, an organization at Stanford that still goes on, and they train cohorts of something like twenty or so leading environmental scientists—people in a mid-career who you can see have been very successful and are going to make an impact and are called to speak to the world, to change the world. Very much like who I was growing up and who I still am.

So you apply. You say what you do. They look at your publication record, your passion, your skills. I was one—I think I may be the only, person who would call them-self a biotechnologist in that program [1:05:03]. It's mostly ecologists, a few lawyers involved, a couple of economists, but pretty much very strongly environmental people. People not so much working on the technology side of it. Anyway, this group has been going on now, I'm going to guess, twenty years, something like that. They have these cohorts of scientists who come through, and a lot of them are now very well-established in the field. There's a network of them, and they communicate and they collaborate and they try to organize action and write letters to the editor and conferences. Particular now with all the things going on with the Trump administration, it's kind of been [raises arms in the air] come back to life, where they're really trying to do things and so forth. I'm part of that organization. I love to see information they share about how to be more effective: "What do you do now as a scientist?" "What's the right thing to do?"

There's a discussion going on about whether it's good or bad to engage in the March for Science next month. "Is that politicizing science more? Making us more of a special interest group versus arbiters of truth or not?" Or do we have to?" So that's an example of how that network helps. People think, distribute information, and so it's very nice. Like I said, I'm kind of an outsider in it, and I kind of feel like when it comes to GMOs and biotechnology and agriculture probably the majority of them are negative on it. I'm kind of a lone wolf there in saying, "This is powerful we just have to use it right." I'm involved in that and it's important me. It's also a network of environmental scientists who are mostly not interested in the kind of stuff that I do. So there it is. I'm not super active in it by any means, probably because, as I said, it's kind of a little bit to the left, or whatever it is, of where I'm at in terms of using technology in the world.

CP: Can you talk a bit more about GMOs with respect to food? It's obviously a big issue for a lot of people.

SS: I follow that pretty intensively. I teach about it at OSU. I've been doing that. I have this outreach program. It's very hot and very political, and I think one thing that's really clear is that it's mostly not about the science. I think the people who are very against GMOs want to make it about very dangerous, inadequately studied science. I just think for them that's a tool, a tactic. I think the people in the know know better than that. There's issues of intensive—probably the biggest issue is industrial agriculture in general: it's incredible benefits and incredible harms. Probably plowing is the most damaging thing we do to the whole planet. It's not just industrial agriculture that plows, it's organic agriculture and everybody else, and they often do it more [shakes head, smiles]. Then you have the use of agricultural chemicals, which are an incredible energy-saver and productivity enhancer, but they can harm things. Rachel Carson and *Silent Spring* helped show that for DDT.

Now we are in a whole different era than we were back then, where things are intensely regulated and monitored and many bad things have been taken off markets, at least in the western world. To get a chemical approved takes hundreds of millions of dollars in tests and studies and labels that restrict its use and so forth. There's a lot of safeguards built into the system that we didn't have back in the old days. But is it good enough? No. It's not going to be perfect. We're going to make mistakes. So how do you think about chemicals used in agriculture? You have systems like the Organic Certification System, that say we won't use any, except actually for quite a long list of exceptions if you read the details. That's another element. The major GMO crops now use chemicals direct or indirectly. They use chemicals in the form of promoted herbicides by being herbicide resistant. They use chemicals in the sense of isolating a pesticide from a bacterium and putting it into plants. This pesticide, something called Bt [bacillus thuringiensis], is one that's widely used in organic agriculture, so it's very, very, very safe. And then they splice it into a plant—well now it's supposed to be very unsafe [pauses and squints in confusion]. It involves things like chemicals and it involves intensity PA regulation.

