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ORAL HISTORY PROGRAM

Rick Bodnar: "Steel in the Blood"

2021

PREFACE

The following oral history is the result of a recorded interview with Rick Bodnar conducted by Andrew Smith on June 28th, 2021. This interview is part of the AIME and Its Member Societies: AIST, SME, SPE, and TMS Oral History Project.

ABSTRACT

Noted as his proudest accomplishment, Rick Bodnar is co-founder of SSAB America's Research and Development Facility. Rick Bodnar has contributed countless research, publications, and patents to the steel industry, with new discoveries in embrittlement and his failure analysis work. Starting off with a bachelor's degree in Physics at Muhlenberg College, Bodnar went on to get his Masters of Science in Metallurgy and Materials Science at the University of Pennsylvania. Throughout his schooling and career, Bodnar encountered many mentors who influenced and helped him along his career path. Bodnar built the foundation of his career at Bethlehem Steel, where he started his career in the steel industry. Bodnar went on to pursue research at the Homer Research Laboratories, get his professional engineering license, and become a manager of 23 years at numerous labs and R&D facilities. At a young age, Bodnar learned what service and community engagement meant from his parents, and he applied these values to his tenets as a manager. Active in professional societies, ASM International and AIST, Bodnar has chaired and founded many committees, along with organizing 15 conferences. Bodnar values the importance of networking and building relationships, and he encourages the younger generation to become more involved in societies and take advantage of their contact opportunities.

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PART 1

00:00:20 Growing Up in Saddle Brook, New Jersey – The Outskirts of New York City

Smith:

Good morning, this is Andrew Smith, Rolling Mill Metallurgist, ASNT level III with SSAB. I'm here today, Monday, June 28th, 2021, in Nashville, Tennessee. We're here to conduct an AIME oral history capture of Richard, Rick, L. Bodnar, a retired director and co-founder of SSAB Americas' Research and Development Facility.

Smith:

So Rick, tell me about where you grew up.

Bodnar:

I grew up in New Jersey, Saddle Brook, a small town and a very densely populated county of Bergen County. I was born July 1st. I have a birthday coming up; I'll be 68 years old. From what I hear, it was a very hot day, somewhat like it is here in Nashville. Saddle Brook is 10 miles from the George Washington Bridge, so I spent a lot of time as a kid in New York City, and it's where the Garden State Parkway actually intersects with I-80. A lot of famous people would stay actually in Saddle Brook, in the hotels for going into New York. As a kid, I played a lot of baseball. I played little league and then Babe Ruth League, that was 13 to 15, and Connie Mack ball, 16 to 18, and I played in high school as well.

I also played some basketball in high school on the JV team. Believe it or not, as a freshman, I was 5'3," and by the time I was a senior, I was 6'2". I was really small, so I only played a couple of years of basketball. I played varsity soccer in high school and then in college. When I was nine years old, I had nephritis, the kidney disease. I almost died; I was in a hospital for 17 days, and I missed school, so that was a kind of a tough time. I was a good student through high school. I made National Honor Society and graduated 13th in a class of 232.

00:02:52 Trying Out for the New York Yankees to A Top Varsity College Soccer Team

Smith:

You had mentioned you'd played varsity soccer and baseball in high school and college. Tell me about some of your other athletic achievements.

Bodnar:

I guess the first thing was I made all-stars in Connie Mack all three years when I played. In high school, I was all area senior as an outfielder. And also, in our league, which was the Bergen County Scholastic League, I was first team as an outfielder, but I also pitched; I played first base. At the end of high school, when I graduated, I got an invitation from the New York Yankees to come to Yankee Stadium and try out, which was kind of a big thing. They had taken the 40 best players in north New Jersey to go in, and nobody made the team. They sat down all 40 players in the visitor dugout, and they said, "Well, thanks for coming out. Don't call us; we'll call you." And they sent us home, so that was something. I could tell you in detail all about that experience.

In college, I had the second-highest strikeout average per nine-inning game, which still holds today, 11.4 strikeouts. This was at Muhlenberg College. Then in 1972, the varsity soccer team which I was part of was ranked third in the country for small schools. That team was inducted into the Muhlenberg College Hall of Fame, so I'm kind of proud of that.

00:04:49 Learning Service Young – The Son of a World War II Vet, Scoutmaster, and 4-H Volunteer

Smith:

That was absolutely extraordinary. Did your parents go to college, and what did they do for a living?

Bodnar:

Yeah, both parents went to college, they have non-STEM degrees, and they both have master's degrees from Montclair State University. My father was a high school English teacher, and then for the last 21 years before he retired, he was a department head in Passaic High School, New Jersey, and that's a huge, huge high school. He was responsible for 35 teachers that reported to him. So, English teachers, reading teachers, special ed, all reporting to my father.

My father was a World War II vet. He passed away in 2008. But, during the summers, he founded and directed a day camp, Camp Iroquois. I was lucky as a kid to go to camp as a camper and also later as a counselor and an assistant director when I was older. I found that that was probably my first management experience. I learned a lot, that you need to have an agenda; you need to have a plan. So, what are you going to do with these kids every day, every minute, every week? So, that was a very good experience.

My father was also heavily involved with the Boy Scouts. As a kid, he was a scout. He was a scout leader later. When my brother was an Eagle Scout, my father was Scoutmaster. I never got involved with scouting because I was always playing baseball. There were always baseball games, but my brother would go away to a Floodwood camp (Tupper Lake, NY) for three weeks at a time and come back with 10 merit badges. I mean, he was just pretty phenomenal.

My mother was a home economist, and she was involved with 4-H in the extension services in Bergen County and Oswego County, New York. So fairs, she'd be judging the best pies and all that kind of stuff, organizing all that. She also was the President of the Woman's Club, which is a big deal in Saddle Brook, so she did very well.

00:07:21 My Wife of 43 Years, Daughter and Son, and Four Grandchildren

Smith:

So, tell me a bit about your family right now.

Bodnar:

Well, my wife, Carolyn, she's been my wife for 43 years. She's trained as a counselor and a social worker. We met at Muhlenberg College, and Muhlenberg College being a liberal arts school, we had to take certain classes, like two art classes. I took the art history class. I also took a drawing class, and that's where we met. My drawing is terrible. I was good at mechanical drawing; I took four years of mechanical drawing in high school, but freehand drawing I was pretty terrible. In fact, my roommates in college, they would often get my sketchbooks out, then just be rolling on the floor, laughing at how terrible I was. In the class, there were

nude models, and so one of the most difficult things to draw is the human body and all its shadows and everything.

That's where I met my wife. She was in the class. She was very good. And, at the end of class, I guess for the final, we had to do an inking of a hawk. And, we both did these hawks and probably put like 20 hours into it. And, of course, Carolyn's was excellent, and mine was probably the best artwork I ever did. For a long time, we had both of the hawks up on the wall in our house. It's kind of a conversation piece. Of course, Carolyn has been very supportive during my career, preparing papers, and I'm pretty much a workaholic or have been a workaholic. She supported that, so that's been very good. We have two kids: Michael's 39 now, and Meredith is 36.

Meredith actually works at SSAB as a truck dispatcher doing very well with computer systems and making sure deliveries are on time. And, our son works for Hologic. He's a lead software engineer, this company makes mammography machines. So, he's writing software, state of the art, probably for the best company in the world in this field. So, he's doing very well. We have three grandchildren at present: one on the way due in October [born Kellan on November 3rd], Jack, our grandson, is six, Cianna is my daughter's only child, she's four, we spend a lot of time with her. So in retirement, they live in Davenport, we live in Bettendorf, we spend a lot of time there. In fact, my daughter, Carolyn, and I coached four-year-old soccer, which is kind of back to the future for me because I coached my kids, I think 13 years straight: baseball, basketball, girls' softball, soccer. So, that was a lot of fun. And then, we have Lucy, who is two years old.

I have a brother, I told you he's an Eagle Scout. He also works for a Swedish company, like I do. They make crystal, and he's the chief financial officer there. My mother is still living, so we moved my mother to Iowa. She only lives about a quarter of a mile away in assisted living; she's 93. We spend time taking her to doctor's appointments and that kind of thing, so I kind of had to retire. I could not be working full time and helping take care of grandchildren and my mother. And plus, we want to do other things, travel and the like.

00:11:24 Choosing Muhlenberg College – Sports and A Bachelor of Science in Physics

Smith:

You had mentioned meeting your wife there at Muhlenberg College, but your degree is actually a Bachelor of Science in Physics. How did that come about?

Bodnar:

Well, in high school, I was very good in math and science, so got some guidance that you should major in chemistry or physics or perhaps engineering. I ended up applying to five different engineering schools, and Muhlenberg, a liberal arts school, and I got accepted. Fortunately, I got accepted to all six schools, and it's kind of a funny story that we went and visited Lafayette College, so driving from New Jersey into Pennsylvania. And, one of the first cities in Pennsylvania is Easton, and that's where Lafayette is. And, we visited the school on a kind of a rainy day, fall day. Lafayette has a lot of hills. Then, about mid-day, we went over to Lehigh. Lehigh is in Bethlehem, Pennsylvania, where Bethlehem Steel is; I spent a lot of my career there. And again, a lot of hills there, and I loved the baseball coach. The baseball coach used to pitch for the New York Mets. So, he wanted me to pitch there.

And then, we went to Muhlenberg, the sun came out, it was kind of flat, people were friendly. There were a lot more co-eds. At that time, in engineering schools like Lafayette and Lehigh, maybe only 10% of the school were female. At Muhlenberg, it was fairly easy to make the sports teams. So, I played varsity sports

there and had a good experience. So, Muhlenberg won out in the end, and I got a pretty good education there and was able to make the National Honor Society in physics, Sigma Phi Sigma. So, I was happy with the choice in the end.

00:13:38 My Shift to Engineering – Master of Science in Metallurgy and Materials Science

Smith:

I see you didn't stop there in terms of your education. You eventually went on to get an MSc in Metallurgy and Materials Science from the University of Pennsylvania. What and/or who were most influential and pursuing an engineering degree?

Bodnar:

Well, as a senior at Muhlenberg, I started to interview, and there's not a whole lot you can do with a BS in physics. You could maybe run an electron microscope and be a technician somewhere. I decided that I definitely wanted to do something more. I wanted to go to graduate school, but I didn't see myself getting a PhD, maybe teaching, being a professor teaching physics. So, fortunately, I had a very good advisor and very good physics professors at Muhlenberg. Dr. Boyer alerted me to the fact that there was a program between Muhlenberg and the University of Pennsylvania and Columbia University in metallurgy and materials science. I applied to both, and I got into both schools and didn't really know what I was getting into other than you need to know math and science, have a good background, which I did.

