
AMERICAN INSTITUTE OF MINING,
METALLURGICAL, AND PETROLEUM ENGINEERS

**ORAL HISTORY PROGRAM**

# Richard Bullock:
# Missouri Rolla Student Chapter Officer – Destined for Greatness

**2019**

**TABLE OF CONTENTS**

**PART 1**

**PART 2**

PART 1

**00:10 Introduction**

Kaas:

Today is Monday, February 25th, 2019, and this is an interview with Dr. Richard Bullock. Dr. Bullock has had a long and productive career in the global mining industry and in higher education. I am Michael Kaas. This interview is part of the American Institute of Mining, Metallurgical, and Petroleum Engineers oral history project. This interview is being conducted in Denver, Colorado, during the annual meeting of the Society for Mining, Metallurgy, and Exploration, otherwise known as SME. SME is one of the four constituent societies of the AIME. Welcome, Dr. Bullock. Thank you for taking part in the oral history project. Like most of your colleagues and friends, I'm going to refer to you as Dick during this interview.

Bullock:

Only my students call me doctor.

**01:12 The Early Years During the Depression**

Kaas:

Right. Let's sort of start at the beginning. Dick, you grew up in the Ozarks during the Great Depression. So, tell us what that was like.

Bullock:

Not pretty. Well, I was born in Kansas City, 1929, so, right at the start of the depression. My Dad was fortunate to have a job where he worked straight night shift for 13 years as a midnight troubleshooter for a streetcar company. It's when you crawl under streetcars in the middle of winter and get them going again. But, his health failed him. So, by 1934, he couldn't work at all. So, just when things were starting to come out of the depression, we were getting worse off.

**01:51 A Run of Bad Luck in the Ozark's**

Bullock:

So, in 1938, we left Kansas City and moved. They bought a hill farm in the Ozarks, a rocky scrub oak hill farm, and we thought we could make a living on that. Well, it seemed like everything that he did went wrong. At first, we got a shack, which we had to repair to live in, and he bought 20 sheep and six hogs. Half of them were diseased; they all died. He bought a hundred chicks, raised them; a big rain came along, and half of them got drowned and died. The dog killed another half of them; so, we ended up with only 25 chickens. So, it was just one thing after another. But, fortunately, Fort Lenard Wood was just beginning to get built about this time. And, my dad and my brother had a good idea of building a skating rink, since they knew that thousands of soldiers would be coming to the area and would need entertainment. They took what money they had left and borrowed a bunch of money, and they

proceeded to build a skating rink. And, that skating rink was our salvation. We moved into the small bungalow they rented in Houston, Missouri and ran that skating rink. And, it proved to be a good livelihood for several years and really helped us out a great deal. We may not have starved if we had stayed on that rocky hill farm, but we would have come close.

**03:12 From Skating Rink to Mining Engineering - Decision to go to Rolla**

Kaas:

So, growing up in Missouri in those days and running a skating rink, how did you get from the skating rink to mining engineer?

Bullock:

Well, a long time afterward, of course. In the Ozarks, most people back then wouldn't think about going to college at all. And, Houston sits only 55 miles from Rolla. Here was a world-class university there, as far as mining was concerned, and nobody ever went there in the 75 years it had been there. In fact, I was the first graduate from Houston high school to ever go to Rolla and graduate. It was a pretty tough school, even back then. And, while I was in high school, I read books, and I saw there were lots of occupations. I knew I had to make a living, I had to get out of the Ozarks. I either wanted to be a structural engineer and build tall buildings and big bridges or something like that. Or mining engineering sounded very fascinating because these guys went all over the world, built mines, very romantic. So, I decided to go to Rolla. The problem was that Houston taught no physics, no chemistry, and very little math. Also, my folks could ill afford to send me. So, trying to go to a school like Rolla, to compete with the Kansas City and St Louis kids, and, at the same time, it's when all the veterans were coming out of the army. The school went from 300 population during the war, very low, from 300 one year to 2300 the next year with no dorms, no places which the university sponsored places to eat. The only places you could get rooms were the good people of Rolla who would rent you a room or part of one or the fraternity houses. So, I had a pretty tough time making that transition.

**05:22 Working for the Howe Sound Mining Company - Lake Chelan**

Kaas:

I know you mentioned in your memoirs having worked in the Cascades and the Sawtooth mountains in Idaho; [were] those summer jobs?

Bullock:

Yes, between my sophomore and my junior year, the school helped us find jobs, and I went to work for Howe Sound Mining Company in the state of Washington. Many of you may never remember it, but it was a Canadian company. And, Lake Chelan is a 45-mile artificial lake, very narrow, 45 miles long and a mile wide and a mile deep. At the end of that lake, 12 miles up in the mountains, was this big underground copper mine. It had about 300 men working, so it was a good size operation. It turned out that that was probably the best place in the world for a young man to go to work because they were really using state of the art techniques as far as drilling and blasting and haulage and everything. It was

an excellent place to get experience and served me well. Not only that, it was an absolutely gorgeous place to be. If you ever saw the pictures Lassie or Lassie Come Home, those were all filmed in what they call Little Switzerland of America, near the mining camp in the Lake Chelan area.

One of my summer jobs between my junior year and senior year was in Idaho. I was originally heading for the Sunshine mine up north. And the other guys were going to different mines Idaho, in different places. So, we thought you could drive up the middle of Idaho in May and then go to these different mines. Well, we got as far as Stanley, Idaho, and all the passes were full of snow. We didn't have any money for gasoline to go all the way back around. So, I rustled a job. I happened to know one of the shift foremen at Howe Sound from the summer before. He was running a small mine, Yankee Gold Mine near Stanley, back in the primitive area, and I rustled a job with him and worked for him the rest of the summer.

Kaas:

Well, that worked out well then.

Bullock:

It was a real primitive mine with carbide lamps, the shrinkage stope where you drilled blast holes with a stoper drill and used cap and fuse for blasting the dynamite. I also worked for one month in the mill. So, that was a really good experience because one man could run the whole mill, small operation.

**08:00 Being Active in the AIME Student Chapter - Destined for Greatness**

Kaas:

Right. Back in those G.I. Bill days at Rolla, did they have an SME student chapter there?

Bullock:

Oh yeah, as a matter of fact, I got active in the student chapter there as a sophomore. As a freshman, I didn't have time for anything besides studies, but did get active in AIME my sophomore year; I was a member of the local chapter but could not afford the national dues (I think it was $5.00 or $10.00) until the next year, 1950. And then, by my junior year, I was a treasurer of that group. And it, by the way, was the largest AIME student chapter in the country. We had 300 members in the student chapter because it included metallurgy, geology, geological engineering, and mining, and all coal mining and metal mining, everything. So, it was a big chapter. And, then the next year, I was president of that organization.

Kaas:

Wow. Destined for greatness, obviously.

**09:04 Mentor J.D. Forrester**

Bullock:

And then, of course, my mentor, JD Forrester, Dr. Forrester, really encouraged it. The first AIME meeting I went to was in St Louis, around 1949 or 1950, I don't remember which. I remember sitting at a table, and he introduced me to the president of Anaconda. Of course, he had worked for Anaconda before. So, that was quite a thrill for a student.

Kaas:

Yes, quite an experience. I think a lot of us got started with AIME and then SME through those days in college when you had student chapters.

Bullock:

Yes, we had a very active student chapter; it was great.

Kaas:

Yes, it sounds so.

**09:49 A New Job with New Jersey Zinc in Colorado - Gilman Underground Mill**

Kaas:

Then, after graduation, you went to Colorado? Do I have that right?

Bullock:

Yes, that's right. It was a good time to graduate. There were lots of job openings. I had ten offers, probably wasn't too usual back then, but I did. I went to work for New Jersey Zinc in Colorado. It wasn't the best offer I had, but it was the most challenging, and it put me in a place where I wanted to be. That was in the mountains. I love the mountains.

Kaas:

So, were you at Gilman?

Bullock:

Gilman is perched precariously on the side of Battle Mountain. This mine had probably the toughest mine working conditions in the country. The high-grade zinc ore combined with pyrites that oxidizes so quickly that they would ignite the timbers in filled stopes or unventilated areas. Many of the mining stopes were 100º to 130º F even with ventilation. Plus, they used heavy timbers for the Mitchell Set mining method, which was like the Square Set, except they eliminated every other post in one direction. That made half of the timber caps exceptionally heavy for the miners to place. The miners were almost all of Mexican descent and were excellent miners. They were tough. They drilled all of the horizontal blast holes with hand-held jack hammers. This was in the days before jackleg drills. It was amazing to see

them handle those heavy timbers. And remember, this was in stopes well over 100º.

Kaas:

You had an interesting- didn't they have an underground mill at Gilman?

Bullock:

Yes, they did. And, the reason for the underground mill was the danger of snow avalanches if they built it on the side of the mountain, and there was no flat place to build a mill. So, they built the underground mill, and it was really unique. Gilman was a good experience in a lot of ways. I spent most of the time at Gilman surveying for mine developments from the underground mine to the underground workings of very old mines around the area; so, I did a lot of surveying in the high mountains in the area, which included putting triangulation stations on a few mountain tops. So, I got in tip top physical condition. When the weather turned bad, they transferred me to the safety department, where I spent most of my time taking and analyzing gas and dust samples.

**11:01 Drafted into the Army During the Korean War - Tough as a Pine Knot**

Kaas:

Then you entered the Army during the Korean War period.

