Milo Koretsky Oral History Interview, November 13, 2015

Title
"Building a Better Engineer"

Date
November 13, 2015

Location
Valley Library, Oregon State University.

Summary
In the interview, Koretsky discusses his family background and upbringing in Berkeley, California, noting the cultural tumult of his youth and his experience of growing up with an identical twin brother. He likewise notes his early educational memories, his decision to attend the University of California-San Diego, and his uncommon switch from English literature to chemical engineering while an undergraduate. Next he recalls his master's studies at UC-San Diego, recounting his research on impinging jet sprays and his increasingly formalized interactions as a teacher.

From there, Koretsky provides an overview of his doctoral studies at UC-Berkeley, commenting on his research on plasmas, his mounting skillset as a classroom instructor, various faculty who made an impact during his Berkeley years, and the broader orientation of the Chemical Engineering department during that period.

The session then turns it attentions to Koretsky's work at and association with Oregon State University. In this, he reflects on his early impressions of OSU and the Chemical Engineering program, speaks of his early research activities, and details his interactions with a few important colleagues, including Octave Levenspiel. Of particular note are Koretsky's comments on the formation, growth and activities of the OSU MECOP program, with which he has been affiliated for his entire Oregon State career.

The remainder of the interview focuses primarily on Koretsky's activities in engineering education. In recalling this program of work, he outlines several initiatives that he has spearheaded, including the creation of virtual learning modules, the authoring of a new type of thermodynamics textbook, his own continuing evolution as an educator, the implementation of studio classes, and a new project that aims to resituate engineering learning and instruction. Koretsky also provides his institutional memories of chemical engineering at Oregon State, describing the impact of the creation of the School of Chemical, Biological, and Environmental Engineering, and sharing his thoughts on the potential impact of the school's forthcoming facility, Johnson Hall. The session concludes with Koretsky's perspective on the current direction of OSU.

Interviewee
Milo Koretsky

Interviewer
Chris Petersen

Website
http://scarc.library.oregonstate.edu/oh150/koretsky/

Transcript

Chris Petersen: OK, today is November 13, 2015 and we are with Milo Koretsky who is a professor in Chemical Engineering here at OSU. And we'll talk a lot about Dr. Koretsky's work at OSU, particularly in instruction and with MECOP, but I'd like to begin at the beginning and talk a bit about your upbringing. Where were you born?

Milo Koretsky: Alright, so I was born in Berkeley, California.

CP: Is that where you were raised?

MK: Yes, born and raised in Berkeley.

CP: What were your parents' backgrounds?

MK: Both sets of grandparents were in Eastern Europe – my father's side in the Ukraine and my mother's side in Poland. And they met in New York, and then my father came out to California and was stationed in Alameda during World War II. They moved over to Berkeley and didn't get back to New York.

CP: What were their professions?

MK: My mom was a housewife, as was common at the time, and my father was a civil engineer. He had his own company for a while and two oil embargoes in the '70s kind of crushed that.

CP: What was it like growing up in Berkeley in the '60s and '70s?

MK: It was crazy. It gives one an interesting perspective, that's for sure. I remember being in grade school and them cancelling school because tear gas was wafting onto the playground. There was a lot of color and a lot of ideas; it was an interesting place.

CP: What do you remember being interested in as a boy?

MK: I was a sports junkie – Oakland Raiders fan and San Francisco Giants fan. I was interested in reading and ideas; actually kind of hopped between a bunch of social groups; music was also an interest.

CP: Playing music?

MK: No, I didn't start playing music actually until my first sabbatical. More listening to it.

CP: Well, you had an engineering father, I gather that put the kernel of the idea about science and engineering in your mind as a boy?

MK: Yeah, although it was a strange thing. I went to do my undergraduate at UC-San Diego and started out in English literature, and then shifted to engineering in my junior year, and that was right after my father died. The last he knew me, I was an English literature major.

CP: What was school like for you growing up in the grade school/high school time frame?

MK: School was pretty easy for me – I'm an identical twin, so I shared an experience with my brother, and it was even easier for him. But I was always engaged in school and interested in a broad set of things. Advanced in math, the more verbal things took more work. I think that's what generated an interest when I went to college in that.

CP: What path did your brother take through life?

MK: My brother is a vice-president at Ticketmaster right now. After high school he stayed at Berkeley and got a bachelor's in math and economics at UC-Berkeley, and at the same time worked for a ticket company college Bass Tickets. He stayed in the entertainment industry and living in the Bay Area.

CP: Can you give us a sense of what it's like to have an identical twin?

MK: Well that's my only reference frame, but I'm really close to my brother and the kind of spoken and non-spoken things we share is really great. It's interesting because, as we get older and go through life, I see a lot of similar changes in us, even though we don't interact as much as we once did.

CP: So I'm guessing that college was sort of something that you always assumed you were going to go to?

MK: Yeah. I have two older sisters, one of whom went to college and one of whom did not. My parents were pretty loose in terms of discipline, but the disappointment in her not going to college and the expectation was pretty solidly grounded.

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CP: How did you decide on UC-San Diego?

MK: That was a pretty simple choice for me – I could pay state tuition. And actually, when I went away to college, I became financially independent at that point – financial aid worked a little bit differently back in 1979. But it was the farthest I could go away from home and still pay in-state tuition and be at a reasonably high-quality school.

CP: Pretty different communities, I'm guessing, San Diego from Berkeley.

MK: Yeah. I actually went away, I had just turned 17 when I went away to college. There was a social aspect that was pretty interesting. It was a pretty dramatic shift in the cultural norms and what the values were of people in San Diego than growing up in Berkeley. And there was a period of adjustment.