Growing up close to New York City, I really didn't want to go into New York City. So, I selected Penn, and that turned out to be a really good choice. There was a lot of ferrous metallurgy activity at Penn that I really didn't know about ahead of time until I got there. I had summer jobs that dealt with the metals industry, interestingly enough. One was at Fein Container, where they made these five-gallon drums for driveway blacktop type of thing. And, they made paint cans. And, I learned about forming, and stamping, and cutting, and actually welding, and some heat treatment, where they would take the lids and put foam on the inside. Then that would have to be baked, kind of a baking heat treatment.

I also worked at Thermo Electric which was interesting. They extruded a plastic coating on top of wires. So, for example, the wires have this plastic coating. I did that for a while. You have to splice wires together, weld them together. So, I learned some resistance welding. And then, the other thing is I spent a lot of time with a machine where you had to load in spools of wire, and the machine turned around and round, and they pulled the cable. So, you see these big wooden spools where they're putting cable down. I helped make cable. So, that was kind of interesting. I liked both of those jobs. So, I knew a little bit about metals, I guess.

And my grandfather was a self-made engineer. He worked for Wright Patterson, the aircraft business. He made a lot of the prototype equipment, so he could make tools, he could make parts, prototype parts, and he knew about heat treatment. He actually had books on heat treatment, believe it or not. So, I had somewhat of a background, and it kind of came together, but I didn't know that it was coming together. I really didn't know what I was getting into until I got to Penn, and it turned out to be a great place to be at school.

Smith:

Did you happen to take any other additional significant coursework?

Bodnar:

I took a lot of courses over the years, courses, seminars, webinars. In fact, I took five additional graduate classes at Lehigh University in metallurgy. So, I've taken a lot of classes. I was fortunate to be able to take a two-week class at the Kellogg School of Management, Northwestern University. It was called "Shaping Innovative Leaders." And, you learned about finance and how to read a financial report, a lot of great information. I really enjoyed the branding of products, which is, of course, important at SSAB, and how branding comes about and how to market. So, it was a really super course, but I've taken tons and tons of courses. The bottom line is, I guess, throughout one's career, we need continuous education. You really do to keep up with the times. I highly recommended if you're not doing that to continue to take classes.

00:18:50 Surrounding Myself with Good People – Metallurgy and Embrittlement Mentors

Smith:

Throughout all your coursework. Did any of your professors mentor you in any particular way?

Bodnar:

I've had great people all through my career, whether it be at work, professors, colleagues. One thing I learned about myself, I need to be around good people, which kind of steered my career. I've had many opportunities over the years, I'm sure as you have, where I'd been offered more money to go to another company, where you'd be a superstar surrounded with average people. That just was not appealing to me. I always wanted to be around good people. Some of the professors I had at Muhlenberg, Drs. Boyer, Raub, Loy, and Milligan, were all good. But, I already told you about Dr. Boyer helping steer me into engineering at Penn. At Penn I had two excellent professors, Professor Dave Pope, who was my advisor.
And, I worked very closely with Professor Charlie McMahon, who's a world embrittlement expert, and I was happy to be part of his embrittlement group.

So, when I was at Penn, it was kind of a halcyon of activity for ferrous metallurgy and embrittlement studies. The embrittlement group studied creep embrittlement (my thesis area), temper embrittlement, tempered martensite embrittlement, hydrogen embrittlement, reheat cracking and stress corrosion cracking. So, students studying all these areas, and then every month there'd be a seminar, and I'd eventually have to give a seminar. But also, there were a number of post-docs that were excellent. I got to work with Dr. Kenji Abiko, a professor at Tohoku University in Japan, who was on sabbatical at Penn. You can imagine starting as a physics major and going to Penn. And so, you start taking metallurgy classes, but also, you're starting a thesis, and you really don't know a whole lot.

And, Kenji Abiko was there; he helped me with machining and setting up experiments and designing equipment, very helpful. H he used to mock me kind of jokingly. When I first started, I maybe did some dumb things in the laboratory. He would say, "Baby work, you're doing baby works." And then, I'd maybe do something well, "You're getting well now," he would say. One time I had to give a seminar, a talk about my research as part of the embrittlement group; it was like my first talk ever. I was pretty nervous. Kenji said, "If you do a good job, you can come over to my house, and my wife will make you a traditional Japanese dinner." And, I thought, oh boy, what am I getting into, you know, raw fish, and I wasn't sure what to do.

But, I gave a decent talk, I think. Then, he invited me over to his house, and I was pretty nervous about that. And, his wife made this beautiful steak dinner. It was fantastic. So, he was good to work with.

Clyde Briant taught a laboratory class. He worked at GE R&D for a long time, and now he's a professor at Brown University. He was very helpful. He was a guy I could go to with questions, and I felt very comfortable with him. He was an excellent instructor as well. And then, Samir Banerji, maybe you know him from Caterpillar over the years? Samir, when he was at Penn, studied tempered martensite embrittlement, probably published about 10 papers in Met. Trans. on the subject. And, actually, Charlie McMahon asked me to review some of those papers. I was really impressed with the guy. And, he asked some questions at my seminar, kind questions. So he was very gentle, very nice, and I've had a lot of interactions with him when he was at Foote Mineral and then Caterpillar. I actually got to speak at his retirement party.

And I have three books that are always on my bookshelf. If you don't have them, you might want to get copies of them. The first is the *Embrittlement of Engineering Alloys*, and it's written by Clyde Briant and Samir Banerji. It's really good, all kinds of embrittlements, including stress corrosion cracking.

Then when I first started working on structural shapes, I got into high strength, low alloy (HSLA) steels, micro-alloyed steels. And, I learned that the Bible for micro-alloy steels was *Micro-Alloying 75*. Although it was a long time ago, many of the papers are still germane today, and it's an excellent book. Then, the last book is *Boron in Steel*. This is a conference that Samir Banerji organized. [Samir gave me copies of the latter two books] And, in fact, at Caterpillar, they kind of jokingly call him Dr. Boron, since he organized this conference and knew a lot about boron steels. I got involved with boron steels with structural shapes, for example, the track shoes on tracked bulldozers and the like. The track shoes were made from a structural beam. The boron steel is heat treated. So, from those three books, I always remember Samir. I said at his retirement party that in addition to Dr. Boron, you could call him Dr. Tempered Martensite Embrittlement as well because he had written approximately 10 papers on the subject in Met. Trans.

00:25:20 My Go-to Guys – Together from The University of Pennsylvania to Bethlehem Steel

Smith:

Did you have any classmates that influenced your studies or your career?

Bodnar:

There were three classmates that I really hung around with at Penn. My best friend at the time, Bruce Metzger, passed away at 59. A typical day at Penn, we'd get into the office at about eight and work on research and take classes. At five o'clock, we'd go to the gym and play basketball. I probably played the best basketball in my life, probably in the best shape of my life, playing every day. And then, we'd come back and study. And then, at nine o'clock, we'd go make dinner at either his apartment or my apartment. We'd eat together and then crash for sleep. But yeah, we studied a lot together. And then, there were two Scotsman, Mike Byrne and Alan Cramb, perhaps you've heard of both of them? And, all four of us ended up working at Bethlehem Steel.

Mike and Alan, they were my go-to guys, if I had primary end questions on steelmaking or vacuum degassing or casting. They were the guys I went to. Mike became the director; he became my boss at Homer Research Labs for a while. And then, he went on to Timken to work and then retired. And, Alan Cramb was at Bethlehem Steel, and then he was at Carnegie Mellon, as part of the Center for Iron and Steelmaking Research. And now, he's, I think, at IIT, Illinois Institute of Technology, as Provost. He's done very well for himself. So, in recent years, I haven't been in touch with them too much. But, they were my go-to guys, and I'm fortunate to know all of them.

00:27:30 My Thesis, A "How to" Experience – Learning to Analyze Data, Draw Conclusions, and Write

Smith:

You had mentioned earlier that you were working on your thesis there. What was your thesis, and how did it help you out with your career?

Bodnar:

Well, my thesis was, "The effects of impurities on creep-rupture properties of martensitic two and a quarter chromium one molybdenum steel." And, it was a project sponsored by the Electric Power Research Institute. One, it helped me with writing because, each quarter, I had to write a quarterly report. And, prior to that, I'd taken a lot of math and physics classes, and I could do problems, but I was not a great writer. And, that was probably my first writing experience, similar to what they do at the Colorado School of Mines – Advanced Steel Process and Products Research Center (CSM-ASPPRC). Every six months, the ASPPRC group wrote semi-annual reports. I think it's excellent for students. I also learned how to design an experiment, how to run an experiment, how to build equipment, how to maintain equipment – vacuum pumps need maintenance – how to analyze data, how to draw conclusions, how to write a thesis, how to write first publications, an excellent experience. My preference is to hire a master's or PhD student, but particularly a master's student with a thesis, I think, is important. And, the EPRI [Electric Power Research Institute] experience, I guess we'll get into later, helped me get into Homer Research Labs, which was a great place to work.

Smith:

Did you take any co-ops, internships, or summer jobs to help you out with your career later?

Bodnar:

Co-ops, I guess at Drexel, right next door to Penn, were popular. But, at that time, co-op and internship programs I don't think were all that prevalent. If I had been offered either, I think I would have taken it. I see it as a great way to preview students. During the course of my career, I think I hired 43 co-ops and interns. And, it's a great way to preview a person, see if they're a good worker, and then perhaps hire them later.

Summer jobs that we talked about, camp counselor, working at Fein Container, working at Thermo Electric, all very good. Particularly, when I worked at Fein Container, part of the job was loading trucks. Then at the Thermo Electric loading these heavy spools of wire, into a machine. I got pretty strong from those experiences, which helped me with my athletic career as well.

00:30:34 The Vietnam War Draft and the First *Rocky* Movie – Significant Events During My Studies

Smith:

Did you have any political or cultural events affect your studies?

Bodnar:

Interestingly, and I've watched a number of the oral recordings, and the Vietnam War and the draft have come up. And, actually, I can remember my freshman year, a number of us sitting around in a room and

waiting for your draft number coming from a lottery. My draft number was 26. I remember, there was one guy in the class, he had a 4.0 [GPA] freshman year. And, he was number one; he enlisted right away. I was going to Vietnam. I was not excited about it, but I decided I was going to serve my country. In the fall, I guess it was 1972; I actually had to go to Newark, New Jersey, and have my draft physical. If you've seen the movie, *Alice's Restaurant*, it was a lot like that.

I can remember a guy in front of me eating aluminum foil and saying, "They're going to take my x-rays, and I'm going to fail. I am going to get out of the draft." It was just a bunch of crazy people, and you're thinking, "Oh boy, I'm going to go to war with a bunch of people like this." So, it was kind of scary. And, the day that I had to go for my draft physical was the day that Muhlenberg was in the NCAA finals of a small school soccer tournament, which we lost. I played fullback in soccer, and the center fullback broke his leg. And, I would have seen a lot of playing time that game. And, I was sorry I wasn't there. So, that really affected my athletic career and really made an impression on me. Fortunately, not too much later, they did away with the draft, and I didn't have to go. But, that was a scary time.