Bullock:

I could have volunteered, and maybe gone in a different branch of service, but I decided to wait and be drafted. Of course, all during the time while I was getting my degree, I was deferred, and as soon as I got out of school then, the draft board started sending me notices of pending draft. So, now was time for me to go in the Army. So, I got drafted. I'd been at Gilman for only eight or nine months. I'd gotten married in the meantime, and I was sent to Fort Riley, Kansas, for 16 weeks of training in the 10th infantry division. I took eight weeks of infantry training and eight weeks of advanced infantry training. It was pretty tough, but I was in excellent shape because of Gilman. So, I was tough as a pine knot. You know, I could easily go through whatever the army had to put me through physically. But it was an interesting time; it was obvious that they were training us for Korea.

**12:20 Selection for Scientific and Professional Development**

Bullock:

At the 13th week interview, they called a five of us from our company in and said that you've been selected for scientific and professional development personnel (SPDP), which was a good program to put people where they had some training instead of putting a doctor as a cook and this sort of thing that the Army was typical of. So, I was assigned then at the end of the 16 weeks to Fort Belvoir, Virginia, where I taught in The Engineer School there training mostly combat engineers. So, that was a very good experience also.

**13:02 Teaching 6,000 Students in the 20 Months**

Kaas:

Did you do research projects there too?

Bullock:

Not to begin with, no. In fact, Engineer Research Development Laboratories (ERDL) was there, and that was the excuse for sending us there, but there really were more of us in the school than there were doing research. They put me teaching pit and quarry operation, which was very logical, and explosives and demolition. They were putting thousands of people through Fort Belvoir at that time, mostly to be combat engineers, all going to Korea. There were about six or eight different programs of enlisted men and officers going through at about 40 to 80 in one class. As an instructor in the engineering school, you would teach four hours to eight hours a day. It was not like college teaching where you taught maybe six or eight hours a week. You taught every day, almost always all day. And during that period of time, I figured up I taught about 6,000 students in the 20 months I was there. That illustrates how fast they were putting troops through there. And those were ranked all the way from privates clear up to lieutenant colonels and advanced officers' courses. But, to teach lieutenant colonels, I had to have a major sitting on the platform with me. I was only a corporal. They wanted my experience of teaching, but they didn't necessarily trust me to teach by myself.

Kaas:

So, after your time at Fort Belvoir, and then you went back to Grad school?

Bullock:

Yes, but those are connected. One thing the army learned in Korea was that, while they knew how-to blow-up bridges and knew how-to blow-up buildings. They did not know how-to blow-up tunnels, and there are a lot of tunnels in Korea.

**15:10 Teaching Demolition with Explosives - Blowing up Tunnels**

Kaas:

So, you were teaching demolition with explosives, but then you proceeded to talk about blowing up tunnels, and that they didn't know how to do that.

Bullock:

Correct. So ERDL, for the Corps of Engineers (COE), had discovered a bunch of abandoned tunnels along the Oregon/Washington border, on the Columbia River. Anyway, they were in the process of trying to blow some of them up. They were experimenting to see what it took to blow one up and they learned, while there, they'd blow a bigger hole in the ground, but they wouldn't destroy them. So, that got them interested in trying to do research on tunnel demolition. I had let Dr. Forrester at the Missouri School of

Mines (MSM) know that I was interested in coming back for a master's, but I really wasn't convinced that I should, but I was interested. Well, he developed a contract with the ERDL and the MSM at Rolla to do that sort of research. There was enough contract money to where I could have stayed on three years doing research at Rolla to earn a doctorate, but instead I choose to get my master's, after which, I left Rolla. But I proceeded then to go back to MSM after I left, to continue my education, one course at a time, taking night courses and library research on weekends. In the meantime, while I was still in the service, I went for about two weeks out to Madras, Oregon, and we blew up some tunnels, at that time, and then went back to Belvoir and continued teaching for a short time and was then discharged. Then, I went back to MSM and started working towards my master's.

Kaas:

So, your master's research, did that continue?

Bullock:

Yes. There are two types of demolition by military standards. One's a “hasty” method, where you do it very quickly, and with the objective of delaying the enemy a short time. Or, you do it “deliberate” demolition, where you may spend weeks and weeks in the preparation, and then you do your demolition and then you leave. But the difference is it will take the enemy a very long time to repair the damage. Well, my part of the research was a hasty method, which could be done very quickly. So, to do hasty method of demolition research, I built 20 concrete models, some as much as 20 feet long and about two feet high, and packed them in sand. I used varying types of explosives and explosive placement distances in the tunnels, and I followed the strict similitude modeling laws, which meant you had to scale everything in every dimension of the parameters; strengths distance, explosive force, velocity, and everything else. So, it was a good model study, and it did prove some things, which the COE did not know about blowing up tunnels. So, it was successful research. It didn't help the mining industry. But most government research contract don’t help industry directly. It did help me, along with the G.I. Bill, it got me through school. Then, my family started coming along about that time, so that's when I left and went to work in industry.

**18:15 Working for St. Joe Minerals**

Kaas:

And so, then you started with St. Joe?

Bullock:

Yes, I started with St. Joe. At first, when I started interviewing with companies, I didn't interview at St. Joe because they didn't seem very progressive. I didn't know much about them. I'd been raised in Missouri, but I didn't know what size they were in the first place, and so I didn't take the interview then. Well, they didn't get many students’ interviews, and Elmer Jones, the St. Joe SE Missouri manager, came back and let the department head know what he was thinking. He wanted to set up a good mining research group that had professional people who were used to doing mining research. Well, that caught my ear immediately. So, I then took the interviews with St. Joe, and I went to work for them. There

again, I had ten job offers, and that wasn't the best paying one; U.S. Steel was the best paying one. But anyway, working for St. Joe and then the mining research really interested me, and that's what I wanted to do.

Kaas:

That must have been kind of an unusual situation in the mining industry in those days. Not too many others…

Bullock:

Absolutely, but St. Joe had been doing what they called research or investigations for many, many years, but they didn't do it very formally. They just used people out of the engineering group or the mining group who weren't really trained in the way to do research. They did not necessarily do library research before they started doing it in mines. It was successful in some ways but not nearly as successful as they wanted to be as far as long-range research. And, that's what we were involved in.

**20:12 Pioneering the Research Group and the Bullock Burn Cut**

Kaas:

So, did you develop specialized mining equipment while you were doing that?

Bullock:

Well, eventually we did, yes. I was the first one of our new research group to arrive at St. Joe. They had hired Dr. John Reed, who had just got his degree out of Berkeley but was a very experienced mining engineer at Brayden Copper in Chile. He was to head the department. He was very qualified, and, later on, became very well known in the industry. Then they later hired Joe Yancik who also graduated from Rolla with a masters. So, the three of us really pioneered the research group, and we [later] took on other engineers. But, my first project was to try to develop a burn cut drift round, which would break a longer distance than they were now able to break in their developments and allow them to advance more and be more productive. People all over the world, were breaking what they called burn cut rounds, which would advance a drift 8 to 12 feet or even 20 feet and break a round that would be successful consistently. But, the dolomite rock in the Bonneterre formation, somehow, was very, very difficult to blast. It was in some cases an algal reef, so it was very spongy. You could drill two 12-inch holes [close together] and blast small holes close to the two of them, and they would recompact solid and you could hardly tell where the original 12-inch holes had been. They couldn't figure out why it wouldn't break. So, my first assignment was to develop a burn cut round where the drilled depth was at least 12 feet and break it consistently, at least 90% effective of the drilled depth. So, that was a big challenge. This would more than double what they were presently achieving.

Kaas:

And this was all open stope mining?

Bullock:

Yes. It was all room and pillar, open stope mining, but they were particularly interested, at first, in improving the development drill round. Later, the productive thing was to apply it to the stoping round because, of course, the rest of mining could be done that way. It took me 18 months of research and trial shooting dozens and dozens of different patterns and the different rock formations to finally figure out why it worked, what it took to make it work, and prove that it worked in all of the rock formations. And, this was before the Swedes published their work. They'd done a lot of research on burn cut rounds, and Olaf Langfors was considered the authority on them. Before he published his book on blasting, he came to visit us and looked at our work. So, I was quite proud of that, and he even notes our work in his book. So, anyway, it was significant, and it did the work successfully. The hardest thing was to prove to people that it was going to work. But to test it, they gave me the assignment of driving a drift, using the Bullock burn cut in the most difficult reef rock in the district, and since we were doing research, the labor contract would allow an engineer to do any task a miner could do. So, I drilled my own rounds, and I helped run shovels and load out the rock. So, I was given the task, along with helpers, to drive 25 back-to-back drift rounds, and get at least 90% drilled effectiveness on the whole thing. So, for the 25 drift rounds, I had to break more than 270 feet out of the 300 ft. possible, and think I broke 280 feet, so it was 93% effectiveness and considered it a success.

**24:09 Progression Through Management at St. Joe - Equipment Development**

Kaas:

Well, then you also began a series of progressions up through management at St. Joe?

Bullock:

Yes. About every two or two and a half years in research, St. Joe would switch me into operations. So, I'd be in operations for a while, then somebody would leave the mine research department, and they would want me back in research. They'd put me back in research to work for a few years, and then they'd switch me back to operations. I switched back and forth three times that way, each time making a step up in management. So, it was a good thing in helping you to learn about their mining techniques in the district and to apply some of the things we actually developed in research. But it also helped me to really progress in the whole organization.