CP: What was your motivation for becoming and English major, initially?

MK: Well, I was totally immersed in the Romantic poets and liked their ideas about things and, ironically, the reaction they had to the Industrial Age, the technology of the time. Also developing the skills to critically analyze and synthesize that material. So it was just intellectually really an engaging area.

CP: And you pursued this for a couple of years, it sounds like.

MK: Yeah, I did that for two years. It turns out that it probably served me as well as my engineering degree because, right now if I look at what I do, I write more than doing anything else. So having that solid writing foundation served really well. It wasn't a grand plan or anything.

CP: Pretty radical shift though, from English to engineering.

MK: Yeah, I imagine most people go the other way.

CP: What brought that about?

MK: My sophomore year of college, my father died. And I had grown up in Berkeley with its history of challenging authority and being anti-authoritarian; I think, upon reflection, probably some of my choices for major, both at the start and the shift, had to do with that dynamic and that relationship.

CP: Was it an easy adjustment.

MK: Yeah. The college I was in at UC-San Diego was Reveille College, named after Roger Reveille, and it had a Great Books type of philosophy where there was a breadth of requirements that spanned all the way from humanities to language to math and science. It cost me one year – it took me five years, although I don't know if I would have got it in four if I'd started just directly. But I had been taking a lot of technical courses that I needed anyway when I was an English literature major.

CP: It seems like something that would take, probably, a little bit longer these days - at least at OSU, from what I understand.

MK: Yeah, I'm sure. I think I graduated with something like 248 credits. When I got to OSU, I think it was 204 was the requirement, and now most programs are down to 180.

CP: As you think back on your time as an undergraduate, as somebody who now thinks a lot about instruction in engineering, are there components of the curriculum that you absorbed from that time that stand out in your memories of being an undergraduate engineering student?

MK: There's a few things. I remember the importance of the groups I worked in and the social interactions in trying to make meaning and solve problems. At UC-San Diego, Chemical Engineering was a small program and the interactions with the faculty and the access to those were important. And then on top of that, not just engineering but the general education – as I mentioned, UC-San Diego had the college system model, and few engineers were in Reveille College, but the kind of breadth required in those college courses also had a high impact. So it wasn't just the engineering-specific coursework.

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CP: You pursued a master's degree at UCSD too, is that correct?

MK: I did.

CP: What made you decide to do that rather than go into private industry?

MK: There's a few things. Again, as I said, I went away to college young, I was seventeen, and even though it took me five years as an undergraduate, I was still young and didn't have a lot of things plotted out. So one thing, I did a master's – it was a reaction in that I was recruited to do that, I could spend another year in San Diego, and there weren't other things up. In addition to that, that was 1984 and the economy wasn't very good, so it was difficult finding employment. So that kind of more happened to me than intentionally doing that.

CP: Mostly just an opportunity then to do something for another year, it sounds like.

MK: Yeah. Stan Middleman was a faculty member there and he's a really good researcher, and I had an opportunity to work in his lab and do a pretty neat project.

CP: Can you tell me about that project?

MK: Yeah. We were looking at impinging jet sprays. And what I was doing is I was – the idea is these were jets for cleaning surfaces, and when they hit surfaces they spray. And so if you have toxic surfaces, cutting down on that spray would be important. So we were exploring different polymers to add in to reduce the spray. And so it was an experimental project and I set up a camera and a strobe light, and a lot of it was the methodology of capturing on image how these jets impinging and spraying. And this was '84-'85, so it was just at the start of the personal computer, and we had this crude digital imaging program. And so I took the images, got them into the program, and then wanted to count drop sizes and did a lot of programming to figure out ways that – so the issue was that pixel values would be different and there would be gradients in them because of the widening of the spray. So I had to trick the program into how to account for pixel values so it could count the drops.

CP: And this became your master's thesis?

MK: That was my master's thesis, yeah.

CP: Was that your first experience of doing research?

MK: Well, yeah, on that scale. We had senior projects which posed as research-type projects, which we did in teams. So I had a project my winter term and spring term, which kind of had some of the elements toward that. But that was the first experience working in a research lab.

CP: You also had your first experience in teaching during this time, is that correct?

MK: Well, I don't know if I would call it my first. I mean, I go back to high school, I was involved in teaching enterprises. And as an undergraduate, I was actually a physics TA; they had self-paced physics courses there, and I did that as one of my two major school-year jobs. And then, as a master's student, I was a more formal TA in the program.

CP: What sort of teaching were you doing in high school?

MK: In high school, I was pretty good at math and some of my friends on the soccer and basketball team struggled a little bit more, so I helped them out to do that so we could focus on important things like practicing.

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CP: Did you have a notion fairly early on that this was something you might want to pursue?

MK: I don't think I thought of it that way, but I knew it was something that I enjoyed and had an affinity for.

CP: And it became a little bit more formalized as a master's student?

MK: Yeah, as a master's student I was, I don't remember, I know the summers I was just on research, but I think all through the year – I was just there one year – I think every term I TA'd for support. So that was a more formal environment then. And again, as an undergraduate, I was doing the self-paced where I was just interacting with individual students, and giving them help, and administering quizzes.

CP: Well you finished up there and then you decided to go ahead and pursue the Ph.D.

MK: Yeah, I did.

CP: Was this another situation where the economy motivated that?