I was fortunate to be at Penn during the bicentennial, so 1976. That was very neat; they cleaned up the city, painted the subway, got rid of all the graffiti. Everything was clean. Every night there were fireworks in different parts of Philadelphia. I think we went to all of them. So, it was a great time to be in Philadelphia: a lot of people there touring the city at that time and disruptive from a class standpoint.

The other kind of interesting thing, a little bit off-topic, is the first *Rocky* movie came out. Carolyn and I saw that movie, I think the first release. So, we saw it the first time it was shown, and we knew Philadelphia at that time. We knew the Italian market. so we spent time down there, and we climbed up the art museum steps like Rocky. It was a neat time.

00:33:52 Interviewing Across Pennsylvania – The Road to My First Professional Job in Industry

Smith:

So, Rick, how did you get your first professional job in the industry?

Bodnar:

Okay, well, I was at Penn, and Charlie McMahon had good contacts at GE [General Electric] and Westinghouse due to the embrittlement of turbine rotors. I interviewed at GE Schenectady and Westinghouse Pittsburgh. Then, not too far from Philadelphia, is Lukens Steel in Coatesville. So, I went to Coatesville, took the train to Coatesville, interviewed there. I interviewed at Bethlehem Steel Homer Research Labs. That's where I met George Vander Voort. And then, I interviewed in the Bethlehem Plant of Bethlehem Steel. I guess GE was in Schenectady; the town was not great. Pittsburgh was pretty far away; that was a six-hour drive. Lukens Steel, I actually did not get into Lukens Steel, so I don't know what happened there. I don't know if they ever hired anyone; maybe they stopped hiring at the time. I interviewed for two jobs at Homer Research Labs, and one was a machinability expert, which I essentially had no experience with.

The other was drawing and ironing cans, that is a forming expert. At that time, beer cans, soda cans, were made of steel and going from three-piece to two-piece cans where you'd have to have very clean steel to draw the long cup, and then put a top on it. And, of course, that business has gone away. It's all-aluminum cans now. I really didn't have the experience for those two jobs. I really didn't know what they were looking for at the end of the day. They said," Well, you really do not have the background." I said, "Yeah, didn't you read my resume?" I mean, it was kind of a bad situation. You kind of wasted my day, and we both wasted

each other's time.

The good news of that interview, I did meet George Vander Voort, and he was doing failure analysis. And, he worked for a group, which I ended up working at later, Metallurgical Services and Investigations group. All the litigation in the company came to that group, some really interesting failures, auto-train, there was a big train that crashed. George worked on that, did all the metallography. That's kind of a very cool job, and it had nothing to do with Bethlehem Steel, so Bethlehem Steel was not at fault. Then, I ended up interviewing for the Bethlehem plant. And, I remembered that, when I was looking for jobs at Muhlenberg, there was a Muhlenberg graduate, or alum, that was the assistant chief metallurgist in the Bethlehem plant. Somehow, I remembered that. I wrote him a letter, and he invited me in to interview. The first time I really saw a steel mill, an integrated steel mill, and it had everything. It was very interesting. I got a job there, and it turned out to be a great place to start.

00:37:24 Starting at Bethlehem Steel – An Excellent Place to Learn

Smith:

What facilities did the Bethlehem plant at Bethlehem Steel have?

Bodnar:

They just about had everything, and I went everywhere, saw everything. That was an excellent place to learn. An integrated plant, they had coke ovens, they had the Blue Goose, which my brother-in-law helped invent. It was a quench car. So, when they pushed the ovens, the car would capture the coke, so the emissions wouldn't be released. And then, they would quench the coke right in the car. So, it was pretty cool, and they had a railroad turnover. When the iron ore came over, in the winter, the ore would freeze; they could turn a whole car upside down to empty it. It was kind of neat.

There was a sintering plant, there were five blast furnaces (small blast furnaces compared to nowadays), two basic oxygen furnaces, five small electric arc furnaces (they were only like 50 tons), two electro-slag refining stations, five foundries, an ingot mold foundry, an iron foundry, brass foundry where they made copper tuyeres for the blast furnaces, a steel foundry where they made steel castings, and a roll foundry where they made cast rolls that are used, for example, in a hot strip mill for work rolls. There were rolling mills there for tool steel billets and a 12–14-inch bar mill, three structural mills making structural shapes, a drop-forge, hammer forges, press forges for making rolling mill rolls (like plate mill backup rolls at Burns Harbor that you're familiar with), and heavy forgings (like turbine rotors and parts for Navy nuclear aircraft carriers and submarines), and machine shops. Number 2 machine shop, at one time, was the largest machine shop in the world -- that was about a quarter mile long. And, of course, all kinds of heat treatment facilities, including vertical, where you take a large turbine rotor and vertically heat treat it while it's spinning to get uniform temperature. So, it was a very interesting place to work.

00:39:43 A Bethlehem Steel Tour Guide – Learning the Processes, Products, and People of the Mill

Smith:

Very extensive facility. Were you asked to give any tours?

Bodnar:

Yes. When I first started, I was told every month you will give a tour. And, I did that for several years. And,

my initial reaction was, "I have a master's degree. I'm not stooping to giving tours." But, it turned out to be one of the greatest things, because it got me all over the mill to see everything. So, I've given tours of all these facilities I've talked about. And, so you don't embarrass yourself, you have to learn all the facts. This facility was built here, started here. This is what you make, so many tons and all that kind of information. After a while, you've got all that down. You gave me a tour of the Burns Harbor 160-inch mill, I remember. So, you know what it's like.

It forces you to learn the processes, the products, and to make contacts in the mill. You need to know people to get things done. You get a pretty good idea of what's going on.-So, this mill was like five miles long, along the Lehigh River. And, you'd walk through the mill, instead of driving. "Oh, I need to go to the machine shop." "So, walk through facilities as you go there, and you will learn more, see what's going on." And, I took that to heart, and I learned to love essentially the tours as a great teaching tool.

Now we have safety and housekeeping tours, and I encouraged other researchers to get involved and get to places underneath the rolling mill, places that you would never go, underneath the reheat furnace. You really get to know the mill and understand it, so it was a great experience. I used to give tours, there would be buses of people. And, actually, this is how I first met John Speer. Actually, I'd met John Speer in 1983. He came to work at Homer Research Labs, and I met him in the hallway. First time we met, he says, "I know you!" I said, "How do you know me? You don't really know me." He says, "Yeah, when I was a sophomore at Lehigh, you gave a tour, Professor Wayne Kraft's class had a tour. So, there was a Lehigh bus that came into the mill. I got on the bus, I had a bull horn. And, we drove through the mill, stopped at different stops." I must've impressed John. John was on the tour, and he remembered that. And, maybe it got him a little bit more excited about metallurgy.

00:42:50 My Career Foundation – Exploring a Variety of Positions Early in My Career

Smith:

So, besides giving tours, what were the first few years of your career like, working as a Looper in the Bethlehem plant?

Bodnar:

I got hired at the Bethlehem plant as a Looper, so meaning in management. So, you're going to work in different jobs, setting you up to become a manager. I first worked as a laboratory investigator, doing failure analysis of most of the products made in the Bethlehem Plant. So, tool steels: customers got tool steel, and it quench cracked. Why did this crack? Or embrittled steel; why is this steel embrittled? Not only tool steels, heavy forgings, structural shapes, and a lot of maintenance items. Actually, all the corporate maintenance items came to the Main Lab in the Bethlehem plant. So, I got to work on crane hooks and copper fittings and all kinds of things.

Then, I worked as a tool steel technical assistant, trying to answer customer claims. Why do we have a claim? How do you improve yield? How do you reduce rejects? A lot of the things that I'm sure you've been involved with of products. When the foreman went on vacation during the summer, I filled in as a foreman. So, that's kind of interesting being a foreman. I learned the word "ship." "Wait a second, the decarb layers don't meet spec; ship it." Or, "It's a little bit out of round; ship it."

Then, I worked as a product engineer for forged hardened steel rolls. That was interesting because I was involved from melting; I would go to electric furnace, watch the steel melted, or go to ESR facility, watch them melt it. Bottom pour of electrodes for the ESR facility. They had vacuum degassing, so I'm familiar

with vacuum degassing. Forging, heat treatment, and all the machining. And then, when there was failure analysis, a roll would come back from the customer. We actually had field metallography back in the seventies, late seventies. We have that capability at SSAB R&D now as well.

And then the last position I worked was a specification metallurgist for forgings, essentially dressing orders as orders would come in. So, what steps? How would we make this? What ingot size would we cast? All that. How would it be forged, upset, blocked? All the testing and all that. And then, when new specifications came in, I reviewed specifications, I made comments that would go back to the customer. So, it was a really good start.

Smith:

Do you think this provided you with a good foundation for the balance of your career?

Bodnar:

Absolutely, I was exposed to a lot. I was very fortunate, and it's a shame that plant is closed down. By and large, now; I guess Lehigh Heavy Forge is there where SSAB is buying backup rolls. That's about all that's functional these days. Yeah, it helped me get into Homer Research Labs. Of course, when I was in the mill, a lot of times, I ran up to research. You have to go up the mountain to reach Homer Research Labs on top of the south mountain. You can look out all over. It was a great place to work.

And, I met George Vander Voort several times. And, he had a career start similar to mine, in that he started in the plant and then came up to research and saw the advantage of really learning the products, the process, warts and all, all the problems, what to work on. And, when I went up the research, that really helped me. And so, I would go up to see George, "Hey, I need to do some special metallography. May I use some metallographic equipment? I need to use the electron microscopes." So, I was at research a lot, and I maintained that relationship. George was an excellent mentor to me.

00:47:20 "As An Engineer, You Need to be A Risk-taker" – Learning to Make Decisions Quickly

Smith:

Did you have any difficulties in transitioning into the profession?

Bodnar:

I didn't really have any problems, but it was different. I learned that, in addition to being book smart (and I did a lot of reading, read a lot of papers) you also have to have practical knowledge: how to get things done, who to talk to. There's a sense of urgency, and I'm sure you know that. Some people want to study everything to death. You can't, I mean, the mill is down. There's a problem. We need to get that mill back up and running. So, you only have a very short period of time to make a decision. As an engineer, you need to be a risk-taker. You don't have all the information. Decisions need to be made. And, one of the key things is developing relationships with coworkers. If you're going to get things done, you're going to have to rely on other people, and they need to trust you. And so, building relationships is very much key.

Smith:

What were your biggest challenges in adapting to working in heavy industry?

You have the not-invented-here syndrome. So, as a young engineer, you're full of ideas; you have ideas. We're not going to change the way we do things. We've done it a hundred years like that. This is how we do things. And, you really have to come with knowledge and facts and have good contacts. If people trust you, you can convince people to change. It was really difficult to overcome the “not-invented-here” syndrome.

00:49:10 First Major Projects – Crane Hook Failures and A2 Tool Steel

Smith:

What were some of your first major projects you had?