Kaas:

This was all happening in the Old Lead Belt in southeast Missouri at that time?

Bullock:

Yes. And, they didn't understand, of course, what was coming. No one knew what was going to develop in the New Lead Belt and the equipment which would be needed. As we learned, this was a chance to develop a whole new mining system and everything that would be needed. So, to use that burn cut round effectively, we also had to develop drilling equipment because the drills they had wouldn't drill the round we wanted, and in a timely manner. So, we had to do research on rock drills and jumbos as

well as the explosives. And we worked on and we designed our own jumbo, first of all, to drill that burn cut round I described. We tested rock drills and got the fastest drill we could. But then, John Reed had been reading about the rotary percussion drills developing in Europe. Now back then, the only thing they had was an all air rotary percussion drill, and it used 600 CFM to run one drill. Of course, we had 200 stopes to operate. We couldn't possibly have that much air. So, we started trying to work out with Joy Manufacturing Company, to develop a hydraulic rotary, air hammer machine RPD drill. They would develop a machine, and we'd test it, and they'd develop, and we'd test it. So, for some of the times when I went back to research, I was working on that program in the RPD drilling systems. And, eventually, we did develop an RPD drill with Joy. They would drill 4 feet a minute compared to the air drills that would only drill two feet a minute. So, they were very productive, and we introduced them into the jumbos at Viburnum, soon after those mines opened up.,. So, they were very productive in the stoping rounds.

Kaas:

I don't know exactly the sequence here. But you were somewhere along here starting your doctorate? Was that before or after Viburnum?

Bullock:

That came much later. Yes, after I moved up through the ranks; well, first, I was a Shift Foreman at Pim North Mine, then I was a Mine Captain at Pim North. Later on, I was a Leadwood Division Superintendent, and I had four mines. St. Joe, SEMO division went from 22 mines in 1955 when I first arrived there down to only eight mines by 1966, that's when I was at Leadwood. I had four mines, and that was half the division. We had 11 miles of underground haulage to get to the main hoist to the mill, it was scattered out so much. There were 300 miles of railroad underground, and I had about 150 miles of railroad to maintain. So, that in itself was a challenge. And then, I was transferred to Viburnum, and I was a Mine Superintendent at Viburnum, and I had the three mines and brought them up to speed. The No. 27 Mine was already started, and the No. 28 we brought up to speed. No. 29 was just at the bottom of the shafts when I got there. I brought those three mines up to getting over 7,000 tons a day from the three mines. Then, I was transferred to the Fletcher Division, and they had just bottomed their shaft and started production. I brought that mine up from scratch to produce somewhere around 5,200 tons a day for several years, and that was quite a challenge but lots of fun, too.

Kaas:

I bet it was.

Bullock:

Fletcher was a fun mine to run because it was such a good grade and was so efficient. We paid off that entire investment of Fletcher in one year of full production. That's how good that mine was. But we had a big water problem there, too. Pumping the water there was a big problem:  6200 gpm at its peak.

Kaas:

And there were a number of other companies down in the Viburnum trend. Was St. Joe the first one?

Bullock:

Yes. St. Joe first stepped out at Hayden Creek, then Indian Creek mine developed, and then they stepped out to Viburnum. They discovered the 50-mile length. They knew the lead was all there all up and down in the whole district. That was the good news. The bad news was it was mostly government land under Clark National Forest. Well, the government would only allow St. Joe to lease 27 miles of that 50-mile length. So, with their very sparse drilling, they had to guess what they thought was the best, and, in some cases, they were right; in some cases, they were not. But, that left the openings in for Amax/Homestake joining together to develop their mine. Comico/Dressler developed a mine. Then, down south, Kennecott took a part of the district. Then, ASARCO came in and outbid St. Joe for a part of it, which was on private land between Fletcher and Brushy Creek, and they simply outbid St. Joe for the private land. So, all those companies began operations, but they all used St. Joe's mining methods and the burn cut round that I developed, and the same type of equipment.

Kaas:

That must have been very satisfying to you to see the use of the technology and also the whole development.

Bullock:

You know that burn cut round is still used today. Of course, they continued to break about 60% of the tons by slabbing methods in stoping and slabbing pillars. But I estimate they have probably broken between 40 and 50 million tons of ore with using that one basic burn cut pattern.

Kaas:

Wow. That's amazing.

**31:40 The New Lead Belt - Viburnum - The Building of a Town**

Kaas:

So Dick, tell us a little bit more about your experiences when you were doing the developments down in the new lead belt in Viburnum.

Bullock:

Well, Viburnum was carved out of the hills. A very modern town. A small town, but a very modern town. St. Joe's hired an expert designer to come and design the whole town: sewer systems, water lines, streetlights, the whole bit. It was a very interesting development. Once in a lifetime, really for a mining engineer to get to be involved in building a whole town and a mining community. By the way, the Viburnum Trend mining complexes were built in the Clark National Forest. It's operated for over 45

years, with no environmental damage. That's important. But, establishing a town, a mining camp is more than just building mines and houses. You've got to build a culture and society for kids to be raised and grow up in. This was already an educational vacuum. The nearest good high school was about 35 miles away. Probably only about 10 or 20% of the kids finish high school, so there was very little opportunity for them.

Viburnum sits at the corner of four counties. It's in Iron county, but there were three school districts close by. So, what we had to do was create one school district, with one high school in the center of the district, with four elementary schools. St. Joe built an elementary school in Viburnum and gave it to the community. There was a small poorly staffed high school on one edge of the district. To get the people to be interested in a good high school in Viburnum, we had to reorganize the three school districts, not just one, but three. So that they all came together to form a large group, and we had Viburnum at the center of it. Well, when you start trying to tell people where their kids are going to go to school, change the school district, change their tax rates, and so forth, well, you got a fight on your hands. I mean a literal fight. We fought for two and a half years to get that done. We changed the school district boundaries in all three school districts, convinced them it was a good thing, got it done, and built a new high school there. And of course, we set it up so that the tax base so that two of their mines were in the district. So that was a very interesting ordeal to go through. The proudest thing was really getting that high school! I was elected to the local school board and was president of the Iron county school board. It was great experience.

Then getting their bank built was a problem too because, again, to drive to a bank was 35 miles one way, 65 miles another. So, to establish a bank for the community would take banking business away from every other community. The banking business is controlled by states, and you have to have a state authorization to form a bank charter. Well, all the other banks were fighting you like crazy that we couldn't form a bank in Viburnum. So, it took us a long time. We solicited and sold stock throughout the whole area and finally raised enough money. It took us another two years to get that charter to build a bank. We finally did that and formed a bank in Viburnum. which of course, I served as one of the directors and the loan committees. It took a lot of time to do those things, but they were worthwhile. That's what it takes; it's more than just building a mine or building a bunch of houses and streets; you have to build a community. Viburnum was a great little community when I was there, and I really enjoyed it.

Kaas:

Right.

Bullock:

Great little town.

Kaas:

Yeah. The new Leadville and the whole Viburnum trend really put another whole lifespan into mining and-

Bullock:

There has been mining in the whole district for 300 years, but organized, large scale mining has been prevalent now for the last one hundred and fifty-five years, and St Joe/Doe Run has been mining there for that long. And fortunately, I've been blessed enough to watch half of it.

Kaas:

Right. Have you visited all those mines down there, even the ones from other companies?

Bullock:

Yes, I have. I'm trying to think of the only mine that I have never visited was the last mine developed was the Casteel mine with St Joe. but I been in all the rest of them. All of the operation mines are connected now.

Kaas:

Sure.

Bullock:

All the mines from No. 28 in Viburnum in the north to Fletcher in the south are connected, the rest of them are all connected throughout the 45-mile district.

Kaas:

Wow.

Bullock:

So that shows something of the prolific nature of this district, and while I have no advance knowledge or any insider information, but I'd guess if the lead price holds to what it is today, they have another eight to ten years to mine, before they mine that district out.

Kaas:

Right.

Bullock:

And the sad part is there are more ore resources to the south. But the state won't let them mine because it gets close to a national park district.

Kaas:

Right.

Bullock:

So that'll never be mined.

Kaas:

Right. At least not in our lifetime.

Bullock:

Not in our lifetime. Viburnum was a good experience.

**37:30 New Doctorate of Engineering - Exhibit Number one for a Successful Program**

Before you moved on to Exxon, was that when you did your research or your doctorate?

Bullock:

Oh, yes, while I was working at Fletcher and mostly when I went back into the research department. But, in fact, since I had been out of school with my master's, I knew that I should continue my education. So, I kept taking courses. I'd commute back over to Rolla every so often and take a course. And then, I took one course from Mineral Area College, statistics. I knew I had to keep educating myself. So, I did communication with Dr. Scott, remember, Jim Scott. Jim Scott said, "Well look, the University of Missouri has developed a Doctorate of Engineering program on all four campuses of the university system. It's been there for three years, and nobody has completed it. The only catch to this program is, you must do your research in industry, and you must do it with real people and real problems and come out with positive results." Well, I was doing research every day, and I saw it was just a matter of selecting one of the research projects I had going. So, I picked one of the programs and used that as my doctoral thesis. But then, I, of course, continued to take courses at Rolla. Two semesters back to back, I had to take 12 hours each semester to establish residency on campus. And, that was a bit tough. But, St. Joe paid for everything, even all the commuting. And, we had an airport right there in Viburnum, and we used the shuttle service sometimes. And, I'd fly back and forth to Rolla. I was the only student that Scott had that commuted by airplane. But it was a good program. And, it was tough to convince the powers that be at Rolla, that there should be such a thing as a Doctor of Engineering. After all, everybody had a Ph.D. there then. And that's the only thing that they respected. They didn't want to see a Doctor of Engineering program awarded. So, Dr. Scott and the dean of our school, Dean Planje, worked very hard with me to get my program approved. Actually, I had more college hours than most of the people on the graduate committee by that time. I did a good research; it was in industry; and they had no reason they could possibly object, and we finally got them to award the degree.