MK: Well, jobs were tough, but with my experience – so one of the reactions to kind of finding myself in a master's was I wanted to be more intentional about what I did next. So the cycle was almost like, just after I started my master's was when I needed to apply to graduate schools. And I applied to several graduate schools and was fortunate to get into UC-Berkeley, which was one of the highest ranked chemical engineering programs at the time. So that was something that I wanted to do.

CP: What was it like returning home and going to school?

MK: Oh, I loved it. One thing that was nice was, again, Morey, my twin brother, was there. And those years in graduate school we interacted a lot. San Diego, for me, was a nice place to visit type thing, I really had some good experiences and really liked the climate. But I really appreciated the cultural richness and diversity that Berkeley had, so it was pretty special to go back and go to graduate school there. And one of the really special things academically was just how many really bright folks they attracted to the program. And I also worked over and took courses in the Physics department, and the same thing was true there. So interacting with a lot of students who were engaged and really good, it was pretty valuable and exciting. Graduate school was great.

CP: What sort of research did you perform during this time period?

MK: I was looking – I got my degree in chemical engineering, but I was really doing molecular spectroscopy stuff; I was really doing chemistry. I was trying to measure concentrations of atoms in something called the plasma. So plasma is an electric discharge and it's used to process materials, and it blasts apart stable molecules. And in the process I was looking at, the atoms led to an etch process. So I developed a system to measure that and concentrations and looked at etch rates and understand what was going on in terms of that mechanism.

CP: You continued to hone your skills as a teacher – you won an award.

MK: Yeah, I think that was an inaugural award too – Dow Chemical sponsored it, the Dow Chemical Excellence in Teaching Award. But that was my second term as a TA there, and that was in Clay Radke's fluids class.

CP: Do you remember how that award came about? What was the process that led to you receiving that?

MK: Every year at the first colloquium they would announce awards and they had votes for graduate students – I don't remember the details, but they'd give, like, three per semester of outstanding TA awards from the previous year. And they did that and I didn't get one. And I remember, emotionally, feeling pretty disappointed because I felt I had done pretty well and nailed the course. And then they invited the representative from Dow up to explain that, "hey, we have this new high prestige award." Then they announced it and for the fall term I was the recipient, there was also a recipient for the spring. So it was a new thing that year, and that was initiated by a relationship between the department and Dow.

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CP: What had you done to develop your skillset as a teacher at this point?

MK: In that course, that was a difficult problem-solving course for students, fluid dynamics, which really challenged them. I led recitation sections, which I basically constructed myself, and then I had help-sessions Friday afternoons. I remember the attendance of those throughout the semester getting bigger and bigger and bigger. Undergraduates were spending 4:00 PM to 6:00 PM, Friday, coming to these things and seeing in value in them. And those weren't conducted the way I would do it now, understanding what I know now, but I was basically modeling problem-solving for them.

CP: You also, my notes say, were an acting instructor at Berkeley. Was that part of the same sort of package that you entered the school in? Or was that a different position?

MK: This was a while ago, so I have to remember. At Berkeley, every Ph.D. student had to do two terms as a TA. And then, after I was done with that, I thought, "this teaching this is pretty cool." So I talked to my advisor and he said, "you can keep doing it," and so I did two terms as an acting instructor. And one was, they needed help with the unit operations laboratory, so that was to fill a need. And then the next time, I co-taught thermodynamics with Dennis Hess. I actually just saw Dennis on the plane back from Salt Lake City, we had the same flight. He's at Georgia Tech now, but his daughter lives in Portland, so we ran into each other at the meeting and realized we were on the same flight and visited as we were waiting to get out of there. But he basically divided the class and he taught half of it and I taught half of it. He really mentored me towards trying – encouraging me to try ideas in teaching and mentoring me to explore that.

CP: So he was influential?

MK: Yeah.

CP: Were there other people at Berkeley that made a big impact?

MK: Yeah, my advisor Jeff Reimer, in both teaching and research and just life in general. And Clay Radke, who I TA'd for in fluids. I learned a lot from Clay; he was a dynamic lecturer and the way that he reacted to a class. And Alan Foss, who was the instructor for the controls course, which was the first course I TA'd. He had a course that had a lecture and laboratory components, and the way he orchestrated those and his care about the student experience. To name a few.

CP: So it sounds like Chemical Engineering was a pretty good fit, especially from the teaching side. But it also sounds like your research was running a little bit afield of straight-forward chemical engineering. Is that a fair assessment?

MK: Chemical Engineering at UC-Berkeley is in the College of Chemistry, so there's a tension in the research environment between doing what would be considered solid classic engineering and being really state-of-the-art cutting edge that Berkeley had pride in on the faculty. So there was a lot of activity which was only loosely associated with engineering but was, really if you look at the work, I think you could classify it in the science domain just as easily.

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CP: Was there a connection to industry?

MK: In terms of?

CP: Between the faculty. I guess I'm trying to tease this out in terms of Chemistry versus Chemical Engineering.

MK: So it was in the College of Chemistry and there was a Department of Chemistry and a Department of Chemical Engineering. The Department of Chemical Engineering had strong ties to industry. I think a bunch of my lab mates went to places like Lam Research and Applied Materials and places like that. So there was industrial sponsorship and there was also relations because industry coveted from the program.

CP: By the time that you finished up, were you thinking at all about industry? Or were you still on the academic track?

MK: Yeah, I think with my experiences with teaching and the creativity of research, and kind of this Berkeley kid who had the slight anti-authoritarian bent, being a faculty member was what I wanted to do.

CP: Is it fair to assume that it's a pretty small percentage of people who are in the chemical engineering track that wind up becoming academics?