Bodnar:

Well, when I was in the lab, I was fortunate, or unfortunate, to work on a number of crane hook failures. I did a lot of reading on crane hook failures. Some of my work was included in the corporate crane hook manual and purchasing specifications. How does a company purchase a crane hook and make sure there's not going to be a problem? So, that was one of the first things.

I worked on A2 tool steel. It's an air-hardening tool steel. It was prone to ultrasonic indications, which led to big rejects. It was a major reason for rejects at the time. They made the product by three means: they could roll a wide flat in a rolling mill, they could hammer forge from the billet, or they could press forge such a product. At that time, of course, there were no Excel spreadsheets, everything by hand, taking down data, lots of reject data, and analyzing it.

I found that press forging actually gave you the best consolidation. And then, hammer-forging and rolling was last. We were able to change the wide flat product over to press forging and reduce the rejection rate. That work probably would've made a great publication. But, at the time, I didn't even think about publications. But, I'm really proud of that work. Unfortunately, I didn't keep those reports that I wrote on the subject.

Another one was when I worked in the ingot mold foundry. The problem was our torpedo car would come over to the foundry, and they would pour ingot molds, that is molds to make ingots. If you poured too hot, you'd have a breakout, and they would spray water, and there'd be steam explosions, really dangerous situations.

So, how could you speed up the casting process and get the temperature down? And, I was there for six weeks recording temperatures of casting. What we ended up doing was dipping billets and blooms into the torpedo car to chill the iron to get it down to close to a casting temperature, so you didn't have a high superheat temperature and did not have breakouts either. So, that was an interesting study, and this study was in the middle of the winter. And so, if you've been in Burns Harbor close to Lake Michigan, the cold coming off of the lake, so cold, but then you're casting, and then you're hot, everything heats up. So, that was interesting.

Carolyn had bought me a tie, a silk tie; at that time, it was maybe a $35 tie. And I had my greens on, I had my mill uniform on, but the top of the knot of the tie was exposed. And if you work in a foundry, there was kish and silica flying all over the place. I didn't have a respirator, so I was breathing that stuff for six weeks. And, the graphite all over the tie, this was totally black when I walked out of the shop. I learned not to wear good clothes in the mill. But, yeah, that was an interesting experience.

Smith:

That's right, because Bethlehem Steel employees and management had to wear suit and tie, wasn't it?

Bodnar:

We had a suit and tie, but then we had a mill jacket.

Smith:

Significantly different from today, being in a mill.

00:53:28 My Mentors in the Mill and Research – Papers and Patents

Smith:

Did you have any mentors while working at the mill?

Bodnar:

I did have a number of mentors. When I worked in tool steel inspection; Bob Marsilio was my mentor. He was a great writer, and he became a champion for me, the first one of my career. He really pushed me along - "Hey, this young kid's pretty good. He'd ought to be considered for other positions." So, that was really good.

Ray Cappellini worked as a corporate product manager in the forging area. I got to know him because he was responsible for crane hooks, which were forgings. Eventually, he came across an EPRI project called high-purity steels for utility components. Since I had the experience with my master's degree working on an EPRI project, that also helped me get into research. So, he was very helpful.

George Vander Voort, we talked about him. He worked at research and was a very good mentor.
Then, when I got into research, one of my first supervisors was Bruce Bramfitt, who has passed away. A good friend, mentor: get involved with societies, write papers, get involved with committees. a lot of good guidance. Telling me some of the things that I wrote, they're not very good, you need to improve your writing. At that time, I was working on heavy forgings, and they were going to put in a new 10,000-ton press. I'd learned from reading literature; people were modeling forging using plasticine or clay in the laboratory. And, I told Bruce, we really need to do this. And, of course, management shot it down, "Hey, you're a physical metallurgist, you can't do this." Bruce and I went ahead anyway, and we started and founded the physical modeling lab. We did a lot of key experiments. We wrote a paper that won the Tannenbaum Award, which, at that time, was the best paper in the mechanical working and steel processing division of the Iron and Steel Society. We really did some neat work. I learned sometimes you need to draw a line in the sand that, ”No, we need to do this,” even though it wasn't popular. And then, it was accepted.

And then, Steve Hansen, he was my boss. Of the 44 years that I worked; he was my boss for 25. Absolutely outstanding, smartest guy I know. He had the ability to manage so many things and stay on top of so many things at once. We did a lot of good research together, writing, reading, and we have a number of patents together. I think we wrote 15 papers together. And, he remains a good friend of mine. And, that’s one of the main reasons I came to IPSCO SSAB, because he mans it.

00:56:46 Homer Research Laboratory – Pursuing Product Improvement and an EPRI Project

Smith:

What eventually led to your transfer over to Homer Research Laboratories?

Bodnar:

Well, I knew the plant and the products, and I knew their problem areas. I knew I could help them in Research if I was there. I got the encouragement from George Vander Voort. Ray Cappellini wanted to do it as an EPRI project, and I knew I could do this. I wanted to head up this project. Eventually I wrote a proposal, and we got the project. And, I was able to bring in, I think, almost $3 million into Bethlehem Steel Research from contract research that we did for third parties. I remember the chief metallurgist at the time, Jerry Hagaman, called me into his office and said, "I really don't want you to go." I mean, he had plans for me to maybe be chief metallurgist someday in the plant. And, I said to him, "I really want to do this. I really want to do this EPRI project. I really can help you with all your products, because I know the problems, I can work on them up there. I want to do this EPRI project." And, he said, "Well, if that's what you really want to do, I'm not going to stand in your way," but he was not happy that I left.

Smith:

What other engineering positions did you hold and where?

Bodnar:

Well, up at Homer Research Labs, I was a research engineer in the metallurgical services investigation group, and it was a very interesting job. And then, I became a senior research engineer, and I worked in several different product development groups and developed, over the years, expertise in steel castings, heavy forgings, including physical modeling with plasticine, rolling mill rolls, plate, bar, rod, wire, rail, and structural shapes. Sheet steel is probably the only product that I had very little interaction with. At one point, I did have the welding lab, where we did weld qualifications for automotive customers. We would have to make so many spot welds to show adequate tip life for a spot welder and that you can make consistent good welds. I've worked on just about everything but sheet steel in depth.

00:59:21 Biggest Challenges as a Research Engineer

Smith:

What are some of the biggest technical or other challenges you experienced as an engineer?

Bodnar:

A big challenge when I started working on forgings at research, and one of my first assignments, was a problem we had with heat indication testing of chromium-molybdenum-vanadium high-pressure turbine rotor forgings. To make a turbine rotor forging, I remember there were 55 manufacturing steps, a very complicated product, probably one of the most complicated products. There's so much machining, heat treatments required, testing of all kinds: magnetic particle, ultrasonic testing. And, this heating indication tests, for one of the final tests, the rotor was put in a lathe, turned at a certain rate, and you put a furnace on top of the rotor. So, the rotor is heated up to the operating temperature that it's going to see in service, and then you would measure runout. So, how much did the rotor run out or distort? In other words, it didn't turn a perfectly round. And, you were allowed two-thousands of an inch run out. We had a number

of rotors that exceeded that, and they had to be scrapped, could not be used, and were a very expensive product. It turned out that the solidification pattern in an ESR ingot was not concentric, and it was not concentric due to the magnetic fields that were there.

So, we did a lot of pre-work where we etched 60-inch diameter ingots. We cut forgings apart longitudinally and etched them. Just an incredible amount of work, and I wrote reports documenting that. And then, we shielded the mold by putting a plate around it - the bottom line was that reduced the magnetic fields by about 20% and still had the problem. The next step would have been to shield the busbars for the furnace with heavy plate. We never got to that; they shut down the furnace. It was an interesting problem. I did a lot of dilatometry, showing the expansion due to the segregation, in different quadrants, keeping track of clock location.

Then I worked on HPS 70 W high-performance steel, weathering steel. And, there's a difficulty meeting the minimum yield strength, 70 ksi. Perhaps you're familiar with that? At Montpelier, the way the product is made, if you fail yield strength, then they put it in a hot stack of plates, try to get a temper aging effect to bring back the yield point to raise the strength, also temper any martensite or M-A (martensite-austenite) constituent that might be there and, perhaps, get a little bit more precipitation strengthening, very difficult problem. At Burns Harbor, they run the plate right through the furnace quickly to temper age it. But, that was an interesting problem.

Coarse niobium rich particles: this is a problem that I first saw in Sparrows Point plate, back when the Sparrows Point Mill was making plate (~1995). We also saw this in Steelton forged back-up rolls; Steelton casts large ingots for these rolls. These coarse particles have a negative effect on toughness and strength. And then, at IPSCO, we've seen them in a lot of products. And so, it's been a project I've been working on for a long time. When I joined IPSCO, Sunday Abraham was working on this problem. So, we got together and published some papers. We just published this past week in Met. Trans., we think, maybe the most definitive paper on coarse particles. So, I am really proud of that and all the good work done there.

And, the last thing is one of the most difficult things for metallurgists to do is to write a specification. And, I see now that there are courses out there to do this, which has been desperately needed. A lot of people read specifications as you do ANSI and the ASTM specs and how to do things. And, I'm sure there are questions all the time. Well, what do they mean by that? Or they don't really address this problem that I'm into. I was involved with writing the ASTM A945 (HSLA 65) standard, largely used for Navy ships. I wrote part of that. So, I went through the process, very interesting.

PART 2

00:00:17 My Engineering Contributions to Industry – Physical Modeling Lab and Patents

Smith:

Can you please share some of your engineering contributions to the industry?

Bodnar:

Well, back to the physical modeling (heavy forgings) lab, Bruce Bramfitt and I founded that laboratory, and a lot of good work came out of that. Some of the EPRI work I did, high purity steels for utility components, involved three and a half nickel-chromium-molybdendum-vanadium low-pressure turbine rotor forging. One of the embrittling elements, in addition to a phosphorus, antimony, arsenic, and tin, was manganese. I showed in the laboratory that if you take manganese out of that steel, you can reduce the embrittlement

potential for the steel but also maintain adequate hardenability. And, based on that work, a prototype forging was made in Austria, Kapfenberg, Austria, at a company known as VEW. Then, I got to evaluate some of that, and then several other rotors were made in Japan. So that was a big impact, I think, on the industry.

I also improved the toughness of the chromium-molybdenum-vanadium turbine rotor by adding a substantial amount of nickel and some niobium for grain refinement. So, we had a finer grain size, and we improved toughness very much. It had pretty good embrittlement resistance, too. Keith Taylor and I prepared a paper on medium carbon bainitic steels, and it was published in Iron and Steel Maker. I think probably one of the best papers on bainitic steels. I don't know that a lot of people know about it, but it's one of the works I'm most proud of. I worked on a number of things where I improved the understanding, such as overheating and burning of steels. Roll steels with high chromium content were more prone to overheating. We wrote a paper on that that gets referenced quite extensively.