Kaas:

Sounds like you were exhibit number one for a successful program.

Bullock:

We weren't very popular with some of the graduate committee, though.

**40:39 How DCF Analysis Orchestrated a Move to New York**

Kaas:

So then, after St. Joe, you eventually moved to New York City?

Bullock:

Yes, taking those courses at night- We knew we had so many professionals in the Viburnum area, Salem and Viburnum, that we finally convinced the Rolla professors to come out to Viburnum to teach night courses. One of the night courses was advanced financial management. In that advanced financial management course, I learned all about discounted cash flow analysis, and how to do this sort of thing. By then, most of the industry was using it. Well, low and behold, St. Joe wasn't. They were doing and evaluating properties by the old payback method. So, I started trying to convince people within St. Joe, the exploration geologists and management, this is a better way to do it. And so, I modified a computer program which the Mexico School of Mines had developed; a cash flow analysis program, which my library research found, and I applied it to our geologic conditions in the Lead Belt and for everywhere else. I made up a very simple table that all the geologists could fill out all the information in and then keypunched the information in. Then, from that, you could perform a discount cash flow analysis. So, I taught a short course to our exploration geologists, so they could start doing this the right way. Well, low and behold, they started sending me all the information. They didn't want to do that. So, pretty soon, I was doing all their analysis for all the exploration groups. I was traveling back and forth to these properties. I was working for the exploration in the New York office more then I was working for the research department at Bonne Terre. So, I agreed to a transfer to the New York office; like a damn fool, because no one had ever left southeast Missouri and transferred to New York. That was crazy. But I did. So, we made the move, and we moved into Fairfield, Connecticut, as a commuting point. It was a lovely city to live in, and I commuted to the New York office. It was handy to Grand Central. It was only a block and a half through the buildings, and so it was handy to 250 Park Avenue. So, it was an easy commute.

Kaas:

Not as much fun as flying to Rolla, though.

Bullock:

No. [Laughs.]

**43:18 St. Joe Acquisition of A.T. Massey Mines**

Kaas:

When you finally got to New York, you continued the feasibility and evaluation work?

Bullock:

Yeah, they gave me a title of Director of Mine Development and Research, and I started doing the exploration much of the time. But, in the meantime, before the actual transfer, they had me do an evaluation on 40 Massey coal mines. A.T. Massey came to St. Joe and asked to be acquired. That's unusual because they were a very profitable company in themselves.

Kaas:

And, it was a family-owned company.

Bullock:

Yes. Morgan had lost his father, and he knew when his mother died, he was going to inherit all this, he and his brother. And, to pay the taxes on that, he'd have to sell it anyway. So, he wanted to pick who was going to own his company. He selected St. Joe, and it worked out great. He had 40 mines. I was given the job of looking at his mines, to appraise and verify the reserves which were kept by Weir of Chicago. I had to verify the condition of their equipment, their personnel qualifications, and whether or not, when they brought in a new mine, could they bring on these as nonunion mines. Half their mines were union, half were non-union, and whether or not when they bought a new mine, could they bring on these non-union mines. And also, then, of course, I had to evaluate the mines all 40 of them. It took me eight months to do that study, and that was a lot of fun. Those people from East Kentucky and West Virginia, were just great fun to be with. I thought when Jack Duncan, the president of the company, chose me to do that job, I thought, "Boy, he must think a lot on me." Well, the truth was, raised in the hills of the Ozark, I had an Ozark dialect, and my Momma came from Kentucky. So, he knew I'd get along just fine with these rednecks from hills of Appalachia, and we hit off just right. They told me everything I wanted to know, and even some things I didn't want to know.

It was about this time that our exploration geologist in Chile heard about a gold prospect east of Las Serena, high in the Andes, and took mule train into the area even before the snow melted. I was taken into the area a few months later to evaluate the property, which turned out to be El Indio, one of the highest-grade gold mines in the Andes and the start of a new mining district.

Kaas:

That's amazing. And then there was a sort of turmoil of acquisition by, wasn't it St. Joe that was acquired by-?

**45:32 Diversification - Profitability - Acquisition & The Move to Exxon**

Bullock:

Well, this came along then after we'd worked for four years to diversify from, well, basically, a lead-zinc company into iron, coal, gold, oil, and other types of energy. We were extremely profitable. A.T. Massey alone paid off themselves in the first year. We paid $60 million for them, and they paid themselves off

very quickly. They sold it ten years later, half of it, for $600 million to Royal Dutch Shell. Anyway, when St. Joe became such a cash cow, the officers said, "Hmm, let's break the company into parts, we'll decentralize into four different commodities companies." Well, this was in 1974 - '75, and I knew the handwriting on the wall. It was not good. I thought what they were going to do was break it into pieces and sell it off. I knew what was coming. They offered me a job to go up to Balmat, they had four mines and a mill running there, and be a manager of that operation. Well, I'd already ran Fletcher mine for four years, and that was the best cost center they had, and I felt that experience was enough of that. I wanted no part of breaking up the company and selling it; besides I would have stuck in Balmat after they sold it. It was a wonderful company, a family company, everybody knew everybody, and we all helped each other; not in the New York office, but in the operations they did. Once they officially announced to start breaking up, I left the company. So, that's when I went to work for Exxon. Exxon had been trying to recruit me for three years with a headhunter. I just put in a call, and three weeks later, I was working for Exxon.

Kaas:

Was that during the period when the oil and gas companies were acquiring a lot of traditional mining companies during the windfall profit era?

Bullock:

Oh, yeah. The oil companies, all of them, Shell, Chevron, Conoco, and Exxon, all four mining companies. Some of them were doing things like Conoco had a great mineral research group, and Exxon had a good research group in exploration and in the metallurgy. But, all of them were wanting to get into the mining business. They thought it was a very easy place to invest money because they needed a place to invest their profits. They thought they knew a little bit about that business, but it turns out, for out various reasons, it didn't work out so well for them.

PART 2

**00:21 Feasibility Studies and Risk Assessment**

Kaas:

So, Dick, we were talking a little bit about your experience in comparing the mining companies' methods for evaluation of properties and the procedures of the oil companies. Why don't you tell us a little bit about that?

Bullock:

In the first place, going from St. Joe to Exxon is like going from a PT boat to a battleship. I mean, one's very flexible, one's not very flexible. St. Joe could turn around on a dime and make a timely decision. For this, they were very successful. Exxon was very slow and deliberate. But, to their credit, they had gone through periods of developing very large billion-dollar projects many years ago and learned how that they had to absolutely have standardizations of how you do a feasibility study. Not just how you do the quick evaluation, but how you do a reliable feasibility study. Now, many within the mining industry have yet to learn learnt this, and I've been working very hard, in the last four or five years, writing/editing an SME published book and injecting lectures and so forth, trying to teach the mining industry that they must start standardizing ways to do feasibility studies because the average project never yields the return which it's supposed to. Only 20% of projects yield the return on investment that the investor thinks it's going to get. And, the overruns are anywhere from 20, 40, 50, 60% overruns on these billion-dollar projects, and this just can't be tolerated. So, we must learn how to do this right.

Kaas:

So, it's all about risk assessment and zeroing in tighter.

Bullock:

Part of it is very much on risk assessment. I am promoting that a new form of risk assessment, which is the construction risk assessment, which most mining companies never consider back in the room where they were doing risk analysis and before they get Board approval.

**02:25 Exciting Projects: Los Bronces, Chile - the El Indio Mine**

Kaas:

Right. So, you had some pretty exciting projects when you were at Exxon, and I noted that you were doing a lot with Los Bronces and--

Bullock:

Well, yes, going back just a little bit, Los Bronces was in Chile, and I'd been working on a big project for St. Joe in Chile, the El Indio Gold mine. I was the only engineer to go in and evaluate that mine before we made the initial buy-in offer and developed the exploration drift. It was a bonanza gold mine: the only

place that I have ever been where you could see gold in the rock in many places on the mountain. After a quick preliminary study on a small mine development of only 500 tpd operations, using cut and fill mining and standard milling practice, and a gold price of only $135 per ounce, the project showed a 36% rate of return. Obviously, we proceeded to procure the property mining rights from a group of Germans which controlled it with the agreement that they were allowed to hand mine as much as they wanted to while we were getting our exploration development started up there. That summer, they had 200 men hand mining all over that mountain; it was an exciting place to be. It was up at 16,000 feet. So anyway, I had been working on that El Indio project. I'd made several trips to Chile and was familiar with the political and economic situation in Chile. So, when I came to work for Exxon, in fact, two days after I left St. Joe, I was on a plane with a group of vice presidents from Exxon flying to Santiago, and we were going to look at Cia Mineria de Las Condes and, possibly, make a bid for that company. The Los Bronces mine was located about 65 kms east of Santiago at an elevation of 9000 feet. They operated Los Bronces open pit mine, El Soldado underground mine and the Chagres Smelter. These had been expropriated from a French company during the Allende Communist takeover of Chile. The Pinochet administration was selling off what the Allende had confiscated, so they were looking for the best bidder for these properties. So, Exxon wanted my expertise to look at the mining properties and evaluate them for the potential of expanding both mining properties. They also wanted my opinion on what I thought of the Pinochet administration stability, since I had just been involved with a major investment there. I predicted at the time that this government was stable for at least 20 to 30 years. We were down there for a week, made a bid, and, sure enough, Exxon won the bid and, later, started that big expansion program.