The more you regulate doesn't mean that people feel better about it. It actually shines a big spotlight on it, and so it's just extremely messy, both from a society and sci—and of course the science continues to grow and innovates [1:10:09]. It does new stuff all the time. How much regulation just impedes public benefits and impedes economic development versus protects the public and the environment. Getting that right is crucial. I'm by no means a supporter of the current presidential administration and the particular individual, but the issue of how much regulation is too much is a really hard technical one, and the soundbytes you get in all the news media are generally misleading and wrong. In the area of biotech, and I've written a lot, I think the regulations are totally out of control. There are some kinds of biotech that should be intensively regulated, probably more than we have now. In other kinds really there's good record that there's no regulation needed at all, zero. We have this thing called gene editing. It's a new technology for modifying the national DNA there for any reason, which is what breeding does, but now we do it with science and precision. That's probably going to be regulated, certainly in Europe, like it's taking a gene from a faraway species. It's from my point, it's just crazy.

CP: Is this the CRISPR technique?

SS: Yeah, it's the CRISPR technique. That's a big source of controversy right now. The USDA put out a proposal to not regulate some parts of that, which I think is innovative and forward-looking. I don't know what's going to happen under the current administration. In Europe it's very likely to go that way. Either way, the organic people have already said on record they will not accept it. It's just an ugly, messy area. Frankly. It's rife with trade-offs.

I just gave a talk last night to my own laboratory group. There was a very good paper lately on the record of GMO crops in terms of pesticide use—do you use more, do you use less, do you use better kinds of chemicals? The reality is it's a mixed bag—we're doing all that depending on the crop and the timeframe and it's just that's the reality of it. We know there's also billions in benefits to the economy. We know there's also improved soil as a result. So what's the right answer? So if you like simple answers, this is not the area for you. I try to, when I speak about it and teach about it, I try to give students a sense of both the frustration and anger at this simple-minded social response—non-GMO labels, organic certification, I'm cleaner and better than you, and a big reason of that—people go to organic now to avoid GMOs. Regulations that are so intense that breeders like me, I could be breeding poplars for Oregon using GMO techniques except that it costs me $100,000,000 to release one variety, even with CRISPR. It's just like [shrugs and shakes head]. On the other hand, we have companies overusing herbicides and creating herbicide-resistant weeds. It's just really complicated and difficult.

My own personal point of view is don't throw out the baby with the bathwater. Take some intelligent middle ground. That's not where society's at in terms of marketing and labels. That's not where regulations tend to be. The regulations reflect people's fears. The regulators like to say they're science based. Nowhere are they really science based. They try. They're always trying, but the political pressure's incredible in the U.S. and in Europe to actually make a science-based decisions, and the activist groups work so hard to influence the science to get their people on the boards and to change the ways decisions are made. I used to be a member of the Green Peace, Sierra Club, Friends of the Earth, and all these guys and now I wouldn't give them a dollar. That's where I started, and now I don't trust them. I give a lot of money to certain environmental organizations, like the Nature Conservancy, which are really science based, but these guys are not. So who are the good guys anymore? In the whole food GMO, food biotechnology area you get all that: the good guys, the bad guys, the bad guys are the good guys how do you decide?

CP: I have a note here to ask you about the future of forests?

SS: [laughs] Right.

CP: Which is a big question, but in hearing you talk it feels to me like a lot of what you're doing now you're creating work that might be used in the future in a different environment. Is it fair to assume that you think the future of forests might, on some level, depend on genetic engineering?

SS: I made the argument that one thing you have in the world with climate change, with people traveling around the world, with pests evolving evermore fast—the stresses on forests are enormous [1:15:06]. There are various papers recording the hundreds of introduced and new pests that are damaging forests everywhere. It's an incredible, difficult thing. The main way we deal with that is through biocontrol, conventional breeding. But sometimes those don't work. One case you may know the story of—the American chestnut? I don't know if you're familiar with that. It was a species that was a dominant species—much like Douglas fir around here—all over the east coast entirely destroyed by an exotic fungus. That was a hundred years ago. Now people have been working through conventional breeding and biocontrol to restore it, and so far not much luck. So a scientist in the State University of New York has found if we study the mechanism of disease, the pathogenesis, and how it really works, and it's like other pathogens, where he's found that they produce this thing called oxalic acid that actually is what kills the tissues. It produces oxalic acid. It kills the tissues and the fungus acts as kind of a saprophyte and just basically eats the dead tissue. And he said, "Well if we can just get rid of their oxalic acid and turn it way down maybe we'll turn it from a pathogen to a saprophyte. It'll still be around, but it's not really going to damage trees." So he's done that. Kind of an amazing thing. He took a germ from wheat, in fact, put it into chestnut and the trees appear to be resistant. So there's a case where genetic engineering was important and it was very, very quickly do what breeding and other techniques couldn't do. So that's a well-known case.