Widmanstatten ferrite, wrote a couple of papers in Met. Trans. on that to improve the understanding. Laser cutting of steel, I've written a couple papers on that, and we're still learning. That's an interesting area, what the effects of different steels and alloying elements in steel are on laser cuttability. I wrote a paper on the physical metallurgy of normalized steels, so that paper that gets referenced often. And, I did a lot of work on accelerated cooling. And, you got to see one of my seminars at SSAB.

Another interesting area that where we have a patent on, Steve Hansen and I, is an as-rolled truck frame rail. So, for the class eight heavy-duty trucks, like the Mack Trucks, the frame rails were made from, say, 1027 steel, with or without boron. So, you would take hot band, cold form it, punch holes in it, heat treat it, and then that would become the truck frame. What we did was rolled a channel shape, which had a thicker flange than web, so there was a modulus advantage. So, you could save weight in the truck. You didn't have to heat treat the channel. And, the micro-alloyed steel that we used actually work hardened in service, so, actually, the fatigue resistance went up. I did a lot of work on titanium nitride technology by adding small amounts of titanium to steel and converted much of Bethlehem Steel's plate products to titanium bearing steels. And, of course, at IPSCO and SSAB, we did the same.

I worked on the high-temperature processing X70 sour service steel, where we received slabs from IMEXA in Mexico because Burns Harbor could not make the low sulfur steel needed at the time. And, that was successful. We rolled the thickest 7/8-inch X70 sour service pipe for the Cantarell pipe project. I was involved with X80, interestingly, when I was director of application engineering and new product development. So, I was involved with developing discrete plate X80 in the mill, going to Berg Steel Pipe, watching pipe formed and made, evaluating it, and then we'd eventually wrote a paper. That was given at the Winter Park Plate Conference in 2011.

00:06:01 Investigating Gantry Crane Boom Failure and Electro-slag Refining

Smith:

Can you provide some examples of your involvement in failure analysis in litigation?

Bodnar:

Yeah, one of my first assignments at Homer Research Labs as an investigator was a gantry crane boom failure; the crane boom came down on top of a ship. It did damage, and I remember it was January 1981. I had to fly down to Sparrows Point at the time, climb up this gantry crane, and there was a plate at the top that held things together. The fracture had fatigue cracks, and I took pictures; it was 30 degrees out (and

windy), and I took samples back to the lab. And, it turned out the crane boom was impact loaded. Somehow, they dropped whatever they were lifting off the ship, the boom got impact loaded, and that caused the crane to come down. The interesting thing is, the next day, a plane, think it flew into Washington DC, one of the nearby airports, skidded off of the runway because of the ice. There was a lot of snow and ice the next day. So, it was great that I got down there right away. It was one of those things, at three o'clock in the afternoon I received a call, you need to be down at Sparrows Point tomorrow morning. I got a plane reservation, flew down almost immediately.

Another thing I worked on was ESR, electro-slag refining, annealed two and a quarter chromium, one molybdenum. The Bethlehem plant had made 20 tubesheet forgings for the Clinch River Breeder Reactor steam generator. The tubesheet forgings contain a lot of holes drilled into each disc. You could imagine a disc that's, I don't know, 20 inches thick or so (actually 15” thick by 48” in diameter), got all these holes and all the piping going through the holes; the tubesheet held the tubes in place. Well, we could not pass yield strength, and it was a low yield strength requirement; I don't remember exactly what it was. It was something like 35 ksi (actually 30 ksi minimum) yield strength. We could not make strength in the fully annealed condition. And, our competitor at the time made vacuum arc remelted steel. And, they had about 0.13% copper (in their steel). At the Bethlehem Plant, the product had, I think, 0.03% copper, so an order of magnitude difference - low levels of copper for today’s electric furnace steels.

But, the interesting thing was we found that the two and a quarter chromium, the high chromium content, reduced the solubility of copper, and, actually, you got copper precipitation strengthening in the competitor material. And, that pushed them over just enough to pass yield strength. And, we could not pass. We just failed by a ksi. And, we went to court, we went to a Department of Energy court. I had to testify in the courtroom. One of the interesting things, I was involved with the discovery process. So, we went around and had to discover all the papers, and Westinghouse was involved, the Westinghouse Madison facility. I went there, went through their files with the lawyer, the Bethlehem Steel lawyer, and collected a lot of information.

And, we found that, I don't know, 40 or 50 papers or reports. A lot of them were written by Oak Ridge National Lab on two and a quarter chromium, one molybdenum steel for this breeder reactor. Creep-fatigue and corrosion fatigue, and all kinds of studies that they did. And, most of them did not even mention copper content. The bottom line is the judge said, "The spec says 0.25% max copper; you should have known." And, our argument was, "Hey, all this work has been done, and nobody has even mentioned copper. It was a residual element. It's not supposed to be in the steel." Anyway, the rebuttal was, we wrote a paper on that to try to set the story straight, even though we lost the case. It was expensive; 20 forgings were scrapped and could not be used.

00:10:35 1994 Northridge Earthquake – 400 Buildings, Unrepaired Cracks, and a Lawsuit

Bodnar:

I got involved with the Northridge earthquake. So, out in the Northridge area of Los Angeles in 1994, the Northridge earthquake occurred. In 1998, we learned that some of the hot rolled structural shapes made in the Bethlehem Plant were in buildings. There were 400 damaged buildings, this is four years later, no legal cases are settled yet. 400 buildings were damaged where the column, the structural vertical column, and the girder that attached for each floor were joined; there was an issue with how the column and the girder joined. But, anyway, Bethlehem Steel got sued. We had material there. I went into a number of buildings; for example, on the fifth floor, there's a crack. Go up into the ceiling using a ladder, take the ceiling panels down, take pictures. A lot of cracked members went to Failure Analysis Associates, an outside testing lab that tested some of the materials and showed that Bethlehem Steel met the specified mechanical

properties. But, yeah, 400 buildings with cracks four years later, still not repaired. I don't know what happened with that litigation, many suppliers involved. Bethlehem settled out of court; we supplied product to specification. The case would've just kept dragging on, and you still kept paying the lawyers. For some small amount, they settled, and I think that was a wise thing.

And then, I got involved with the Atlanta Summer Olympics pipe bomb, where an ATF agent, that's alcohol, tobacco, firearms, and explosives, agent came in. He had a piece of pipe from the bomb. And so, he asked: what could we determine in a laboratory? We determined that it was 1022 steel. The pipe wall was about a quarter-inch thick. I could not find any weld, so it had to be a seamless pipe. It was low copper, so presumably made by an integrated steel company. That's about all we could tell. So, I don't know if that was all that helpful to the ATF agent. But, I had read later about the nails inside the pipe bomb; actually, the nail manufacturer has some marking on the nail head, right below the head of the nail, that you could tell what plant it was made from.

00:13:31 Capital Projects – Hard Work with Great Rewards

Smith:

So, through all your work across the industry, tell me about some of your involvement in various capital projects.

Bodnar:

If you ever have an opportunity to get involved with capital projects, they're high visibility and get a lot of attention. It's a lot of work, a lot of pressure, but in the end, the rewards are great. So, I highly recommend if you can be part of that to try to become part of it.

I was involved with a 10,000-ton forging press installed at Bethlehem Steel, which is now part of Lehigh Heavy Forging. And, we were involved with the modeling lab and doing work. A kind of interesting story about that was I had to present to the forging experts, the guys running the press that knew forging much better than me. I'm giving them a seminar, and that worked out okay, but I was pretty nervous for that talk.

I was involved with the ADCO unit, the adjustable cooling unit at Burns Harbor, which is long gone, and there's a new unit out there that you know well. It was very interesting developing all the products and starting with the commissioning of that, and some of my seminar came from that experience. I've also been involved with MULPIC (multi-purpose interrupted cooling). So, you know I've written a literature review on that. I had joined IPSCO right before QL5 (quench line number 5), they were building QL5 and normalizing furnaces. I started at that point and made input and helped to develop what steels and products we were going to make, so designing the chemistry, the MSPs (melt shop practices), and heat treatments for these facilities. The R & D facility was an experience of a lifetime. I was asked to design, construct, order all the equipment, hire the staff, write all the job descriptions and then manage the facility for 10-1/2 years. I learned so much. I mean, I even picked out the carpeting, the paint colors, and the furniture. I mean, it was incredible. I had just learned so much through that experience. I guess maybe that's enough on that.

00:16:10 At My Happiest Doing Good Research with Good People

Smith:

When were you the happiest in your career?

Bodnar:

Happiest when I'm doing good research surrounded by good people writing excellent papers. And, I think there's a lot of emphasis on papers. Oh, you know, Bodnar just cares about writing papers. No! I care about doing good work. And, if you write a paper, it's a kind of win-win for the company and the individual, because the company gets the best work product. It's really polished. It's really well done. It's well researched, has all the references. So, I really think that's been good. When I was working on the research center, from the time they said design the facility to the time we opened, it was almost two years.

When I've supervised people, I think that I have been successful. I got a lot of satisfaction out of that. And, when I collaborate with people. I talked about coarse niobium particles with Sunday Abraham, who has taken my job as the Director of R & D. I mean, there were many nights where I'm planning to leave at 4:30 or 5:00 pm, and we start talking about coarse particles and mechanisms and research, and what's going on. And, before we know it, it's 6:30 pm. Oh, my God! But, I was just totally lost in the moment, just so into it. That makes me happy.

Smith:

Throughout all your work, when did you struggle?

Bodnar:

The biggest struggle was when I reported to management that really didn't understand what I was doing, didn't appreciate what I was doing. We would have meetings and "Tell me again what you do."
Very frustrating; it's hard to get motivated under those circumstances.

00:18:23 Working with My Colleagues – Encouragement and Great Conversations

Smith:

Do you recall any significant experiences working with colleagues that you can share?

Bodnar:

Yes, when I started at Homer Research Labs, the vice-president of research, Don Blickwede, was an MIT graduate PhD. He was a student of Professor Morris Cohen. I don't know if you know that name, a very famous professor, probably the professor that has done the most work on steel. And, interestingly, Charlie McMahon, who was one of my advisors at Penn, was his student. George Krauss, at Colorado School of Mines, was also a student of Morris Cohen. Anyway, Morris Cohen, who was under contract, would come to Homer Research Labs a couple of times a year. And, of course, I knew the name. I got to meet this guy; he's a giant in the area of physical metallurgy. So, every time he came in, I made sure I would have an appointment with him for a half-hour or so.

Any engineer could go meet with him, say, "I'm working on this. How would you go about doing this? Or, what's the best way to solve this problem?" And, Steve Hansen also is an MIT graduate who studied under Morris Cohen. And, Steve was always there. I didn't know Steve. The first time I was there, I described the problem. So, the first 15 minutes, I described my problem and asked for his help. Then that last 15 minutes, Professor Cohen would give you advice on what to do, and his prized student, Steve Hansen, would also comment. I've learned a lot from Steve from his comments in those meetings. After the first meeting, I said, "Wow, I want to work for this guy. He's really, really, really sharp." So, that's how I got to meet Steve

Hansen. Unfortunately, Morris passed away; he was not only very bright but a gentleman.