Exxon had three different groups. They had the Exxon Minerals in the New York office, and there were, maybe, 60 people in that organization. Then they had the Esso Eastern group, which is all the minerals group all around the rest of the world. They were very large minerals exploration groups. Then they had the Exxon USA, which is only the metal mining industry group within the United States. And, that's the one I was going to join. So, I wasn't connected directly with the Los Broncos project, but because of my expertise and my evaluation and feasibility of ongoing projects, I had to sit on all of the reviews, and I kept up with the projects' planning. Other overseas projects which I reviewed for Esso were the Rundle Oil Shale, Golden Grove copper/zinc and Harbor Lights gold in Australia and Gays River zinc in Nova Scotia. Engineers from my feasibility group assisted in the project as needed. I had started out with a very small group of engineers to evaluate projects. But, because we had so many projects (12 projects eventually) I had to build up a very large, multi-discipline engineering staff to do this. There were about a hundred people, all totaled with non-professional and personal staff. So, my engineers, we're helping them also in Los Broncos with projects they were working on. So then, later on, when Exxon decided to join those three minerals groups into Exxon Mineral Company (EMC), I was made vice president of engineering, technology, and research. Los Broncos then no longer was part of my feasibility group because I didn't head the feasibility group in the new organization, But, I had four or five engineers working in the contractor's office, in the design office, and I had to keep track of all the engineering and approve these, and it was done. So, I still had a finger in the pie, and I was out there often to Ralph M. Parsons' engineering office in Pasadena to look at the engineering and what the design engineers were doing. One of the unique things about the Los Bronces Expansion project (LBXP), was that there was no safe area to construct a large mill and, in fact, there was not a viable water source for a mill the size which EMC wanted to expand the mine (80,000 tons per day). So, their solution was to build the mill down in valley near Santiago. The method of transporting the ore down to the mill, approximately 27 kms, was decided by the Esso Eastern feasibility team: to drive a tunnel and place nine flights of conveyors for moving the ore. That's how and why I soon got very involved with tunneling technology and tunnel boring machines.

The Esso Eastern Vice President had decided that the expansion of Los Bronces should be from the 8000 tpd to 80,000 tpd. At the end of the feasibility study, they had estimated that the project was going to be a nearly $2 billion project, and that was in 1985. They had a professional project manager who came in from Exxon Corporation to be the project executive (PE) of that big mega-project. And, he was a man about 50 years old, and a very capable man, but he would have his hands full, since they had four project groups within the project itself. The project group in Chile, and they had many activities going on there, and they were to be the eventual operators. The engineering management group was in Florham Park, New Jersey. That's where all Exxon project management expertise originated. Then they had the project group in Houston, which was where they originally started the project in Esso Eastern. And then, they had the Pasadena design group, and all these four groups had to be coordinated. Now, all of them came from different backgrounds, and all had different ideas on how to do things. So actually, they were squabbling all the time and trying to decide how to do this, that, and the other. That poor PE was running back and forth between these four projects, and he was traveling all the time. Unfortunately, he had a heart attack, and he died.

Kaas:

Wow.

**07:55 Inheriting an 80,000 Ton a Day Project**

Bullock:

So, we thought, well, they'll send in another project executive to take over this major project from Exxon Corp or Esso Eastern. No, they didn't. They said, Dick, that's your job now. So, I was given that task of PE of the mega project, for which I really had no qualified experience. But it was a challenge which I gladly accepted.

Kaas:

Another job.

Bullock:

Yes, another job. So, I was no longer vice president. I was now a project executive of the Los Broncos expansion project, and they had already decided to expand from 8,000 tons a day, simple, small operable mine, which is about at 9,000 feet in the Andes, to about 80,000-ton mine in one fell swoop. Exxon wanted to do everything big. They didn't want any small projects. Everything had to be a big project. And so, that's what they went with. So, I inherited an 80,000 ton a day project in the Andes in Chile. They only had about 18 more months of design to perform when I joined the project; so, we completed that 18 months and went through all the completed evaluations and everything. Everything looked good. During that 18 months, I traveled nearly 300,000 miles. For Exxon companies, they also wrote a Design Basis Memorandum for every major project. It was really a necessary item on any project where you spell out everything that must be done and transfer those engineering designs to the engineering construction contractors, so there's no question on their end as to what to do and how you should do it. Then they do a special risk analysis, which is called a Project Appraisal Risk Adjustment. It

looks at the project from when it started to be executed every area, every activity, every function, every major procurement, has to have a risk analysis done. Then you estimate the probability, how much it's going to possibly overrun or under-run. You put all that together and then you have an excellent idea, through all the construction, what it's going to take to actually build that project. Then, you go back and adjust the final feasibility estimate to the new estimates, and that is what you go forward for project approval. That particular project gained about a billion dollars to that estimate. So, that illustrates how fallible most project feasibility analyses really are. The project still had an 18% ROR using the trend price of copper.

Kaas:

Sure.

Bullock:

So anyway, we went through all the analysis and reviews and got approval on the lower levels within the Exxon Mineral. We then took the project to the Exxon's Corporate Management Committee in the corporate office. And, meanwhile, the price of copper had dropped down below a dollar, and Exxon New York office said we don't want to invest $2 billion on a project copper project in Chile. So, they cancelled the project, and there went my job as far as that position. We spent about six months trying to find a joint venture partner, and we only had one interested company, and that was Rio Tinto Zinc (RTZ). They had a copper resource in Panama, Cerro Colorado property in the state of Chiriquí, [on] which they wanted a joint venture partner. They agreed to consider our joint venture if we would consider theirs. So, a team of us went to Panama to examine this property. The bottom line was that it was not near as good a property as Los Bronces, and they were not really interested in Los Bronces. That was the end of that effort. Well, they sent me back to the engineering group, which was smaller than when I left it, since meanwhile, they downsized Exxon Minerals a lot because they were beginning to realize that they didn't want in the metal mining business that they thought they wanted in. At first, they wanted to get into zinc, uranium, and copper. Uranium was already looking really bad, and they were shutting down their uranium mines in Texas and Wyoming, and then they were backing off on their zinc properties a lot. So, they started downsizing. Well, I took over the engineering group again. Then I worked with the group in Los Broncos in Chile, where they had worked a plan to expand to a 40,000-ton expansion at less than half the cost. So, that project went forward, as a local effort in Santiago, and I went back to Houston. So, I wasn't directly involved in engineering down there. I did have to keep reviewing their work, and I did loan them, engineers, occasionally to help cover the work. But that was what happened to Los Broncos. Finally, then, it did develop into a 40,000-ton mine, and it's been very successful. Instead of driving a tunnel through which to convey the ore from the top of the mountain down to where they could build a mill down in the valley, they used slurry pipelines, and it worked out. It was great.

**12:25 Global Study of Zinc – Challenges and Property Development**

Kaas:

Right. So, then you mentioned that you were doing an, I guess kind of, a global study of zinc.

Bullock:

Yes. Of course, they had Crandon property, and Crandon, to this day, is probably the best known unmined, zinc, copper resource left in the world. I say that unequivocally. It's a wonderful property, too bad it couldn't be developed. There's just too much environmental resistance, and the native Indians were so much against it. The people that owned cabins in that area, from Madison and Chicago, had a great influence and control Madison on this issue. We did everything technically correct to satisfy every environment concern and just could not get permits, even though we spent millions and millions of dollars there. Three companies have tried to get permits to develop it and failed.

Kaas:

Right. I noticed that there is a lot of exploration activity going on the Michigan side, not far, just a little bit to the east of Crandon now. And, Michigan seems to be permitting some of these pretty willingly, but it looks like Wisconsin is still a big challenge.

Bullock:

Yes, we will see if that works out in Michigan. The Crandon property was then sold to the Indians for a few dollars or a few $100,000. I don't know how much. But they're sitting on a tremendous asset. One of these days, maybe 30 years from now, those Indians are going to think, let's see, we could make more money doing this than we can selling cigarettes or on our casinos, and then they could develop it. But that's what it will take. It will take the local tribe there finally saying let's develop this; it could be a wonderful property and produce lots of zinc, copper, jobs and cash flow to the tribe.

Well, anyway, getting back to the story about the Zinc study. The Exxon Minerals management were also trying to develop a zinc property in Tennessee and even build a zinc refinery in Kentucky. A site had been staked out and optioned in Tennessee. And, of course, the Canadian minerals group had zinc properties also they were developing. So, it was planned to be a major zinc producer. But they didn't know where they would lie in the cost comparison to other people's properties. So, they called on a couple of us to make a study of worldwide zinc costs. They said you go visit all the major zinc mines and zinc smelter/refineries in the world. At first, it was no time limit on the project, but it was going to take several months to visit all the major zinc producers in the world and estimate their costs to produce a pound of zinc. The other fellow, Nick Ciani, was going to look at the mills and the smelters, and I would look at the mines; combined, we'd come up with a total cost of each property to produce a pound of zinc. We would then put them in a cost seriatim curve. We knew what our costs were going to be, and we'd come up with a cost estimate for every property to figure out where we were and see whether or not they could compete on the world market. In metal market downtimes, you need to be in the lower quartile of a cost seriatim to compete in our industry in all downtimes.

