ORAL HISTORY PROGRAM

George E. King: Using a Hands-On Approach to Breathe New Life Into the Oil & Gas Industry

2024

PREFACE

The following oral history is the result of a recorded interview with George E. King conducted by Jennifer Miskimins on October 3, 2022. This interview is part of the AIME and its Member Societies: AIST, SME, SPE, and TMS Oral History Project.

ABSTRACT

Always curious to learn how mechanical devices worked, George E. King spent his childhood in Oklahoma taking apart and reassembling anything he could get his hands on. Coming from a long line of scientists and mechanics, King was inspired from a young age to go into a technical field. He earned his BA in chemistry with a minor in physics from Oklahoma State University, then went on to obtain a BS in chemical engineering and an MS in petroleum engineering from the University of Tulsa. He began his professional career with Amoco's Tulsa Research Center in 1971. Throughout his 50+ year-long career, King has proven to be a very hands-on kind of guy, always promoting the benefits of fieldwork and encouraging new engineers to focus less on the books and more on the world around them. His passion for engineering comes from his love of diving into complex and challenging problems deemed unsolvable for many. One of his greatest achievements was the innovative experiments he did with the Valhall oil field to increase production. Despite his great success, King remains humble and passionate about sharing his knowledge with others. He generously sends educational materials to educators around the country, free of charge, for the sole purpose of spreading knowledge and advancing the field of engineering. Learn more about the ways the oil industry has benefited from King's involvement in his oral history.

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00:16 INTRODUCTION

Miskimins:

This is Jennifer Miskimins, SPE trustee to AIME and current AIME President. I'm here at the SPE Annual Technical Conference and Exhibition in Houston, Texas, on October 3rd, 2022, with Mr. George E. King. Mr. King is a registered professional engineer in Texas and Oklahoma with over 50 years of upstream oil field experience since starting with Amoco Production Research in 1971. His technical background includes basic research on fracture-driven interactions, casing damage during fracturing, energized fracturing, production and fracturing chemicals, acidizing, asphaltenes, perforating, well integrity and completions, complex formations, unconventional resources, sand control, low-pressure gas well operations, applications work on quail tubing, tubing cut off, formation damage, and well repair operations.

Mr. King has published over 100 technical papers, a book on completions and workovers, and multiple book chapters. He has also been an SPE distinguished lecturer and chaired numerous conferences. He was inducted as an SPE distinguished member in 2015, awarded the engineer of the year from the Houston Region of Texas Society of Professional Engineers in 2012, received the 2004 Society Petroleum Engineers Production Operations Award, and also received the Amoco Vice President's Award for Technology from Amoco in 1997. This recording is part of AIME's oral history capture program.

01:54 GETTING OLDER, BUT NEVER GROWING UP – MY CHILDHOOD IN OKLAHOMA

Miskimins:

So, George, tell me about where you grew up.

King:

I was born in Okmulgee, Oklahoma, in July 1949, and my father died almost 3 years later, leaving my mother to raise two small kids on an Oklahoma school teacher's salary. My mother remarried six years later, and the family moved to Muskogee. I graduated from high school there, then on to [college, first in Tahlequah, Oklahoma, to get two years of courses out of the way, then on to Oklahoma State University in Stillwater, where I majored in Chemistry and Physics. In my Senior year at Oklahoma State, I applied for a summer job with what was then Pan American Oil Research in Tulsa. When a stranger identified as Bob Fast called me in early 1971 and told me I had been accepted for a summer job at Amoco Research in Tulsa, I was thrilled but immediately realized I did not know what Amoco was. It took me an hour after I eagerly accepted the job to learn that Pan Am had changed its name to Amoco, and I jumped head-first into a new field of science. The summer job was my introduction to the oil industry and, with a bit of luck, turned into full-time employment. With Amoco's encouragement, I went to the University of Tulsa at night to attend chemical and petroleum engineering classes. It was a busy time, as during my 15 years of full and part-time university work, I was also working full-time. When Amoco offered employment, the conditions were that I needed more schooling in the Petroleum sector. I liked to think of myself as a grown-up, but as the fascination with this new science opened my eyes, I knew I was still just a kid with a lot of learning to do.