Working with Bruce Bramfitt, and I've touched upon this before, his encouragement to get involved with societies, get on committees, to chair committees was very helpful to my career. You just learn so much. Write papers, review papers, read papers, go to conferences, start a laboratory. I would have given u if; we were turned down by management. They said, "No, you are physical metallurgists, we're not going to support physical modeling." And, we pushed ahead and did it anyway. I probably wouldn't have had the courage without him.

Andy Goodman, he was a project engineer for the R & D facility. I probably talked to him every day for two years. He was just an excellent project manager for the project. I've learned so much from him. He had a temper too. I remember I had made a drawing where all the equipment goes, and we had Jominy test equipment. I moved the equipment to the corner because it's portable, you can move it around the lab, and he put the outlet and all the electrical there. And I said, "Well, we're got to use this by this furnace over here." [Goodman said] "Oh, how could you do that? Because now we don't have electricity over there." So, he was really mad at me. But, yeah, I can remember when he retired, I spoke at his retirement, gave him a big hug.

Then, working with Sunday Abraham, I talked about discussions, technical discussions with him. We could get lost for literally hours after work, and we just totally lost track of time talking metallurgy.

00:22:26 My Excellent, Award-winning Research Group and Unexpected Recognitions

Smith:

Did you and your research group receive any honors or awards in your career?

Bodnar:

The group has won a lot of awards. I'm very proud that, since 2009, and even after I retired now, the group has won at least one award every year. People are doing good work. I'm really proud of what's been done there.

I've been very fortunate to win numerous awards over my career, including 24 best papers, which I'm really, really proud of. Some of the awards, the American Iron and Steel Institute (AISI) Institute Metal, we've won several times. The Hunt-Kelly Award we've won a number of times. The Gil Speich Awards is for the best paper on the utilization of physical metallurgy. I have won that four times. I'm very proud of that. Michael Tannenbaum Award was the best paper given at the Mechanical Working and Steel Processing Conference – won that twice. And then, I won the Jacquet Lucas Award, which is given out by the International Metallographic Society for the best poster paper, and it’s a very prestigious award. And, there's some money that comes with that, too. I'm very proud of that.

Smith:

Are there any awards that you are particularly proud of?

Bodnar:

Yes, particularly the fellow awards, becoming a Fellow of ASM International, formerly American Society for Metals, then AIST, which is part of AIME. I'm a Distinguished Member and Fellow as of 2018. To win those

kinds of awards, they're based on your peers. It's peer recognition. When your peers say, "Hey, you deserve to be at this level." And, to join John Speer, Bruce Bramfitt, Steve Hansen, and George Krauss, and other people that have won these kinds of awards. You're part of a peer group now. It really makes you feel good.

Smith:

Were there any awards that were totally unexpected?

Bodnar:

Yes, there were. The Charles Pankow Innovative Applications Award, I had no clue that was coming. And, that was given by the Civil Engineering Research Foundation. And, that was for working on high-performance steels, including developing of HPS 70W. I'm also a Fellow of Alpha Sigma Mu. It's kind of like an engineering honor society. I received that in 2012; I had no idea that was coming. We won the Charles Hatchett Award, 2012, that's for the best paper on the use of niobium. I had no idea that was coming. And then, your own committee, the Plate Rolling Technology Committee of AIST, gave me the Norm Hodgson Award. And, I worked with Norm Hodgson, and I knew Norm Hodgson at Burns Harbor; he has since passed away. But yeah, that was very, very touching. I still have that award in my office.

00:25:49 Professional Engineering License – A Broad Knowledge of Engineering

Smith:

You have your PE license. Why did you pursue it, and has it helped you out in your career?

Bodnar:

Yes, so I started at research, Metallurgical Services and Investigations, and we were involved with litigation. And so, if you have your PE license, professional engineering license, the legal system accepts you as having a broad knowledge of engineering. So, if you don't have your PE license, but you have a PhD, and you're a world expert in some narrow area, when the questioning starts to deviate from that topic, then they may say, "Well, you're not an expert in that area. You don't have the basic knowledge." So, I think if anybody is going to be involved with litigation, and metallurgist can well be involved, I mean, I've been involved during the course of my career several times, you want to have that PE license. That's really the main reason. And, it came in handy when I had to testify in court for the Clinch River Breeder Reactor tubesheet forging issue.

00:27:11 A Manager for 23 years – Managing Numerous Labs and R&D Facilities

Smith:

Rick, switching gears a bit, how long were you a manager?

Bodnar:

23 years.

Smith:

And, what kind of groups did you manage?

Bodnar:

I spent nine years as a research supervisor at Homer Research Labs. I had three groups that I managed during that time in the product development and applications technology areas. I also was the director of applications engineering and new product development when I first started at IPSCO/SSAB. At that time, there were three plants: Mobile, Montpelier, and Regina. Also, in that position, I had QA responsibility, or quality assurance responsibility, for the five cut-to-length lines. So, that was a very, very busy time. And then, I was the director of research and development for 10 and a half years.

Smith:

You managed a number of labs throughout your career. Can you name them, and how did this experience help your career?

Bodnar:

At Homer Research Labs, I changed groups due to reorganizations. I ended up managing a whole lot of labs. We had a pilot hot rolling mill, and we had pilot cold mills. So, we could actually roll plates, accelerated cool plates in the lab, simulate hot strip mill product as well. I had a chem lab, the light microscopy lab, electron microscopy lab, heat treat lab, we had a quenching and deformation dilatometer, creep, and fatigue & fracture labs. I also had a finite element analysis area where we had workstations and engineers doing design, thermal cutting, and welding lab. Managing all of these labs put me in an excellent position to design an R & D facility and to manage the facility.

00:29:29 Important Tenets as Manager – Model the Way, Be Open to New Ideas, Build Relationships

Smith:

In your own opinion, what are some of your major tenets as a manager?

Bodnar:

Number one, and most important, is hiring good people. You got to spend time and make sure you hire the right person, even down at the co-op level. I mean, we would take people out to dinner the night before, to break the ice, and make them feel comfortable. They interview better the next day. And then, spend time with the person. If you don't hire a good person, he or she is going to create a lot of problems. So, if you hire a good person, that'll alleviate problems and maybe extend your capability, if they have the skillset. You have to model the way. If you want people to act a certain way, you have to model the way. You treat others the way you want to be treated. Be honest with people. I'm not sure managers always do that. People would ask me questions, and I would say, "I don't know, I'd try to find out," or "I know, but I can't tell you," for whatever reason.

I never would assign work that I wouldn't do myself. Delegate the stuff you know the best, and most managers don't do that. It's hard to give away when you have become a world expert in an area, and then you become a supervisor. Of course, you want to continue doing what you know best. That's the stuff you need to delegate, and you need to focus on things you don't know. You can see a lot of examples where people don't do that, but that's what I try to do. You always have to have a plan, particularly when there's a meeting. You've got 20 people in the room, and if there's no agenda, there's no plan. You're tying up a lot of people. It's a lot of time money being lost. So, there always has to be an agenda or plan.

Try to keep people informed. I know as an engineer; I want to know what's going on. Try to inform people as best you can. Try to give the big picture on things. If people understand why they're being asked to do something, they maybe can bring new ideas to the table. Although, over the years, there have been people that have worked for me that said “Don't tell me why, just tell me what to do, and I'll go do that.” So, you have some employees like that. But, I think, in general, people want to understand why they’re doing something, and it allows people to buy into what you're trying to do. Be open to new ideas. I mean, I always have a plan, have an idea. Okay, this is what I'd like to do, and then somebody will raise their hand and say, "Well, I think I got a better idea." I'm quick to switch gears. "Okay, your idea is better. I agree. Let's do it."

You've got to build relationships with people, not just say hello in the morning and goodbye at night. Spend some time trying to really try to get to know your employees and build trust. Then, be an advocate for your employees. People raise issues. You may not know the answers. You have to have the courage to go to management, not with every little thing, but those things that matter, that are important to your people, you need to stand up for your people. Be an advocate for your people, and you don't always see that being done. Those are the things I try to do as a manager, and you can't always learn those from a book, either. So, you learn from experience.

Smith:

You talked a bit earlier about hiring interns and co-ops. You have hired 43 interns and co-ops as a manager of SSAB R & D over a 10-and-a-half-year period. Why do you think hiring interns and co-ops is important?

Bodnar:

For a lot of reasons, we already discussed. Even the co-ops contributed, and in research, and in most places within SSAB Americas, people have way too much to do. You can't do everything. There's not enough time. So, if you have a good co-op, they can help out and do the job. Again, if you hire somebody that's not very good, you have to redo things, and it just takes too much time.

00:34:02 The Power of Diversity and Writing Meaty Papers

Smith:

So what has been your experience with diversity?

Bodnar:

Diversity. So, I guess my big experience with diversity was working at Bethlehem Steel. And, at that time, when I started Bethlehem steel, particularly in Bethlehem, about 50% of the engineers graduated from Lehigh University. Lehigh University is an excellent school, and I took classes there. So, there's no knock against that. But, we'd have meetings and brainstorming, and when people come from the same place, you're not getting a wide variety of ideas. They've all been trained to think the same way. So, the brainstorming sessions, in retrospect, were not that impressive. And, when I came to work for IPSCO, you can imagine we were going to start up the heat treat lines. And, we had people from Algoma Steel, and we have people from Bethlehem Steel, myself and Steve Hansen, and we had people from US Steel, and people from Oregon Steel Mills, which is now EVRAZ.

We'd sit around, "What grades are we going to make? And, what products are we going to make? And, how are we going to make it?" “At Oregon Steel, we did it this way, and US Steel, we did it this way, Bethlehem, we did this way, at Algoma, we did it this way.” And then, we would take the best of the best ideas. And, I

can remember walking out of some of those meetings, “Oh, my God! Just incredible. Just so powerful.” That's when it really hit me that no, you don't want all Colorado School of Mines students. John Speer would hit me over the head, probably, but you wanted diversity in schools. When I was hiring, I wanted the best people. I don't care if they're Chinese, Indian, Russian, whatever. I want the best people I possibly can find. That's just going to add to the diversity. So different nationalities, different countries, different schools, I think it's better for the company.

Smith:

What are your likes and dislikes as a manager?

Bodnar:

I like seeing people be successful. I mean in sports too; I love watching people be successful. There's a lot of gratification, particularly if I was able to guide or help someone to be successful, win for the company, win for the person, and actually win for me.

What I most disliked was performance appraisals, mid-year reviews, end of year reviews. I used to put a lot of time and effort into it because it's a person's record. This goes on record, and I often would add things that people, if they did their self-appraisal, didn't even write in themselves. It's an important job. It's awfully unappreciated, unappreciated by the company, unappreciated by the person you're reviewing. But, I always felt they needed to be done right, and I put a lot of time into it, more so than the average supervisor.