MK: Yeah. I would say it's a higher percentage at Berkeley than a lot of other schools, but even so, the majority go into industry. And if I look at my friends who I've stayed in touch with, they've done pretty well going that route. I've taken a financial hit taking the path less traveled.

CP: Did you come directly to OSU from Berkeley or was there something in between?

MK: There was kind of something in between, but yes I did come directly. So I was hired as a lecturer; I graduated in December '91 and then spring '92 I was a lecturer at UC – Berkeley. So I had two courses there that I taught, and then that summer I came to OSU at the end of the summer.

CP: Can you tell me about the process? Was it just a matter of there was a job open, you applied for it and you got it?

MK: Yeah. So in '84 and '85, when I graduated with my bachelor's and master's, the economy was tanked, and then it came back while I was in graduate school. And by the time I finished it was tanked again. And that reflects on academic positions, but even more the lack of industrial positions make the academic positions more competitive. So it was a tough time. I interviewed and I had two offers – one was from San Jose State and one was from Oregon State University. I didn't have to think very long and hard about that, so I came up to Corvallis.

CP: What was your impression of the university at that time?

MK: I really liked the Chemical Engineering department. It was a small department; I think I was the eighth faculty member. There might be like twenty-seven now. It had a history of both high-quality scholarship and a real value towards the undergraduate learning experience. So folks like Octave Levenspiel and Charlie Wicks, they weren't faculty members at the point, but their ethos towards these things just permeated the place. OSU was a lot smaller – that was twenty-three or twenty-four years ago – classes were smaller, the scale of things were smaller.

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CP: What was the reputation of the department from the outside?

MK: I guess it depends on what perspective you have. I think, within the community, it was well-respected as a balance thing. If you look at *U.S. News and World Report*, I think where we are at today, which is in the seventies, in terms of rankings. That's what that is.

CP: It was in the seventies then and it is now still?

MK: Yeah, I think so. But I don't understand how those metrics work.

CP: Yeah, that's interesting to hear given how much bigger it is, from eight faculty to twenty-seven.

MK: Yep, yep.

CP: What were the initial duties of your position here?

MK: I came on the Oregon Joint Graduate Schools of Engineering. An idea of that was there was this growing industry in high tech, and so there was a legislative initiative to support that and it was targeted at hiring. So at that time, semiconductor processing was an emerging area of chemical engineering, as a chemical progress. Andy Grove, one of the founders of Intel, was a chemical engineer in the late '60s, early '70s. Even in the early '90s, understanding how the principles of chemical engineering applied to the processes that went on to make computer chips was an emerging area. So I came both to establish a research program doing that, and to create educational programs for undergraduates and for folks in industry for continued education. I remember teaching a class from 8:00-9:30 in the morning at OSU and rainy trips up to Washington County to teach a week's worth from 6:00-9:00 PM up there and then driving back. So those were long Thursdays.

CP: I'll say. And you set up your research program in the computer chips?

MK: Yeah, so set up a research program looking at thin-film deposition, thin-film matching. I looked at computer chips, also was looking at electroluminescent phosphors display materials. Computers and televisions had cathode ray tubes at that time; we were looking at one of the competing technologies to make flat panel displays.

CP: Was there a partnership with Intel or another specific company like this?

MK: Yeah. There was a company up in Beaverton called Planar Systems that I worked closely with. I also had a group in Finland.

CP: I'm interested in knowing of some OSU people who became important to you over the course of time.

MK: OK. So the folks within the unit – Jim Frederick was the department head there, so he was great. He left shortly after I got there. Octave Levenspiel had retired but the creativity and the interactions with him were great. The year after I got here, we hired a few folks, one of whom was Skip Rochefort, who is still a colleague. He wasn't quite as cantankerous then – no I didn't say that. [laughs] Having him as a colleague over the years and bouncing things off him; we collaborated to start an options program in Chemical Engineering, so that students could focus their study in a line of technical electives. One of my first research collaborators was John Westall in Chemistry, just a great guy who I learned a lot from. It was really funny, the relationship with John, because he was a chemist but he thought more like an engineer. And I was an engineer who thought more like a scientist. So we'd be in non-normative roles in our interactions. And then there was John Wager and John Arthur at the Center for Advanced Materials Research. So quite a few folks.

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CP: Can you tell me more about Levenspiel? He's obviously an accomplished member of the emeritus faculty.

MK: Yeah. Octave Levenspiel is a curious character. He has a very creative mind and likes to provoke ideas and challenge people. He was given a moniker – The Dr. Seuss of Chemical Engineering. The story goes – he retired a few years before I got here – but the story goes that there was a signed poster or book or something from Dr. Seuss when he was retiring, and it said something like "To Octave Levenspiel, the Dr. Seuss of chemical engineering, from," I forget Dr. Seuss' real name, so and so, "the Octave Levenspiel of children's books."

CP: Do you know how he developed that reputation? Was it just his creativity?

MK: Creativity and he's – so this was before the personal computer, that he worked. So he would draw out his ideas. He had cartoons. He was a very conceptual person. There's different ways of approaching chemical engineering, but a lot of people are very good at mathematizing it and doing very careful models that are in the mathematical world, and then using the math to come out with new understandings. And Octave was a much more conceptual thinker. He would draw these very neat creative drawings as ways to conceptualize his understanding, and use the drawings in much the way other engineers use mathematics – as tools not only to express his thinking but to help promote his thinking.

CP: At what point did you become involved with MECOP?