**15:50 Identifying and Visiting Zinc Mines Around the World**

So, I started out, at first, to investigate who were the major zinc producers around the world. The first mine we went to was in Honduras. It was an Amax mine in Honduras. We visited four or five mines and two smelter/refineries in Mexico, including San Martin, Santa Barbara, Nica mines and the smelter/refineries in San Luis Potosi and Torreon. This was a wonderful experience. And then, we visited six mines and smelter/fineries in Peru. Most were all high up in the Andes including Cerro De Pasco. One of the mines was over on the Amazon side in the jungle, near the head water of the Amazon, near the village of San Ramon This was very interesting property to develop in that country. By the way, this was during a period when the Shining Path, the Moist terrorist were very active in Peru, but we had a

military jeep and driver with us the entire time. Since we were already in Peru, EMC had agreed that we should venture further south and visit two major open-pit copper mines operated by Southern Peru Copper Company (SPCC), mainly the Cuajone and Toquepala Mines, and estimating costs there as well. After Peru, we returned to the states and started calculating cost on those properties that we had visited.

To be able to perform mine cost estimates, I learned to estimate mines, through industry experience, and I had started working with the Bureau of Mines using their computerized system, which they had just developed and put it on tape. Besides all of the mining functions, if you knew certain factors, such as efficiency factors and production factors and knew the basic costs of their power and what the labor costs were and the support activities, you could estimate their cost, And, you could input everything into to this computer program, and it would come out with a cost estimate. Well, I did this and tested this technique with some properties I knew the cost of, And, sure enough, it was very accurate because I knew how to use the adjustment factors. A novice could not use the program because they would not know how to make the adjustment factors on productivity: but, as I applied it, it was very accurate.

So, I estimated cost for all these properties I visited in South America and Central America. Then, I started in North America. First, I visited the Balmat mines of St. Joe Minerals. I knew their cost from earlier years of working with them, but they had finished the development of the Pierpointe mine which I had never seen. And, it was a great chance to visit some old and very dear friends. Next, I visited a huge Kidd Creek mine and concentrator. Then, I visited the Brunswick mine, mill and smelter. Then the Mattabi and Lyon Lake operation of Noranda. Next, I went north of the Arctic Circle, just south of the Great Slave Lake to the Pine Point operations of Cominco's. Then, it was across British Columbia to Sullivan District and spent several days there looking at their mines and mill. Then, over on the east coast to Vancouver Island, Myra Falls operation H-W and Lenx Mine. I had saved the last one in Canada to as late in the year as possible (April). Still, the temperature was between 60 and 70 below zero. Polaris Mine was about 200 miles from the North Pole on Little Cornwallis Island. That was a very interesting mine in itself to visit. But, it was a great visit to a very unique mining camp. The funny thing there, I was supposed to be going in one day and fly out the next. Well, I flew in, and we got a whiteout. I was there for four days.

Kaas:

So, you had a lot of time for extra study of the property.

Bullock:

Comico built wonderful mining camps in the artic, and the camp was all floated into Little Cornwallis Island on barges during a three-month thaw period. Even one room the size of a gymnasium, and the mill were all floated in on barge. So, it was a very interesting camp. To top the visit off, the World Hockey Cup games were on. And, of course, these guys took their hockey very seriously, both the games and the partying. So, I really had fun watching the hockey games with them.

Kaas:

Now were you able to look at any of the eastern bloc countries or the communist bloc?

**19:24 Accelerating the Project - Traumatic Experiences**

Bullock:

No, what happened then was I got back after the Polaris mine trip, the corporate development people called me and said, “Well, we’ve got to accelerate our project.” They said we had to wind it up in about three or four weeks. I said, “Well, we couldn’t possibly do that.” They said, “Well, figure out a way to do it.” So, what I did, I had a questionnaire of 32 questions that I used as I travelled through the mines. I'd been asking these questions casually, throughout each visit. The host wouldn't really know I was estimating the cost for them, kind of being an industrial spy, figuring out what their costs were. So, I sent a copy of these 32 questions to all our exploration geologists located near these world major zinc operations, and they visited these mines. That way, I could get all this done at once by different people, and then they sent me the information in Houston. I then cranked the machine and got cost estimates as it turned out on all the zinc mines in Australia, Spain, and through Eastern Europe. I can't remember the names of the mines now, but they were able to get to the costs. Meanwhile, corporate development had me estimate another half dozen greenfield mines not yet producing; the most significant was Red Dog in Alaska. We got, I think, probably 80% of the world's zinc mine production costs done that way. And then, before I even finished the cost seriatim, Exxon Minerals had a big meeting, called most of the employees in and announced that they were having a major downsizing. And, you people in this room, we're all going to be laid off within one week. (Actually, they were getting into a position to get out of the metal mining business in everywhere but Chile.) Then, they actually asked me, "Could you stay on a couple of extra weeks and finish your work?" And, I said, “Yes, I'll do it.” So, I stayed on and finished that assignment, and we did finish the cost seriatim. And, sure enough, the zinc production by Exxon would have been in the lower quartile of the world zinc cost. Crandon was even lower cost than Red Dog. To check my work, unbeknownst to me, the development group hired Pincock Allan and Holt to perform cost estimates of about a dozen of the same mines. I didn't know they did. But they came in very close on our cost estimates. So, I felt good about that.

Kaas:

Yeah, that's, that's quite an accomplishment.

Bullock:

It was a lot of fun. It was a fun job and great experience.

Kaas:

Right? But it must've also been quite a traumatic experience. All of a sudden, you get a one-week notice.

Kaas:

So, after you, after Exxon was sort of closed out from underneath you, then tell us what happened.

**22:38 A New Job with Fenix and Scission**

Bullock:

Well, I'd never been without a job in my life. On that day, they announced that they were laying us off, they announced that they were laying off 6,000 people within the entire Exxon on that one day, most of them in Texas. You couldn't buy a job. I tried every university, every college, every mine that I knew of. To complicate the problem, I had just remarried, and my wife had her family in Texas. There were just no jobs to be had in Texas and, in fact, the whole mineral industry was in a bad slump, and no one was hiring. It took me four months to find a job. And, I took a job on the nuclear waste project in Nevada. They were looking for a project manager for a project on the Nevada Test Site, the nuclear waste shaft facility. It was to be a research studies facility for their nuclear waste to eventually be stored there, and our job would be to design the shafts, design the research facility, and supervise some of the development of this facility. This was right down my alley; I could do that. So, I took a job with Fenix and Scission, and I got the job really through networking with a former Rolla classmate. And, it worked out just great, but with a big, big cut in salary, about a third of what I was making at EMC.

Kaas:

Wow. Would you want to share with, perhaps, some of our younger members who might watch this video how you experienced that? What advice you might give them, if they had some ups and downs in their own career?

**24:24 Speaking from Experience – Sound Advice**

Bullock:

I'd say, first, be prepared to take a step back when you need to. All these people being laid off by Exxon, when they get laid off were put with a very good outplacement group contractor. And, they were given good severance pay. So, that helped for about four months. But you've got to make up your mind then, to be flexible, be willing to take a cut in pay and position, and swallow your pride a bit, and just be willing to do whatever it takes to find another job. And, that's what I did. It was tough. I could have, I guess, gotten a rocking chair and retired then. My wife was a teacher in a junior college, and she said, “Well you don't have to go work. I'll keep making a living.” But that wasn’t like me. At 57, I was not ready to retire. I had to go to work and do things. And, unfortunately, she had her family in Texas, her grandchildren, her parents. And, she wouldn't leave Texas, so I had to go to Las Vegas and live there by myself. At the time, I did not understand a DOE government project, and I thought that the project would only take 18 to 24 months and then return to Texas. The shafts were to be the, approximately the same size shaft as those we had sunk at St. Joe. I knew the details of those shafts which were proven technology. I lived in Las Vegas for the project which was going to be constructed at Yucca Mountain on the Nevada test site, about 90 miles north of Las Vegas.

**26:09 Another Dramatic Change – How Not to do a Project**

Kaas:

So, what was it like being a government contractor as opposed to working with contractors?

Bullock:

Well, there was another dramatic change because it was a government contractor. I didn't know this; maybe most people don't know it. A government contract, when you're working on a quality assurance

program, maybe it's because it's quality assurance or maybe it's just because this was DOE, which has atomic energy commission oversight. Whatever it was, there was at least 10 contractors on that project, at the same time, which had oversight over our design. But it was our job to design this facility. Then, the ten other contractors, all full time, were looking over our shoulders telling us other ways we ought to design it than what we planned. A similar design with a 12-foot shaft sunk about thousand feet was exactly what we'd been doing in southeast Missouri, and we're the experts at this sort of thing. And, I knew exactly how to do it, and we even had drawings of how to do it, but you couldn't convince these people that this was the way you could successfully do it. They wanted everything done and reproven as a consensus of the committee of 11 contractors. Are you sure this sheave wheel is strong enough? Are you sure that the head-frame that you designed is strong enough? Well, what's this? What's the strength of this beam? You had to prove every single thing and put it down on paper so you could prove, by quality assurance, that indeed it was correct. Now, that may be necessary, but I don't think so. If that job would have been turned over to a private company, they would've had an underground research facility in 18 to 20 months for sure.