Another thing that I dislike is reading something that's poorly written. There's a lot of publications out there that are poorly written; they should never have been published. And, we all have too much to read, and I'm the person that, if I'm targeting a subject, say accelerated cooling, I'm going to read every paper, everything I can possibly find on a subject to become knowledgeable. And, there's a lot of junk out there. One thing, a goal that I used to give my people, is to try to write one paper a year. And, I say this to you, too, in your position, one good paper. And, I remember a lot of young engineers, "Oh, we've got to publish this and that. We want to build our resumes." No, we're not going to publish junk or very incremental stuff. Good papers that are meaty that have new things to say, we'll publish that. I tried to do one good paper a year. So in my career, I think I have 112; they add up. But then, you’ve got people working for you doing the work. I'm a secondary author, contributor, but I think that's important.

00:38:51 ASM, AIST, and ISS Society Involvement – Committees, Committees, Committees

Smith:

So, when did you first learn about AIME?

Bodnar:

In graduate school. So, I remember TMS (The Minerals, Metals, and Materials Society), Iron and Steel Society, and Met. Trans. That was the publication that everyone wants to have, the most popular, best-reviewed journal. That's where you wanted your stuff published. And, fortunately, I've had several papers published there. I'm so happy to be part of this thing. And, I congratulate AIME on their 150th anniversary. And, to do an oral capture during such a time is a big thing.

Smith:

What technical societies do you belong to or did you belong to?

Bodnar:

Well, I was involved with the Iron and Steel Society, which became AIST and ASM. For a long time, most of my career, both societies. And then, TMS, I've kind of been on and off. I'm a member at the moment, but several times I've lapsed. There's not a lot of ferrous metallurgy in TMS, and they're trying to get strong again, but it's been cyclic over the years. The Heat Treat Society, the International Metallographic Society, the Pennsylvania Society for Professional Engineers, and the Association for Women in the Metals Industry – it is very important to support women, particularly those women working for me that were involved with the society. So, I was a member for 10 years in that society.

Smith:

What is or was your involvement in these societies?

Bodnar:

ASM Lehigh Valley Chapter, I was a chairman of the Young Member's Committee. So, you have to bring in a speaker and give out the Young Members Award, Outstanding Young Member. I got involved with the Historic Landmark Committee also in that chapter, and that was a lot of fun. Then, ASM also had a ferrous metallurgy committee, and I was involved with that, and I actually helped organize four conferences.

ISS and AIST, I was a founder of the Heavy Forgings Committee. When I started working on heavy forgings; there was no place to give a paper annually. So, you do good work. Where are you going to give a paper? So, we actually started the Heavy Forgings Committee that lasted for only four years and then died as I moved on to working on other steel products. I was a chairman of the Mechanical Working and Steel Processing division executive committee. We had our own logo, among other things that we did; I'm proud of that.

And then, as a board member of the Iron and Steel Society representing the Mechanical Working and Steel Processing division. And then, I was chairman of the Product Physical Metallurgy committee, which is now in AIST, it's the Metallurgy - Processing, Products, and Applications Technology Committee. So, it's continued on. I am a member of the Plate Rolling Technology Committee, although we have other members at SSAB, like yourself. Congratulations on becoming chairman of that committee. And, the Kent Peaslee Junior Faculty Award Committee, I did that for six years, and my term just came to an end. And, the last three years, I've been on the Kelly-Hunt Outstanding Award Committee.

00:42:52 Historic Landmark Committee at ASM – Honoring the Steel Industry's History

Smith:

Some of your society work is focused on recognizing history. Tell me about your accomplishments in this area.

Bodnar:

Historic Landmark Committee at ASM, I got two historic landmarks recognized. One was BethForge, actually going back to way before the time of BethForge. In 1898, they took tool steel and developed the high-

temperature austenitizing heat treatment that gave great properties. So, interestingly, you want to heat treat at a very high temperature for high-speed tool steels, and that made high-speed tool steels possible. And then, the Grey Mill, actually a steam-driven 48-inch rolling mill that made many of the sections that went into large buildings that expanded the skylines of many of the cities in the U.S. This makes me very proud. That mill operated from 1908 to 1995.

I also wrote “The History of the Mechanical Working and Steel Processing Division of ISS.” That was back in 1995. So, that is not complete, but it was complete up to that time. I wrote for the preliminary and final programs for one of the Mechanical Working Conferences when it was in St. Louis, Metallurgical Tidbits on St. Louis. We talked about the Eads Bridge, where the first alloy steel was used in the bridge, for example. And then, recently, the history of Bethlehem Steel's research department, I contributed two of the articles. One was essentially summarizing all the work that was done on accelerated cooling and direct quenching at Bethlehem steel while Homer Research Labs was still around. Bethlehem became defunct in 2003. Then another paper on vanadium steel custom shapes, such as a forklift mass section and a truck frame rail section. And, Bruce Bramfitt was a co-author to include his joint bar development. So, joining railroad sections together with a heat treated joint bar. This was a vanadium-bearing as-rolled product.

00:45:37 From a Young, Naïve Engineer Attending Conferences to Organizing Fifteen

Smith:

You have authored numerous papers and helped to organize 15 conferences. Do you care to comment on some of the lessons learned?

Bodnar:

Yeah, I remember Charlie McMahon telling me about publications. He said, "You want to publish in the hot areas, the areas that people are interested in. If you publish a paper on some obscure topic, the paper is not going to get read, and it will be lost." And, don't be afraid to put forth controversial ideas. So, even if you're proven wrong later, don't be afraid to put forth those ideas because it'll push the knowledge forward. I mean, people may say, "Wait a second, I don't think that's true. I'm going to do this experiment," and continue the development. So, you kind of spurred developments.

We had Professor Brian Pickering at the Mechanical Working Conference a couple of times (1989 and 1993). He visited Homer Research Labs, I was happy to meet him, and he's written another great book. The name, *Physical Metallurgy and the Design of Steels*, is an excellent book, textbook. I asked Brian Pickering, "So, Brian, what do you think of Mechanical Working and Steel Processing Conference?" And he says, "As a conference, very good, but people are too nice. In the old days, it was very controversial. People would debate and get up and argue over certain metallurgical phenomena and data, and present their own data in rebuttal. And then, this would be captured as part of the discussion in the conference proceedings.” It is really incredible to go back and read some of the conference debates, some of those old papers. I'm very happy that we, at the research facility, SSAB, acquired George Krauss's personal library collection and Bruce Bramfitt’s, who obtained quite a lot of Homer Research Laboratories library books. We've acquired those at the research facility. So, there's a lot of good information and old information, 40, 50 years ago, still germane today, and some of the discussions are really interesting to read.

The other thing Brian told me, he says, “It's very interesting about attending conferences. So, when you're a young engineer, perhaps, attending a conference, you don't know very many of the people there. You show up, and you are sitting in the audience; you're looking around. I hardly know anybody. And then, you get in the prime of your career, and you've been active, you've organized conferences, you've chaired numerous

sessions. You've been chairman of committees. People know you. You know most of the people there." People used to say when I went to Mechanical Working Conference, we had attendance of maybe 300 people, I knew most of the people. And then, you get to the end of your career, like I am now, and there's a lot of young engineers that, I'm sure, are going to be at AISTech that I won't know. And then, there's a lot of people that I know that are deceased or retired that are no longer participating. And so, you come full circle from initially not knowing anybody to the end, not knowing very many people. So, I thought that was kind of interesting, Brian's perspective.

00:49:38 Society Benefits – "I May Not Know Anything on A Subject, But I'll Know Who to Call"

Smith:

How has societal membership benefited you in your career?

Bodnar:

Oh, contacts. So, I'm not the smartest person in the world, but I know a lot of people. And, people ask me, "Hey, how can I get information on this?" I know who to call. I know who to contact. That's been very successful. And, if you're not going to conferences, not meeting people, and not meeting the experts in your field, it's a great way, particularly organizing conferences. MULPIC accelerated cooling, so who are the experts in the world? I'm going to write a letter; I'm going to invite them to present at my conference that I'm organizing. You get to know those people over the years; it's very valuable.
Giving papers and particularly giving feedback are also important. And, I remember as a young engineer, so many times, Professor George Krauss was in the audience and always asked a question. And, sometimes, I did not know the answer. Or, sometimes I'm like, "Oh my God, that's a great point. I'm going to go back and read about that, or I'm going to go do that experiment after leaving." And then, you get to the point where you can pretty much anticipate what kind of questions people are going to ask. But, yeah, George Krauss was great. I learned so much from his questions.

Learning going to conferences, listening to papers and learning, reading papers and learning, asking questions and learning, practicing management skills. There are so many management skills. As a chairman of the committee, how to run a meeting. How do you keep the meeting going? How do you draw out the people? You see a lot of times where AIST, well, here's the agenda for the meeting. Well, wait a second, we need to also talk about this and this and this. You should be adding to that and enhance the agenda. Don't just rely on AIST. Their staff is great and all. They have their perspective and maybe what at minimum needs to be discussed, but you can do other things beyond the norm.
Visiting competitors, going on tours, so I used to go on tours all the time and see competitive mills. You learn so much. In public speaking, you improve your public speaking. And, in my case, Bethlehem Steel lost money a lot of years; it was tough to get to conferences. The way I got to conferences, write a paper. But, I'm the committee chairman, doesn't matter. Somebody else can step in and do that. Somebody else can't step in and give the paper. So, once you get a paper approved, you are going to the conference. And, that's what I did, try to do one paper a year to try to get to the conference. That's how I got to the conferences.

Smith:

How do you see technical societies benefiting people in the industry today?

Bodnar:

Many of the same ways I talked about. I like what AIST is doing now. The visualization and, of course, SSAB

is a member of Purdue Northwest in their center for simulation and visualization, digitalization, and all the things going on with digitalization now. I think it's a hot topic. Decarbonization, another hot topic, and SSAB is a leader there. All the training courses, I think are excellent. The competitive awareness you get from the tech briefs from all the societies. And, the technology roundups, you're involved with the plate mill roundups and what our competitors are doing. I think that's all really good information to get. And, also, safety, now the emphasis of safety within the society, good articles every month in the Iron and Steel Technology magazine.

Smith:

If you were to recommend AIST or ASM International to a new graduate, what would you tell him or her about it?

Bodnar:

Many of the same things. The opportunity to meet people and make contacts is just so key and so important to my success that, like I say, a lot of times, I may not know anything on a subject, but I'll know who to call, who to ask, who to get guidance from. Listening to and reading papers and improving your knowledge, giving papers, getting feedback through a Q and A, improving public speaking, learning management skills, learning how to run a meeting, learning how to organize a conference. I've been around, you see things not done so well and some things that are done well. And, yeah, you learn from that.

00:54:39 Steel Mill Tours – Attracting Young People to the Industry

Smith:

In your opinion, what can we do to attract young people to the industry?