MK: Jim Frederick walked into my office the first year I was at OSU, and I remember that because kind of a bizarre little office in the corner someplace that I got out of the next year. He came in and said, "hey there's a really interesting program that wants to expand into Chemical Engineering, among a couple other disciplines. I think you'd be great for it." So MECOP was in Industrial and Manufacturing Engineering, manufacturing engineers took it. Chemical Engineering and Electrical Engineering and, I want to say Mechanical – maybe Mechanical was the year after that – but they were the first three of when it shifted from the Manufacturing Engineering Co-Op Program, MECOP, to the Multiple Engineering Co-op Program, MECOP. So the acronym stayed the same but the 'M' changed.

So I was in figuring out what we needed to do with the curriculum because students needed two six-month internships. Recruiting students and interacting with companies. That was back in the time when the program was at a size when every student who was out on an internship had a mid-term review with their mentor from industry, and a representative from OSU. So I was driving around the Northwest largely, and Washington County, visiting students and learning about what industry did through participation in MECOP.

CP: And it grew quite a bit from there, I'm guessing.

MK: Yeah there's, I want to say, 500 students out now for summer. It was a great idea and it's a classic win-win where the students at the university benefit and industry benefits, both from the work that they do when they're on internships but also having access to that pool of students as a stream of employees.

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CP: Can you talk a little bit more about the nature of the program from the student perspective? What the expectations are, what they actually do as part of MECOP?

MK: Yeah, it's changed over the years, as anything does when it goes through different scales. But the basic framework of MECOP, the philosophy, is experiential learning, and that three months isn't enough to integrate into an organization and be able to meaningfully contribute. So MECOP is centered around two six-month internship experiences and one thing that stayed consistent, although it's changed somewhat in its articulation, is that students need to have two very different internship experiences. So this provides them with a contrast – they learn through the experience but they also can juxtapose the experiences. It lets them, as they're exploring career opportunities, look at things from one versus the other, which they might know they want. So there's a lot of aspects in which it provides rich opportunities for students to learn what the landscape is of being practicing engineers in the manufacturing sector.

CP: And what were you doing to grow the program?

MK: My role was advising students, recruiting students, interacting with industry in these events that MECOP has. And then, as I said, going out and actually visiting sites and interacting. For the Chemical Engineering department and then later Environmental Engineering and, for a brief time, Bioengineering too, both recruiting students and making sure that they had the curricular path to both be gone for two six-month terms and to graduate. And to negotiate with them what the expectations were of being in a professional setting, as well as interacting with industry and promoting our students. Learning about ways that our students could be move effective.

CP: And what portion of your job did this task become? At some point, it sounds like it could have swallowed it up almost entirely.

MK: I think I got advising credit for it, so it was more than my ten percent service, but I didn't get any course release or relaxation of research expectations. It was just kind of something that I did as part of the role in the department. MECOP bills itself as a completely industrially sponsored program, and if you look at how the money exchanges, that's true. And if you look at how policy is set, that's true. But I think there is a labor source there that's tacit, and that is the folks who are paid by OSU to carve out the time in their jobs to do it. And the reason we do carve out the time in our jobs to do it is because it's a really great opportunity for our students. And that's what we care about.

CP: But it doesn't sound like it was super helpful to the promotion and tenure process for you.

MK: Um, so, yeah. I'm on record here so I don't know how much I want to get into editorializing, but I think if you look at the promotion and tenure process, not just OSU but the academy has a ways to go between what's recognized and valued in that process and the work that needs to be done. And so MECOP is an example of that. And there's folks who recognize this, and I think that is on the table and there's discussions about that. But ideally if you set up MECOP as something that has huge value for OSU students and for the Northwest economy and for university/industry relations, then if someone is taking their time to put effort into that, there should be a way that's recognized in annual evaluations, and promotion and tenure, and that type of thing. We still have a little ways to go towards realizing that.

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CP: So you had a parallel track of research happening at the same time. We talked a little bit about the computer chip work, there was also some work on bridges, is that correct?

MK: Yeah, that's work that I did with John Westall. Basically the issue was, there's a whole set of bridges on the coast that were designed by the architect McCullough. And not only these treasures but they're the bloodline of the coast for transportation. And there were some practices in constructing the bridges which were problematic long-term, one of which was mixing the sea water in when they were making cement, which led to corrosion processes.

So ODOT basically had to implement an aggressive program to try and keep bridges from crumbling, and they implemented a process called cathodic protection. In cathodic protection, you basically put a metal on the outside of the bridge and you hook it up to the reinforcing steel that's structurally holding it up, and you let the metal on the outside oxidize rather than the reinforcing steel. So that's a really neat electrochemistry problem and chemical engineering problem. And I worked with John and we got a few grants from ODOT and one grant from NSF to understand some practical and theoretical aspects to help deploy these systems.

CP: Which were put in play for the bridges?

MK: Yes, indeed.

CP: Looking at your vita, you've been an Intel Faculty Fellow on a number of occasions, can you tell me about that?

MK: The Intel Faculty Fellow was one of Intel's tangible ways to support educational programs and curriculum development. So it's basically a call for proposals and you come up with an idea, "this is what I want to do for a small amount of money." And it came with money and the title of Intel Faculty Fellow.

CP: Was this a means to pursue these strands of research we've been talking about already?

MK: Well, that's actually kind of the start of me going to the dark side and becoming an education researcher. Through my MECOP experience and then through coming here and teaching the discipline in a way oriented towards emerging technologies, starting to develop ideas about the disconnect between processes and ways that students learn and the practices we had in teaching them. So having crazy ideas and trying them out, and keeping the ones that worked, and learning about how learners learn.