But anyway, it was a very good experience in learning how **not** to do a project. But we also had a lot of work to do. And, I think we did good work, and we finally got to where they wanted to be. The other thing was actually finishing the design took us about a year for that first design. We had a review every three months. You had to lay out all your information, hundreds of copies, and at least a 1,000 people would look at this information and make all these comments. You had to respond to all those comments. Every comment, by quality assurance standards, had to be responded to. So, it was just a lot of work besides the engineering design. So, we got the first one design completed. Then, DOE changed their mind about where they wanted the shafts, and how they wanted the facilities built. So, we had to start again from scratch, and do it all over again. Well, that took another six months to a year. We got that one done. Then, they changed their mind again. They now wanted to do it by tunnel boring machines and using entries of inclined tunnels. So, that's the way we had to redesign the facility. And, in that case, design specifications for a tunnel boring machines and machines to excavation of the research rooms in the rock. So, all that had to be done differently. The design and execution of our work took us several months. So, we did do the design, finally, and we'd got the tunnel boring machines designed, and they contracted it construction and delivered onsite. The operations contractor then developed a tunnel down to about 2000 feet below the top of the mountain, across the block under Yucca Mountain, which would be a part of the future repository and then back up an incline and out of the mountain. And, all of this took eight years instead of my 18 to 20 months original estimate. So, I finally retired from the project when I reached 65.

Kaas:

Right. Well, we know you didn't retire from the profession. It sounds like you could stand to be retired.

**29:56 Retirement - Doing What You Like - Behre Dolbear and Rolla**

Bullock:

No. Well, retirement's a myth. Retirement's doing what you like to do. I like to be involved in building things and designing things, constructing things. So, after I retired, I decided I wanted to consult. Now, consulting is not easy to get into, particularly in the mineral industry where they have very long down periods; so many people always out of work and looking for something to do. So, I consulted for DOE for a few months, and then I signed up with Behre Dolbear as a senior associate, not an employee. And,

there were probably 30 or 40 of us senior associates. Each of us had our specialties. And, the way you got work was they'd bid a job for whoever wanted a job done. A feasibility or a due diligence study or whatever engineering or geologic study needed to be done; and, if you had the application offered to you, they put you on the bid list; and, then, if they won the bid, you would get to work; if they didn't you didn't work. So, I got to work that way on many projects, and we had a good relationship. I started working in Las Vegas; two projects I remember in particular: Pine Creek tungsten mine near Bishop, California and The Palca XI in southern Peru, where I was nearly kidnapped by the Shining Path. I continued working a little bit with Behre Dolbear while I was at Rolla but only during the summer break. And then, again, I started working for them after I left Rolla and did a lot of work for them.

Kaas:

Right. And so, you became a professor and chair of the Mining Department at Rolla?

Bullock:

Well, yes. I'd been consulting about three years, I guess, at that time, or a little less. And, John Wilson called me and said, “We were wanting to hire a new professional on staff, should be an endowed chair.” So, they were raising money to fund this endowed chair, the Bob Quenon Chair of Mining Engineering on the UMR campus. He asked, “Would you be interested?” I said, "Nah, I'm not interested." But then, he said, "Well, you think about it." So, I thought about it. In a few days, I called him back and said, “You know I really should be, it's time to do some payback. You know, I had a great mentor (Dr. J. D. Forester) as a student, and it’s time I paid some of that back to the students who are coming along.” So, the wife (I had remarried) and I agreed that was a good time to go to Rolla. So, I sent them my career portfolio, and I was selected. So, we moved then from Las Vegas to Rolla, and I went there as an endowed professor first, and then became the endowed chair when they finally got all the money raised. And, that was a good experience. The best thing I ever did really was going back and start teaching kids in college. We had a wonderful staff. Larry Grayson and John Wilson were great people to work with as well as Jerry Tien, Paul Worsey and Dave Summers. That was a very exceptional teaching staff, as well as a support staff, including Barb Roberts and Jimmy Taylor.

Kaas:

Yes, so, do any of your graduates particularly stick in your mind as favorite students?

Bullock:

Well, there are a lot of them that do. I was teaching them from three to five classes a semester. And, all I did was teach, by the way. My contract was such that I didn't do research. I told them when I came here, I'll either do research or I'll teach. I won't do both. And, that was fine. So, John Wilson knew it. So, yes, I had a lot of students, and, as far as the outstanding students and which ones I'd want to name, they were really are all great. It was an outstanding bunch of young professionals, and it really restored my faith in young people. I'm beginning to realize that these young people coming on in school nowadays are really sharp, at least the ones coming to Rolla. Those coming into engineering schools, in general, are good students, and they’re earnest in what they want to do. And, they have their heads on their shoulders. So, I had really good students, and they have been very successful in the industry, and I've kept up with them, and we keep in contact on social media.

**34:21 Distance Learning at Rolla and Beyond**

Kaas:

Just about this time, you were starting, or the university was starting, to do distance learning. And, I understand that you taught some of those courses.

Bullock:

Yes. Actually, I had been on campus about three and half years when I started teaching distance learning on campus. And, it was mainly to pick up people who wanted to continue their education while still in industry. I started helping to develop a Masters of Engineering, not Masters of Science. A Masters of Engineering where students could now get a Masters of Mining Engineering degree. I started teaching, at first, just one course, underground mining. Then I added tunneling and underground construction and mineral properties evaluation feasibility studies online. And, that's what I taught, all three courses consistently every year. And, the bad part, at first when I started teaching, it was you didn't get any extra compensation. But that eventually changed. But, I still did it, and I realized, well, I could teach anywhere online. I didn't have to be in Rolla. And, my wife didn't care for the town of Rolla too much. It was a typical college town, very clique-ish. And so, we decided we would move to the state of Washington. So, after six and a half years on campus teaching full-time and online, I moved to Washington and continued teaching online, and I'd teach three courses a year online for a while. Finally got down to teaching was two courses. Then, finally, when I really started retiring, only one course a semester online.

Kaas:

Well, I think the young people at this convention are certainly plugged in to all the technology that would have been nice to have at your disposal when you were starting this program. It was a real pioneering thing for Missouri, I think.

Bullock:

Yeah. It was easy for me to do though, to make that transition because when I was a student one of the best instructors that I had in toughest class I ever had was chemistry because I had no high school chemistry. And, fortunately, my professor handed out lecture notes every day. If you knew his lecture notes, you knew everything he said, and everything was in the book that you needed to know. My students got lecture notes on every class I taught my entire time at Rolla. I already had them on the computer, and they were very easy then to turn into lecture notes for online teaching. So, the conversion was very easy.

Kaas:

How did you interact with the students when you were doing the distance learning? I mean, did you have video as well as-

Bullock:

You could if you were on campus, you could. I didn't really think it was necessary for them to see my ugly face nor see the overhead projection of whatever I wanted to teach them. And, we did have online messaging, if you had a question, you could ask it. I just insisted they ask online program rather than send me an email because I wanted all of the students to know what the question was. They could identify themselves, or they didn't have to, it didn't matter. I got a lot of questions, and then I'd answer them online. So that was very, very productive. And, I had students from everywhere, actually, a few from Canada, a few from Mexico, Peru, Chile, South Africa. So, I had students from everywhere with online courses.

**38:03 Shrinking Number of Mining Schools**

Kaas:

It looks like that might be a long-term direction as we see a shrinking of the number of mining schools that we have.

Bullock:

Yes. I think it is, you will always need the mining schools, but then, it is a way of continuing education that's more important.

Kaas:

Right.

Bullock:

Then the undergraduate is continuing education for students that can’t get back to school, or if they need to continue their education, and they now have an opportunity to do it.

Kaas:

Right.

Bullock:

That's really important; I want to push that.

Kaas:

I don't think there's anyone in the industry who would argue about that because you only learn so much when you're in a formal educational setting.

Bullock:

Yes, that's for sure.

Kaas:

A lot of on the job training,

Bullock:

One thing the people at Rolla hated was that I would tell my students, “I didn't start to teaching until I'd learned enough in the industry to teach.” I didn't make very many people happy at the university, but it is the truth. Too many of our teaching staff, nation-wide, have insufficient mining industry experience (in my opinion).

After I left Rolla, I started working a lot more as a Behre Dolbear Consultant primarily performing due diligence reviews. Every year we did at least one for Stillwater Mining Company, and I also performed a room and pillar design study of Milpillas Copper Mine for the Peñoles groups. But my main efforts were two large jobs in China where two different companies needing the due diligence for IPO’s to be listed on the Hong Kong Stock Exchange. For the first China trip, the mining complexes were all in Hunan Province and were:

- Huangshaping lead-zinc mine near Guiyang;
- Shizhuyuan Polymetal mine operations near Chenzhou; and
- Hsikwangsha Antimony mine and plant operations near Lenghijang.