Growing up? I don't think I ever have, and my wife would attest to that. But basically, my childhood was interesting as we lived in a very small town where I spent hours roaming the alleys and digging in

trash cans for anything mechanical that I could dismantle and try to reassemble. I spent summers with my grandparents down in a tiny rural burg called Schulter, Oklahoma. And that is really the foundation of my curiosity. If there is one thing that is unique about me, it is that I am curious about just about everything, and I like to dig into it, primarily to understand how things work. In school and in life, I did not specialize in anything. Like my grandfather, I was a generalist. This all came from what I did as a child. I had a lot of fun growing up or getting older, I would say. And if you look back at this, you can see how different people and events shaped your life. And that's what I think is a unique characteristic about people that are successful for long periods of time.

Miskimins:

So, speaking of people that influence you, you were raised by your mother after your father passed away at a very early age. She had a Master's degree in Biology from the University of Oklahoma. So, how did her scientific background influence you?

King:

In two ways. One, from the time I was born up until the time I left home at about 18 or 19, life was a continuous biology course. I never took biology in high school or college. And I wouldn't take biology under my mother because she expected me to work a lot harder than I was willing to work. But science was always there, and it did not take much to really infect me with a passion to develop much more knowledge in science. You can tell by the variety of different topics that you read, which surprised even me; I realized that I am certainly not a master of everything or anything. I'm simply a jack of all trades and a master of none. But the curiosity carried me through – even today.

04:45 THE MOST POWERFUL INFLUENCES ON MY CAREER

Miskimins:

So, you received a BS in Chemistry from Oklahoma State and then went on for a BS in Chemical Engineering and an MS in Petroleum Engineering. Who or what influenced you to become an engineer?

King:

My mother would have told you that I was born an engineer because, from the time I could crawl, she had to really watch me because if I came to something that could be disassembled, I would take it apart, and some of the time, I could get it back together again. And that was just the start of things. Now, coming up, who influenced me to go further? Well, my mother was the first technical source on the biological side, but my grandfather, her father, was on the mechanical side. He was born in Italy in 1888 and came over with his family in about 1895. He developed into a natural mechanic and could literally fix anything from a hay bailer to a pocket watch. There are some people who have that ability to just walk up to something, take it apart, see how it works, fix it, and put it back together again. Perhaps it truly is genetic, or maybe it is just familiarization alongside a knowledgeable person. But my grandfather was a natural mechanic, as am I, as is my son. Hopefully, one of our grandsons will pick it up, or maybe even the granddaughter. This is a little bit of what started me along a practical engineer path.

The most powerful influence in the oil industry was George Holman, a former area engineer for Amoco in Andrews, Texas, and my first boss at Amoco Research. He recognized that I had the ability to talk to

people about mechanical things that are in the oil field: pumps, gearboxes, and other equipment. I could see how they operate and could even connect on the chemical treating side. George had been a field engineer with Amoco for quite some time, and he knew almost every field foreman in the company. So, he arranged for me, even though I was based in the research center in Tulsa, to go out in the field chasing well problems at least one week a month. That was better than any college course you will ever take because you walk into an area that the field foreman knows much better than you. You introduce yourself and say, I want to learn about what you're doing, and then you listen. Field foremen taught me more about engineering than any college professor did. I am not putting anybody down, but that is where I learned my place in this industry – transferring much-needed knowledge of how things worked in theory but seeing how things must be adjusted to make it work on a practical level. When you go further into my transition, I count people like Bob Fast and highest-caliber engineers such as Michael B. Smith and Ken Nolte in the fracturing field, as well as other people I worked with in Amoco, BP, Apache, Viking Engineering, and all through my SPE experiences. These are some of the greatest people in the engineering field. I'll never be their equal, but I was always their admirer.