CP: Can you talk about some of the ones that worked?

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MK: A project I still have going on is in its eleventh year, and that was seeded by Intel. But basically this came out of modelling work that was done to understand one of the processes; actually, the modelling work was done with a company that wasn't Intel but was in the same industry, and kind of a competitor but not really. But the idea was that we had this model, why not develop a virtual reactor to let students practice process development on before they got to the high stakes real world.

So Intel provided the seeds for this idea, which was implemented for the first time in an elective course I taught, which was thin film materials processing. And out of that emerged – we've had four or five NSF grants as a follow up, including one that's just about to end and a second one that we're working on now, which is our industrially situated virtual laboratory project. Where basically we put students in teams, have them take the role of practicing engineers, and recognize and use the foundational knowledge that they're gaining in the curriculum in a way that aligns much more closely with how they would use it in practice.

CP: So am I understanding correctly that this is sort of a virtual laboratory that's online that they're simulating work that would be done in a laboratory?

MK: Virtual laboratory is a little bit of a misnomer and it's kind of stuck because that's what we originally called it. Processing engineers are given their assigned tools and one of the things you might be assigned is a team to develop an end process. That's a lot of responsibility. So what we've done is we've simulated how the – so there are knobs you can control and there's desired outputs that you want. And we've simulated, and we have a 3-D animated kind of virtual world where they go in and they have an opportunity to develop this process. But the data they collect is generated by a simulation rather than a multi-million dollar piece of equipment. And they can do it in minutes rather than the eight hours that it would take to do a run.

So it gives students an opportunity to collect data, but most importantly, there's a consequence to how they understand what the data tells them, because that's what they're going to use for their next experiment. So it's a different way to situate what we now give the fancy name of material aspect practice, which basically is interacting with equipment. It's a different way to do that than we're really capable of doing in our undergraduate labs due to resource time and time constraints.

CP: What was your role in developing the module? Was it more from the ideas side or were you actually building the software?

MK: I'm not a coder. I like to solve problems using MATLAB and things like that, but I'm not a coder. I guess I'm kind of the principal investigator in the sense that I had the conception and found folks who have the skills to do that. The structure of the computational side was developed by an Honors College who I worked with, Connelly Barnes, he was an Honors College student in computational physics. I knew Connelly because, when he was a senior in high school, I was teaching his mom thermodynamics. She kind of bugged me to look at his resume. And I thought, "oh, he looks pretty good." And afterwards, he was coming to OSU in the fall and needed something to do in the summer. So I said, "I can put him to work," so I started interacting with Connelly right after he graduated from high school.

He helped code a program for my textbook, Thermosolver, and in interacting with him I realized he was really good. My original conception was "I have this high school student coming," I really didn't prepare well for him, so I kind of prepared this binder with what I thought would be a summer's worth of work for him, and went through the first few pages with him in our first meeting. And I didn't see Connelly for about a week and a half, and he showed up and said, "well, I got all that done, what's next?"

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So he programmed Thermosolver and we got this Intel Faculty Fellowship and I said, "Connelly, you want to work on developing this virtual lab environment?" So he set up the structure of that, but it was an html thing; that's what we delivered for the Intel project. Then we got some students from Computer Science to build a 3-D virtual interface for it. A footnote for Connelly is he's now assistant professor at University of Virginia in computer science.

CP: That's really interesting, you deployed a lot of undergraduate assistance to make this happen.

MK: Yeah. My trajectory – there's no way, at that point, that I had access to graduate students to work in the area. As I started being successful in doing scholarship in the area, then my colleagues – there was a process of acculturation of my colleagues, and right now I have four Ph.D. students and four post-docs working. So that's kind of the evolution of the enterprise for doing canonical research, engineering education research. And it's really great students like Connelly Barnes who really enabled that.

CP: When you say acculturation, do you mean basically convincing them of the value or the validity of this line of work?

MK: Yeah. One of the things, as faculty members, we're guardians of the sanctity of the discipline; there's a reason for that. But it's also challenging when you work in boundary areas. As part of doing the work in a boundary area, if you want to be sure not to be successful, you just go in and say "I want to do this" and challenge everybody. But rather, if you can build relationships and let it evolve and grow as it will, that's a lot more fruitful. And my unit has been completely supportive; I really appreciate that. As far as I know, out of my group came the first Ph.D. in chemical engineering nationally to do engineering education research. And folks from around the country will interact with me and ask me, "how did you do this? I really want to do this." One thing about Oregon State University, the culture of the unit all the way up to executive vice provost and provost are very supportive of this type of scholarship.

CP: You mentioned your textbook, I'm interested in knowing more about that – the genesis behind it, and writing it, and how it's been received.

MK: Yeah. So I started teaching thermodynamics with Dennis Hess, as I said, at UC-Berkeley. In classical thermodynamics, you don't invoke the molecule. But that makes it where the subject becomes largely mathematical. And we ask of our Chemical Engineering students, we ask them to take all this chemistry, which gives them a way to understand the processes and access to them, using kind of a Levenspielian conceptual model type thing. Well, all the texts kind of have this very formal mathematical approach to it and students didn't respond well. So I started trying some texts and each one I tried was worse than the one before.

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And so it started with a set of notes just to use in my class, and that went on for a few years. Then at one American Society of Engineering Education meeting I met Wayne Anderson, who was an editor at Wiley, and I started talking with him and he said, "well, have you ever thought about making this textbook?" And I naively agreed to that. But the basic approach is to conceptually – the math is in there, but in addition to this, the concepts are formed in a way in which students' understanding of chemistry gives them a conceptual anchor. And the text has been very well received; they use it at small schools like Caltech and MIT.