About a year after this project, we were asked to do another due diligence for an IPO for Western Mining Holding Company of China. The mining complexes examined were:

- Hogequi, open pit and underground copper mine NW of Baotou, Inner Mongolia, near the Mongolian boarder;
- North of Xitieshan, Qinghai Province a cluster of polymetal underground mines on the northern part of the Tibetan plateau; two of which were Yulong Mine and the Xiasia Mine;
- In Sichuan Province, six small underground coal mines, known as the Mole Mines, which were to be shuttered and open three new, much larger mines;
- Lead-Zinc mining complex in Shaanxi Province.

While we were in China, another company requested that we examine a large-thick rutile deposit in Shanxi Province. Rutile is a Titanium mineral. I was accustomed to seeing small crystals of rutile, but here was a thick bed of it, about six to eight feet thick. In all, our work took us to eight different provinces across China. It was very interesting and educational.

I performed one final mineral property examination in a very unique area of Mexico; the State of Hidalgo. Very little exploration takes place here, probably because the mineral rights of this state seem to be granted to the “El Petron” of the particular area, who also controls most areas of the commerce in that area. This deposit was from 7 to 14-foot thick manganese mineral. Sr. Meyer was the El Petron of this very large area of very rugged terrain.

**39:17 Satisfying Work as a Research Engineer - Writing About Hydraulic Drilling Techniques**

Kaas:

So, Dick, we've covered an immense amount of ground here this afternoon because you have such a tremendously interesting career, and it's certainly not over yet. But, I wanted to maybe ask you to look back a little bit and tell us a little bit about what you think personally your best accomplishments or the most satisfaction that you've gotten out of all these various types of jobs that you had and go from there on some other things.

Bullock:

I think, for my personal satisfaction, the work that I did with my first job as a research engineer on that burn cut round, it probably had more impact on that particular industry than anything else I did. The fact that there's been over 40 million tons of rock broken with that one system I developed. It's real clear to me that this was significant, even if nobody else knows; at least I know about it.

Kaas:

Sure.

Bullock:

I am very proud of that. Also, I think the work that I did on the all-hydraulic drilling is worthy of note. This was being pioneered in Europe and in this country, too. Nobody seemed to understand why it was working, why you could drill so fast, why it worked so well or why it was more efficient than any other type of drilling. I think the papers that I wrote and the techniques I used to analyze the specific energy of all of the drill types helped even the people that were developing it to see the relationships with some of these things and move the development of it a little faster. I wrote and published six papers on the all-hydraulic drills. And, I think it helped move that technique into the mines and tunneling a lot quicker than it would've otherwise gone.

Kaas:

Sure, sure.

**41:30 Industry Need for Standards - Sloppy Engineering**

Bullock:

I think that was a significant thing. Moving forward, I would hope that the next thing I'd be very proud of is if the industry would finally start seeing some standards which are needed from my evaluation and feasibility studies, presentations, and publications. The recent book that I wrote half of and edited on mineral property evaluation and due diligence (it's a handbook) would help the industry focus on, not just the geologic reserve, strict rules they have now, but also some strict guide lines for the engineering and cost estimating accountability. We concentrate on accuracy of the reserve but seem to show no interest in how inaccurate the engineering and cost estimates are.

Kaas:

Great.

Bullock:

So, what we, as an industry, have done is you've shifted where the scam can be done. Not in the reserves anymore, but it's in the sloppy engineering and cost estimating, leading into the analysis is where the misleading in done. Most of the time, it's accidental sloppy engineering. However, in at least three cases that I've worked on, it was intentional, and that's what you've got to be aware of. So, I think when the industry finally learns that, they must come up with standards, it would be a great thing for the industry. If you just read that book, follow it, then your feasibility analysis will withstand the test of due diligence and produce a mine/plant that will produce a financial reward which is projected.

Kaas:

I noticed that the book is for sale in the SME bookstore down here. It was the first time I'd actually seen it cover to cover, and it's an excellent book. It covers all the ground.

Bullock:

The surprise came out of the PDAC up in Toronto. The SME Book Store took 80 or 100 copies up to sell. And that's all it took. Well, it sold out the first day.

Kaas:

Well, that's a good testimonial. That you're onto an important topic.

Bullock:

Yeah. I hope it does, there's some real benefit though.

**43:30 Daniel C. Jackling Award Recipient in 2011**

Kaas:

And, this was also the topic of your Jackling award lecture in 2011?

Bullock:

That's when I first started preaching about it.

Kaas:

Okay. Okay.

Bullock:

No, well, it was really based on not just on my opinion. Deloitte did a study which showed that in South America, I think it is 60% of the major projects overrun and about 40% in this country overrun. I think in Europe their numbers are slightly below that, and in South Africa I think it's only 20%. That's significant, and nobody's doing anything about it. Many projects are overrunning by two to four billion dollars.

Kaas:

Right, right.

Bullock:

I hope it does.

Kaas:

Yeah. I know I always consider as a lifetime SME member that the Jackling award is the most prestigious award we give. So, not only that, but it's maybe the largest.

Bullock:

Do you know what I did? It's so big, that plaque's so big, I didn't even take it home. I gave it to the school, and it's on the wall there, hoping it will inspire some young mining engineers.

**44:43 A Long List of Publications - Major Efforts with SME Colleagues**

Kaas:

That's a good use of it. But, your list of publications as a contributor and as an editor is almost four or five pages, single-spaced. So, it's a bit a tremendous.

Bullock:

Actually, it's 60; there's 60 of them.

Kaas:

Yes. Right. And, many of them really major efforts with some of your colleagues in SME. I know the underground mining book with Bill Hustrulid and an endless series of papers going way back.

Bullock:

Fortunately, I got active in AIME first, then SME. Very active; I was the first mining program session chairman of SME. We had three conferences that year [for] which I solicited papers. Then I got on the publications committee and did that for several years. Remember Maryann Snediker? I worked with her for several years.

Kaas:

Yes.

Bullock:

And, I was reviewing papers and books all the time. So, I got acquainted of what was the benefits of these things. I was writing papers for St. Joe. Well, St Joe's boss always called me a blabbermouth because I liked to publicize what we were doing. People need to learn about it. Anyway, Bill Hustlrulid came up with the Blue Book that he wanted to do, and I started helping him edit papers for that book. I wrote some articles for that one. And then, when they wanted to redo that blue book, of course, it wasn't possible to redo that. So, we did the underground handbook that came up after that. Bill and I worked together on that, and that was a big effort. We had 88 people contribute to the chapters in that book, so that was a big effort.

Kaas:

It was a huge editing job wasn't it?

Bullock:

Yes, and I wrote three chapters of that book.

Kaas:

Right. Right.

Bullock:

When the SME handbook came along, I think I wrote six chapters for it, so that was a big job. And, I solicited and edited another eight chapters. There were a lot of chapters for that book.

Kaas:

Right. Well, whoever it was that said that engineers don't know how to write, you're definitely the counter-argument to that.

Bullock:

My wife can always find mistakes in my writing. I'm still a hillbilly and write like one sometimes.

**47:01 The Memoirs of a Mining Legend - *From Hard Knocks to Hard Rocks***

Kaas:

It helps to have a good proofreader, and your wife is usually the first to be critical in a helpful way, though. Well, we've talked a lot about your work experience. And, I know the one thing that I'm getting very anxious to read is your recently published memoir. I think the title, which is *From Hard Knocks to Hard Rocks: A Journey in My Shoes: From the Hills of the Ozarks to Mines Around the World*. So, that's a great title, and we can see how well it fits from our discussion here this afternoon.

Bullock:

Well, I think it will help people understand who I am, what I am, and how I got to be such a mess: lots of good news, lots of bad news. You know, it is very difficult to handle a job, do all the things you need to do for your career, for your company, do all the things you need to do for your family, and then do all the things you need to do in civic jobs for your community. And, for the first 20 years, I think I did a pretty good job of balancing all of these. For the last 25 years, I don't think I did such a good job family-wise. Anyway, there were a lot of interesting times, and describing my times as the hard knocks in the Ozarks; my dad was a plumber, electrician for a while. I dug ditches for him. In the Ozark hardpan, it ain't easy. He also owned only one of two concrete mixers in town, which he'd rent out. And, I had to go

with it to mix concrete, so I mixed a lot of concrete, shoveled a lot of gravel. So, those are the things that really taught me to work hard and long and then persevere. So, that helped a lot. Those are the hard times, hard knocks. Well, we did persevere, and we came out of it, and all of it benefited me greatly. And, I got to be a mining engineer in hard rock mines. In high school, I read books about mining, engineers, building mines all over the world. It sounded exciting to a young kid who wanted a way to get out of the Ozarks.  Sure enough, it worked.

Kaas:

That's right. You did it. You did it all. Can you think of anything else you'd like to add to the interview Dick?

Bullock:

I can't think of anything else I left out- I'd say the mining education system, they need to be more flexible and don't worry so much about getting qualified PhDs from China and Taiwan and all these other places. Use more adjunct professors out of industry. I can name you half a dozen. Some of them have gotten doctorate degrees, but a doctor's degree doesn't teach you what you learn in industry, and that's what you ought to be teaching.

Kaas:

Right, right.

Bullock:

I preached that to the SME educational committee meetings years ago, but they wouldn't listen.

Kaas:

Okay, well, I think we're there.

Well, I'd like to sort of, maybe, conclude here, but I want to thank you, Dick, for participating. This interview was so interesting, and I felt honored to be able to do it with you.

Bullock:

I appreciate the interest and read that book. It's two volumes: one covers 40 years; one covers 43 years.

Kaas:

Okay. It's on my do list right now.