08:18 EARLY EDUCATION AND THE MILITARY DRAFT DURING THE VIETNAM WAR

Miskimins:

So why did you choose the universities that you chose to go to?

King:

They let me in! Now, maybe that merits a little bit more explanation.

Miskimins:

Maybe!

King:

When I was in high school, I had a great chemistry teacher by the name of James Dunn, a World War II chemist who worked in the naval research centers [on propellants]. He would not tell us even half the things he did. I told him that I wanted to get a degree in chemistry. Well, he said, “Okay, pick your area.” And I said I would like to go to Oklahoma State because my mother had gone to OU and my sister had gone to OU, and I just figured I wanted to go somewhere different. So, he said, “Go over there while you're a senior in high school. Get an advisor. Take the pamphlet of the local junior college or small teachers’ colleges that were around Muskogee.” He said, “See what subjects you can take that will fulfill it without you losing any hours when you transfer.” So I did that, and it took two years where I was driving from Muskogee to Tahlequah, putting 500 miles a week on an old car that I managed to keep going and working from two o'clock in the afternoon until 10 o'clock every evening at a sand plant, running chemical tests on glass quality sand. When I got to OSU, everything transferred, but I found out that going to a university is a whole lot harder than going to a junior college. And that is where my grades kind of went down a little bit, but somehow, I managed to finish.

When Amoco offered me a job at the end of the summer, they hired me as a lab assistant, at the next to the lowest lab assistant grade there was, and on the condition that I would go to the University of Tulsa at night and get an engineering degree. I quickly took that job since I did not ever have any other job offers. I was planning on getting married that next Saturday and my time was tight to get

everything done. So, I made a plan to go to the University of Tulsa, going three hours to six hours a semester and then three hours to six hours in the summer. It took me about three years, but I worked my way through and got a chemical engineering bachelor's. But again, as I got interested in petroleum, I thought, why don't I go a step further? So, I applied to grad school at TU, and of course, my grades were not good enough to get me into the graduate program. However, I had one very good professor, Kermit Brown, with very solid industry experience, who asked, "Why aren't you in the grad school program? I have not seen your application for graduate school come through." When I replied, the grad program manager told me that I would have to get my grades up from a 2.8 (over 160 hours) to a 3.5. He looked at me and said, "Don't worry about it; somebody will call you tomorrow." The next day, the head of the department in graduate school called me, and he said, "You've been accepted, on condition." And so, I was in graduate school, and I was able to keep my grades at 3.6 all the way through. Kermit Brown was the enabler for that, and for that, I will always owe him a debt.

Miskimins:

That's a pretty good person to have in your court.

King:

Yes.

Miskimins:

[Did] any political or cultural events affect your studies while you were going to school?

King:

I knew the military draft physical was coming at the end of the summer. This was the old-time draft in 1971. My draft number (based on a birthday drawing) was 37 out of 365, so I figured I was gone. This was in 1971, while we were still in Vietnam. I went through the whole medical physical draft process, and only those who have been through it will understand. It involved a series tests and examinations, body fluid testing, and an army intelligence test. When we got around to the final interview, the army doctor was tired of looking at the stacks of doctors' excuses that most had brought with them. And that doctor was taking everyone. I had no excuses to present, so I just walked up and related that the physician at my birth told mom that I was born with a heart murmur. So, he picked up his stethoscope and listened, and he said, "That's not much of a heart murmur." He picks up his pencil and hovers it over the acceptable and non-acceptable boxes. And this is where you leave almost the next day for boot camp. But then he puts his pencil down and riffles through the papers until he finds the Army Intelligence test. I had made ninety-nine out of a hundred, and I would have argued with them about the one I missed, but that was not the time to do that. So, he is sitting there with his pencil, and finally, after five seconds that seemed like a year, he says, literally, "Oh hell, we don't need you," and checks the non-acceptable box. Well, I could have turned handsprings after that, but that is not smart either. When I walked into Amoco Research the next day, George Holman sticks his head out of his office and says, "Hey, are you in the Army?" I said, "No sir, they didn't want me." George said, "Well, in that case, we're going to offer you a job." That Saturday, Sandy and I got married, and that has been over 50 years ago. So, perhaps that is a political event if you want, or a cultural event, or maybe both if you really care to classify it. But other than that, nothing else came close. I was very lucky. I may never win the lottery, but I'm okay with that.