CP: And there's a software component to it.

MK: And there's a software component that Connelly Barnes did as a high school student and first-year college student.

CP: A question about institutional change: the Chemical Engineering department ceased to exist in 2005 and the School of Chemical, Biological and Environmental Engineering came into being, it sort of folded these three former departments together. I'm interested in your perspective on the impact there.

MK: Yeah, so OSU's growing, the number of students are growing longitudinally over time, and there are these structural shifts. We shifted from a department with one program to a school with three programs. So like any type of change, it's an interesting process. I think that it's a lot healthier in the context of the university to have a much larger group and that critical mass. Each of the programs comes from their own social and historical roots, so there's work that we have done, and we have a recent grant from the NSF from the Revolutionizing Engineering Departments Program which I think will give us an opportunity to do more of this work. But there are implications in terms of culture and status of different units which are influenced by their histories. Overall it's a healthy and vibrant school, and it's a great group of faculty. But having three units which are all one in some sense and then they're distinct units in another sense, and how that plays and negotiating it, I think there's still work we can do to even make it stronger.

CP: And in a personal sense, this led to an expansion of your MECOP purview, is this correct?

MK: Yeah. In MECOP I was doing Chemical Engineering, which I was centrally situated in. And then the Environmentals came in and they were in CECOP, which had formed quite a while after my involvement with MECOP. But that was the Civil Engineering Co-Op Program and it has a whole different board, and it's a lot of municipalities and a lot of consulting firms. So it's a very different culture than the manufacturing base you need for environmental engineering students. Over the years, we've unified the curricula – a lot of it, I didn't understand the curricula for some. There were faculty in Environmental Engineering that kind of did the detail work on that thing. So it was a challenge in providing knowledge of the internship program I did, but also having to learn how to work with others and hand off some of the components that I was able to integrate into the one in Chemical Engineering.

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Now the Bioengineering was a whole other thing. So we tried to get Bioengineering to fly in MECOP and it did not. And pretty much my assessment is that most of the bio-industry was just too small to make the commitment that they needed to MECOP. So it was a lot of smaller start-up type programs, but we just couldn't get critical mass after trying. There were some companies – Oregon Freeze Dry hired a bioengineer every time – but there just wasn't enough critical mass to make it fly for the bioengineers, which is too bad. That's a status thing right there, you talk about three programs and two have access to MECOP and one that doesn't. That's an issue within the coherence of the school.

CP: You've won several awards for your teaching, I'm interesting in knowing how you've evolved and how you've innovated and grown as a teacher over your time here at OSU.

MK: Yeah, I can reflect on this in many ways, but one way is to think of how my mental models of teaching have changed. When I got to OSU – and this is kind of thinking back on the days of Clay Radke and what an amazing lecturer he was at Berkeley – my idea was, if I could organize information in my mind and present it really well, that was a way I could help students learn that. And then as I tried different things and understood the really rich array of research, I've transitioned. I went to a point where I went, "well, students need to construct understanding for themselves." So it's better than – rather than organizing it and transmitting it to them, it's better to put them in positions where they have to integrate what you want them to learn and kind of place it with what their prior knowledge is. So you shift the organization from the faculty member to the learner. So that's kind of one step.

And then, most recently, I've been wrestling with the idea of the difference between knowledge structures and disciplinary practice. So a lot of times we organize things conceptually, and this is grounded in research too – if you look at experts, it's not that they know more, a lot of times what distinguishes expertise is the connectedness of their knowledge. And conceptual educators base a lot of strategies on helping students make these connections. So I think there's value in that and there's a lot of educators who do that.

One thing in my recent sabbatical at the University of Washington – I was working with folks at the Life Center there – their viewpoint is that all concepts are contextual, so you can't just form a structure that you apply to any context. So I've been shifting towards the idea of developing conceptual knowledge structures; to putting students in situations which are related to tasks that they have to do as engineers, and then understanding the conceptual practices in terms of disciplinary practice. And I'm not sure where I sit on the knowledge structures to disciplinary practice divide. I know what the learning scientists claim is true, but I'm not completely sure.

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So basically, to sum this description, is kind of looking at a progression in the ways I think about learning. And so that totally changes what becomes important for me in the learning environment and how I structure that.

CP: How much has your involvement with MECOP, and the feedback you've received from industry, played into how you think about teaching?

MK: I haven't explicitly thought about that so much. I've had interactions interacting with students on their internships, I've heard companies' presentations about what they do, I've heard hundreds and hundreds of student presentations about what they did on internship. So certainly in the aspect of considering disciplinary practice, there's that element there. I think one thing which caused dissatisfaction, and maybe one reason I'm really interested in having an impact on the work that we do with the Engineering Education Research Group, is that you would occasionally see students who were able to take the foundational knowledge that they were working with in their coursework, and own it in a way that they could apply it to their internships.

But doing that in a deep and meaningful way was more often the exception than the rule. Part of it is what opportunities and what projects students have, but I would argue a bigger part is just that – well, there's a lot of elements, but one of them is their ability to activate and operationalize that foundational knowledge they have in this new environment. So I think we can do a better job with that and we're working, trying to mess around with stuff to see if we can.

CP: What kind of feedback has the department received, or the school received, from industry as far as the quality of graduates that OSU is turning out from Engineering and going into industry, and the success that they're having?