Bodnar:

I think people need to see steel mills. It's better if it's a clean mill like we have at SSAB. I think people outside of the industry have no idea what a steel mill has, what it does, what the people do, what kind of jobs are even available. I think it's key to go on a mill tour. And, I think it's key to have a young person, like yourself, that's very impressive, knowledgeable, and a shining star, a rising star, come speak to kids. I can speak with students, and I have, but I think they can relate better to a younger person. I encourage you to do as much as you can; it'd help with the recruiting, I'm sure.

Smith:

What milestones in the industry do you think had the biggest impact on it?

Bodnar:

When I started in the Bethlehem Plant, it took eight hours to make a heat in an electric furnace. Now, you have ultra-high powered electric furnaces, 40 minutes you've made a heat of steel. The electric furnace is so flexible. If there's an economic downturn, you just press the off button, you power off. If you have blast furnaces and BOF shops, it's hard to shut down that blast furnace. Continuous casting, I mean the quality has gotten so much better and faster to make than ingot casting. Thin slab and thin strip casting, the productivity. Hot charging, probably we should do more of that and understand that better. Steckel mills

are very cool. We had one in Conshohocken as part of Bethlehem Steel, and IPSCO/SSAB has Steckel mills, and they're so flexible. You can make coil; you can make plate. You can roll very light gauge. We are rolling, at Montpellier, down to 3.2 millimeters.

Thermal mechanical control processing, all the metallurgy, the deep metallurgy that we've learned about control rolling, accelerated cooling, how you can save alloys and improve productivity. The computer models getting better and better every day for improving process consistency and quality.

When I started, you used to write reports by hand; there was no word processing. The fact that we have word processing, PowerPoint presentations, and Excel spreadsheets - we used to get big graph paper taking down data and plotting it by hand. It's so much faster now. You've got digitized micrographs, macrographs, electron micrographs. All those things are just so much faster. The engineers are so much more efficient.

Smith:

Throughout your career, what are some technical challenges that you experienced towards the beginning but now seem rather trivial?

Bodnar:

Well, hydrogen flaking, although we still have hydrogen flaking from time to time, boy, that was a major problem. And, largely, although in the Bethlehem Plant, we had a vacuum degasser, there still was a problem with ESR moisture pickup in the lime, the slags that we use in ESR. They're much, much better now.

Low-sulfur steels, we're making two PPM sulfur levels these days. I mean, it's just incredible. The levels were two orders of magnitude higher when I started.

Calcium treatment, Sunday Abraham and I wrote a very good paper on this subject because people don't generally understand calcium treatment, including many physical metallurgists. And, I think that's made a big contribution. But to get a hundred percent calcium treated, you modify all the sulfides to become spherical, and they don't become elongated during rolling and control the oxides. They liquefy some of the oxides in the liquid steel making.

Making low nitrogen steels. I still hear this, that, oh, it's electric furnace. The nitrogen levels are too high. We're making 35 PPM nitrogen via electric furnace with vacuum degassing today.

And then, there is copper. I heard this a lot. There are many mills that would never make it, the copper levels are too high. They're going to have hot shortness. We're making the high copper steels routinely, 0.35% copper in a steel without issue.

01:00:05 The Future of the Steel Industry – Fewer People, More Automation

Smith:

Where do you see the steel industry 20 years from now?

Bodnar:

This is a hard one. It's hard to look to the future, and maybe this is more near future than 20 years. You're

going to have fewer people. I think you're going to have more automation. You're going to have more reliable sensors in the mill. You're going to collect big data. You're going to have these huge models. You're going to have more computer programs, more computer models. You're going to be able to simulate more processes. This is going to make the process more consistent. And, of course, SSAB and others are also working on hydrogen in their iron making to make sponge iron and fossil-free steel with hydrogen. I think it's exciting, but that's the near future. I can't really project 20 years because things have changed so much during my career.

Smith:

Are there any misconceptions that you repeatedly see about the industry that you wish you could change?

Bodnar:

You still hear from people; the steel industry is a dinosaur. It's a dirty, rusty business. When you walk into today's mills, you have modern computers, modern pulpits, modern equipment. It's not like that at all, but that's still a misconception. And then, I've heard this from academia, particularly those that are not involved with the consortia, steel consortia that are out there. What more do we need to know about steel? We know just about everything. There's very little research that needs to be done. There's very little work that needs to be done. Totally a misnomer. That kind of bothers me. You have the professors that are teaching students. I would assume that they're teaching that steel is uninteresting. We know everything about steel. We don't.

01:02:32 Passion and Drive for Working in the Steel Industry – "Steel in the Blood"

Smith:

How would you rate your work-life balance during your career?

Bodnar:

Terrible. I'm a workaholic. I've been a workaholic. But, you know, the interesting thing is work-life balance, that wasn't even a thing when I was a young engineer. I was taught by my parents, essentially, good things happen to people that work hard. You're supposed to work hard, and that's what I did. I brought the briefcase home every night, but not always opened it. And, for 13 years, I coached my kids' teams, and so I left work early. I left work at four o'clock. We had practice, and we had games, whether it be little league baseball or a soccer game or basketball or a girls' softball or whatever. I was there for my kids. But then, I'd come home, they would go to bed, nine o'clock the briefcase would open. I might do work, even on vacation. I mean, I love what I do. It's really not a problem for me.

Smith:

How did you develop such a passion and drive for working in the steel industry?

Bodnar:

The bottom line, you get steel in the blood. And, I've said that for a long time, but I've heard a lot of other people say that, including some of the other oral captures. Every day seems to be a little bit different. I learned something every day. It was exciting; there were always exciting problems to work on. And, I think, as you go on in your career, the more you know about steel, the more you realize how little you know

about steel. So, I mean, there's so much more to learn. And, the other cool thing is, nobody knows everything about steel. So, you could find your niche or area where you're the expert; like ultrasonic testing, you are the expert. I think that's kind of neat that there can be a whole lot of metallurgists in a room, but you may be the expert on ultrasonic testing. I may know something about accelerated cooling, and then the next guy knows something about steelmaking, but nobody knows it all, and we all need to work together. It's kind of neat. When I worked in the Bethlehem Plant and at Homer Research Labs, I used to drive past the steel mill every day. Driving past a steel mill is just so cool. Once you know what's going on inside, you just get excited.

01:05:21 Attributes of My Success – Hard Work, Communication, and Willingness to Take Risks

Smith:

What attributes do you have that have contributed to your success in the industry?

Bodnar:

I'm not the smartest guy in the world, but I'm a hard worker. I'm going to put the time in. I'm going to read everything I possibly can read on a subject. I'm going to become the world expert on a subject. I think through athletics, I'm competitive. So, for most of my career, I'm the guy with the master's degree. A lot of guys worked for me, colleagues of mine with PhDs, I'm like the underdog. So, I have to be at least as good or better. So, I think that's driven me to some degree, helped me be an overachiever. I'm a good planner. I now write well. When I first started, I wasn't very good. I can communicate well. I read everything, I mean, almost to a fault. Some of the stuff [I ask myself], "Now, why are you reading this?" I've got to read everything.

I always surrounded myself with good people. So, I had people tell me, like Bruce Bramfitt or Steve Hansen or Sunday Abraham or Keith Taylor, or whoever, "That's not a great idea. That's not one of your best ideas." I think it's important to have somewhat of a safety net. And then, have people that, when you do have a good idea, they really champion it and get behind it. So, that's been good. I have a practical approach to problem-solving. I feel that sense of urgency. I'm not a scientist, I am an engineer, and I'm willing to take risks. A lot of times, we don't have all the information. We have to make a decision, and I'm not afraid to do that. I'm very loyal. I'm honest; I'm trustworthy.

Smith:

Do you think that luck played a role in your successful career?

Bodnar:

This is an interesting question. I do. I mean, why did I pick Muhlenberg college? I got accepted to these other five engineering schools. It was just a kind of gut feeling. I mean, the sun came out. I just felt comfortable on campus. The people were friendly. I could make the sports teams. And then, I met my wife. Finding ferrous metallurgy, we talked about, when I was at Penn, it was a halcyon for ferrous metallurgy. There's no ferrous metallurgy being done there now. But, I was at the right time and the right place. I met all these people working on cool stuff. Starting in the Bethlehem Plant, that was not my first choice, and that's where I ended up. And, it turned out to be a great place to learn because they had all this equipment, all of these things that I learned.

Working for EPRI, I worked on two EPRI projects, actually more than that. There were subsequent projects

when I was at Homer Research Labs that we did with EPRI. Who knew? It turned out to be a great thing. And then, moving to IPSCO. So, I'm moving from integrated steel mills to IPSCO mini mills. How's that going to work out? How am I going to like that? It turned out to be a great place to work. particularly timing, just starting up a new building and starting up new heat treat facilities; so exciting.
And then, having the job of a lifetime. SSAB management saying, "We need to build a research center." And, I want that job. And, I think I was a perfect candidate for it to do all the things that we did. To see where the center is doing great and thriving and doing good work. I'm very proud of that.

01:09:38 Proudest Accomplishment – Building the SSAB Research Center

Smith:

Is there anything that you would have done differently, and how would it have changed where you are and what you have done?

Bodnar:

I often thought about a PhD. So, why did I leave Penn? I think I was tired of going to school. I had cockroaches in my apartment, so we'd bring an exterminator in and they moved to the next apartment, and the next apartment would bring in an exterminator. Then the cockroaches moved back. I wanted to get married. I didn't have any money. I wanted to make money. It would have been nice to get that PhD. And, Bruce Bramfitt, actually when I was working at Homer Research Labs, he said, "You should go back and get your PhD." And, Steve Hansen told me, "You're doing a great job. You're not going to make any more money with a PhD." So, once you start working, it's just based on your contributions; you get paid. So, I was making a nice contribution, and they were taking care of me financially. But, it's embarrassing; I go to conferences, and here's Dr. Abraham, here's Dr. Taylor, here's Dr. Dengqi Bai, and here's Mr. Bodnar. It's a little bit embarrassing, but I'm happy to be associated with them. So, maybe I have a PhD by association, maybe.

Smith:

Finally, what career accomplishment are you most proud of?

Bodnar:

The research center. I'm really proud of that. Of all the things that I've done, it is kind of a culmination of my whole career to design, build, construct, hire the people, and purchase the equipment. Compared to other labs, we use like 95% of the equipment we bought. Yeah, I made some mistakes on what we bought, but we're using most of that equipment. Some other labs that maybe use 50% of the equipment. Yeah, they've got a lot of equipment. They don't use it. It's old or whatever. Hire good people, doing good work, I'm really happy.

Smith:

Is there anything else you would like to say?

Bodnar:

I want to thank you, Andrew, for conducting this interview. You've done a great job, and I think it's important to have a young guy like yourself do the interview. I really appreciate the opportunity from AIME

to reflect on my career, and I've had a great career. It's been nice. Thank you.

Smith:

And thank you, Rick, for sharing your story with AIME and AIST.

Bodnar:

Thank you.