But then we have other species that are at earlier stages of that same devastation. There's Emerald ash borer, there's Hemlock adelgid, a few other things around the world that are in that category of what looks really bad for the species. From my point of view when you have a crisis like that you want to use all your tools, and genetic engineering is definitely one. Where you come in, and you don't say, "Well, what genetic variation the tree species has is going to have to be good enough." You say, "What are all the tools I have?" And if a guy at the State University of New York or elsewhere says, "I think I understand how this pathogen works;" let's take a gene and move it. Let's tweak a native gene. We do have some things that are somewhat similar in chestnut, but we need to edit it. We need to do CRISPR to change it. And let's do it fast because this is an emergency to get this out and start testing it. We can't wait for twenty years of regulatory analysis and ecological approval. But we can't do that. We can't do that today because of the rules and regulations and people's phobias and the inability of companies to see that they could ever use such a trade. There's almost no investment in that kind of technology. To me that makes no sense, the line between precaution and paranoia. Precaution is taking intelligent measures to look before you leap. Paranoia is being so afraid and building an institutional system that's based on fear, and I think that's where we're at with genetic engineering and it makes no sense.

Anyway, I think it could be a powerful technology for the future. All trees can be semi-dwarf in a future time if people were to actually allow that to happen, and maybe they'd be more productive and more stress resistant. But we're not going to know in my lifetime if that's true or not. I think there's powerful things we can do with it. I think the uses would be selective, these really more egregious cases that I mentioned, because conventional breeding is very powerful and there is essentially no limits on it. You can take a species from anywhere in the world and move it here to Oregon and if it works, it's fine. That's radical genetic engineering, really, and we can do that without any constraints. But if you tweak a gene there's these huge constraints and issues. So why mess with tweaking genes when you can do that other stuff? We've sort of painted ourself into this corner, if you want, a bit.

CP: Graduate students, I assume, come to your lab because they're attracted by your work and want to pursue similar topics. What do you tell them? I mean, it sounds to me like you hit a time period of cultural history, I suppose, where you could do the work that you did, but that window has closed.

SS: Right. Well, I tell them a few things: [if] you're going to graduate and get a job in the forest industry doing biotechnology, the job opportunities are very small. So I tell them you have to be competitive with any agricultural biotechnologist. You need to be able to get a job at one of those companies or the USDA that's still doing some of this, particularly for serious diseases [1:20:04]. And you need to have what I call a bio informatics training, meaning that, putting the GMO thing aside, you need to be able to do state of the art computational biology, which doesn't involve GMOs because that's the entree to where most jobs are in the broad area of biotech science. Otherwise, a lot of them come to me because they're motivated by the things we're talking about. They want to see the world change. Because they see how powerful genetic engineering is. They see all the misinformation out there, including from the good guys [air quotes]. They're angry and they're passionate. So I tell them, "Eyes wide open. This is the reality;" that's what they say. Again, it's really critical that they do state of the art work. Then they'll get a post doc and they'll be able to move into other areas.

CP: A couple of concluding questions. I'm interested in your perspective on change in the College of Forestry, that change is very visible to everybody right now—there's a big hole where Peavy Hall used to be. Tell me how the college has changed and moved in different directions in the years of your association.