MK: I think we're similar to a lot of programs. Very rarely do folks from industry, very rarely are they dissatisfied with the technical capability. There's a lot of other things in engineering work, a lot of other knowledge and skills and attitudes, that you need that I think could be developed more fully. There's kind of two elements to that. One is recognizing that engineering is a social profession. Essentially you're working with people and you need those people skills. There's this misconception of the anti-social engineer. Well, it's a highly social profession and cultivating those skills and teamwork skills, we've made some curricular changes over the years to support that. I also wonder, you have feedback from industry, which is really important, but I wonder how that norm is set and is that norm the right thing? I think of Steve Jobs who has the attitude, "I don't want to ask people what they think because I'm going to create something that they can't even conceive of." I'm wondering if we can't do that with education, but I don't know.

CP: That feeds into my next question, you referenced the fairly recent grant that was received to resituate learning and instruction. Can you tell me about that, the ambitions of that?

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MK: Yeah, this is hugely ambitious. We want to change the learning processes and culture in the school. So this is a program that was created by Donna Riley, who is now at Virginia Tech, she was a program officer at NSF and she wanted to have high impact; and the whole tide of NSF has gone in this way. She realized that a lot of the approaches were a mile wide and an inch deep, and that you really needed opportunities for concentrated activity. And so they created this highly ambitious program and there's three acronyms: one is IUSE, which is Improving Undergraduate STEM Education; one is PFE, which is Professional Formation of Engineers; and one is RED, which is Revolutionizing Engineering Departments. And the call for proposals was almost dizzying from all the elements they want.

So we put together a team, I was on sabbatical and working with Sue Nolan at University of Washington, and they have work which started with the George Lucas Foundation, it's now supported by NSF, in project-based learning. So using some of those ideas. And then a colleague, Michelle Bothwell, was interim director of the DPD program and brings kind of the history of valuing diversity and the issues of difference and power. And then we have new a new faculty member, Devlin Montfort, who was hired to do engineering education research, so he brings training specifically on the area. And we all got together and started working on this.

And kind of the big thing that we want to do is – so we say resituate learning, let's resituate it in two ways: one is to change it, so to go from these knowledge structures that I was referring to earlier to disciplinary practice, by creating activities that are more meaningful and more consequential. We're focusing on our sophomore and junior level student classes. So that's one element. The other element is creating a culture of inclusion. So that means understanding and valuing difference. So there's work all the way from professional development of faculty to cultivating interactions of our students and how to teach them the norms of the program. So that's just a small project that we've bitten off.

CP: Developing that interpersonal side of engineers that you referenced.

MK: So it's the interpersonal side but it's also being really concerned about interactions in the most broad sense, and understanding and valuing that folks can come from different places and that's good, and they have funds of knowledge that they can bring from those places.

CP: You referenced studio classes, what is a studio class?

MK: Yeah, so this is something that we blatantly ripped off from physics – Lillian McDermott at University of Washington and at Rensselaer they've been doing it. But basically we have this period of enrollment growth in CBE – Ken Williamson was department head at the time – and someone said you can use crisis as an opportunity. We used it as an opportunity to restructure our curricular programs and to move away from this transmission base of learning. So what we did is we punctuate lectures with activity-based sections that have a limited number of students. Ideally there's twenty-four students and they work in groups, they socially make meaning. So we put students in eight groups of three, and they show up for a studio, and they have an activity to do. But that activity draws on knowledge that was transmitted in lecture. But they're held accountable for what was presented and they're given the opportunity to work with it and apply it. And we have nine courses in the curriculum that are designed this way.

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CP: Well the school will be moving into a new facility pretty soon and I'm interested in your thoughts on the impact of Johnson Hall forthcoming.

MK: Well we're kind of in little drabby digs over in Gleeson, so the opportunity for some of us to move over to Johnson Hall, a new modern state-of-the-art facility – so Johnson Hall is organized where the first floor is kind of College of Engineering general and then the second and third floors are going to CBE and research activities, both in terms of providing infrastructure to do technical research and then geometries to facilitate collaborations in the research clusters. It's going to have a huge impact in the way we do our work and undoubtedly the productivity. Pete and Rosalie Johnson have just been absolutely fantastic to the department and now the school.

CP: I'd like to conclude with a question we've been asking most of the folks we've been interviewing for this project, and that's just to reflect on change over the course of the time they've been here and give some thoughts on where OSU is heading right now as it looks towards its 150th birthday.

MK: That's a tough question. If you look at our arc, there's a changing landscape. If you look, more and more of the educational support is coming from tuition dollars out of students' pockets, rather than state support. Where we're pulling our students from has greatly increased; the number of students we have is greatly increased. These all present tremendous stressors on the system. And then you look at things like disruptive technologies, just recently projections that there might be credentialing alternatives to higher ed. I think that, as we've worked 150 years, we need to continue to be responsive and adaptive and create the types of systems that are effective towards meeting these needs within these resources.

With that said, I think that there is no greater place for – I know there's a range of learners in terms of what age them come from, but if we look, the majority of learners here are in the eighteen to twenty-four, eighteen to twenty-five. And if you look developmentally, they're ready. At the age, the ability to kind of develop critical thinking and abstraction and complex thinking, the human mind is just primed to do that. And there's no better place to do that than the types of social environments and interactions that a bricks and mortar university like OSU can do. And then if you look at the history of the Land Grant institution and the access that they provide, I think it's generally exciting to say, "hey, we have these challenges and we have these opportunities, and it's up to us as a community to effectively negotiate those and continue to have positive impacts for the learners here."

CP: Well thank you Dr. Koretsky, this has been very interesting and I wish you the best of luck moving forward.

MK: Thanks.

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