SS: I think we have a great leader, Dean Thomas Maness is very visionary who really wants to move the college ahead very powerfully. He wants to move into the environmental mainstream if he can. He's trying to build much better bridges with environmental organizations than we've had historically. He wants to reduce polarization we've had amongst the pro-industry and the pro-environment folks, and I think that's happening over time successfully. He wants to move into this advanced laminated technologies and this new building, which is a big part of the money and the push is to do that kind of thing. I think that's really positive. [...] The college is also now in different parts of campus, and that's hurt a sense of unity that we have. I think he's trying to set us on the right path and do the right thing. I hope he can bring his vision through to completion, but I think that's unknown right now.

CP: What kind of impact do you think the new forestry complex might have on the college?

SS: I think new buildings—I've been discussing this with various colleagues. There's obviously a big cost, but the environment you live and work in matters. It matters to how you feel, how you interact with people. I'm in Richardson Hall, which is about 15 or 19 years old. But it was designed with lots of light and lots of wood, and it's brought people together. Even though it had its own little design flaws—we found out it was bad at keeping out things like rain [laughs]—it's a really beautiful environment. So I think he wants to take that to another level and create a sense of greenness and collaboration and innovation that I think a new building helps to motivate. I like the idea, and I think there was criticism about whether it was green enough and how green you need to be to tear down an existing functional building, but also quite old fashioned and not a great collaborative space at all—very much in the old model of people basically in file cabinets. I think they've done a lot to try to be green while also making it something you can sell to donors—because donors don't want to invest in changing the siding on an existing building; they want to invest in a vision. So I think he didn't really have a choice but to create a new building. I'm hoping that the dean comes back and the building is as beautiful and as functional as we hope it will be and helps bring us to another level. But right now I think we're in this precarious place where we're a year or two out from having that building. And all building projects I know of it costs more than you think and then you have to make difficult decisions as you go and does it actually do everything you thought you were going to do with it. So I think there's those risks as well, but I'm hoping.

CP: My last question for you. This is a sesquicentennial project, and I'm interested in your point of view of the university as it looks towards its 150th birthday. Where do you think OSU's positioned right now?

SS: I really felt really fortunate to be part of this institution for—I think I'm going on my thirty-first year that I've been here. Both the leadership I've had in the College of Forestry has been excellent. John Byrne and Ed Ray I think have been inspiring and responsible leaders. I have not gotten involved in administration significantly, so, like every other faculty member, I know them. I wonder if we are investing far too much, given our limited state budgets—administrators just seem to be everywhere. I wonder if every administrator is really needed and what they're doing, what they're impact is. In general I like the ethics and the structure of the place, and I'm proud to be a part of it. I like the emphasis that we have on equity and diversity here, and I think that's really important. Oregon is a very white place, and it's a white place for institutional reasons, and, in my opinion, those need to be corrected and addressed. So I'm proud that we're doing that pretty actively. We're doing that pretty actively in forestry as well. I think that's the right thing to do. So in general I feel good about it.

I would love to see more of the administration explain who they are, what they do, and how cost effective they are. They don't seem to feel the need to do it. I don't think that's right. In that regard I would love a little bit more of a business sense of explaining to faculty how they're making smart decisions and what the administrative decisions that they make really cost as compared to—could we have 10% less administration or 50% more faculty members doing innovative research and teaching? Those tradeoffs, I don't understand them, and I don't know if anybody does because I don't think that administrators feel the need to explain them to plebeians like me, and I don't like that. In general very positive but with some sense that maybe we have some runaway administrative investments. I think that's a common problem in higher education as far as I understand it. So how do you reign that in, or how do you at least understand it and decide if you agree with it or not?

CP: Certainly not the first time I've heard that.

SS: But in short I feel privileged to have been here. The community has been an extraordinary place for me to live and raise my children. When I go back to my Yale reunions and those folks are all over the world, and they say, "Hey you've traveled everywhere, where would be your ideal place to live?" I always say, "I'm living there." I've traveled the world too, and this is an incredible place to be.

CP: That's a good note to stop on. Thank you very much. I really appreciate this.

[1:27:36]