Miskimins:

I think that's a little bit of winning the lottery, actually. So, you mentioned your GPA. What's your feeling about the emphasis that's put on GPA in high schools and colleges these days?

King:

Bob Fast summed it up perfectly one day. There were 130 applicants for those summer jobs [in 1971]. I was one of 30 that got picked, and at the end of the summer, I was the only one they offered a job. So, I finally went back to Bob after I got to know him and asked, "Bob, I know I had the worst grades of kids in that summer program, so "Why did you hire me for the summer?" Bob looked at me with the most quizzical look on his face, shook his head, and he says, "I never look at grades. You were an Eagle Scout, and you worked your way through college. I figure here's somebody that could actually get a job done." That was what I have said many times addressing seniors in college and [company interviewers]. Yes, having good grades will get you in the door, but the real education part of it? [That is what the individual must learn in the real world.] That pretty well sums it up.

Miskimins:

I like that a lot, especially as a college professor. I like that a lot.

16:26 AN APPRECIATION FOR FIELD WORK – EARLY DAYS AT AMOCO

Miskimins:

So, you talked about your first job and then getting this offer from Amoco. What did you do with that first job? What were the duties?

King:

It was really interesting. They started me off in the acidizing lab. I realized that in the tests they were running on core etching, the outcome was totally dependent on the way you ran the test, and it really did not mean a lot. And so, I actually got them to scrap that type of testing and really look at field-based testing. Get it out of the lab; get results from field performance. And that, to this day, has been my choice of how you test technology. You get it in the field, you get enough instrumentation, and you get good information on performance. If I have any critique of any engineering field, it is this: we are one to five miles away from what we work with: you cannot hear it, you cannot touch it, you cannot see it, and you do not want to smell or taste it. So, what are you left with? It is drawing conclusions from the tests and your imagination of what you can pull together from all the data that you do have, the rates, the temperatures, the pressures, the type of response that you are producing, the changes, et cetera. That's what really makes the educational part of that work. Moving out to the field is where we need to be, and performance is what we need to check.

Miskimins:

So, you started working for Amoco in Tulsa. Where else did you work in your career?

King:

I have worked in 30 countries doing either training or solving problems, and on every continent except Antarctica. We haven't found any oil down there yet. But most of the time, it's been out of an engineering central district. When I get out to the different operational areas, we'll look at problems, sort through [the performance], and hopefully, we can find a solution. I will talk more about the difference between answers and solutions a little bit later. But basically, what we are doing is I am using what I must help the workers that are at the "coal face," if you will, and the work is hands-on. I have since found that I could do that pretty easily from a laboratory or an office, but if you gave me a choice, I'd be right out there in the field looking at the problem.

19:31 HOW MENTORS HELP MAKE A CAREER

Miskimins:

So, you've mentioned some of the mentors in your life. Anybody else? And how, overall, do you think the mentors helped you in your career?

King:

The lack of mentors can break you. You can try to do it yourself. But it is not all about opening doors; or getting you opportunities so much as it is making you believe in yourself. And a good mentor will find the things that you do right. They'll build on that. They will mention the things that you do wrong, but they don't dwell on them. I'll give you an example. George Holman, again, as I will come back to him time after time. I thought I could really write well coming out of college. So George had me write a report, and this was in the days (early seventies) when if you wanted to send a report to somebody, you had to mail it. I had written a report, and he knew better than to try to correct it and edit it himself. So, he sent it to Sally Golf, who was a former editor of SPE Journal. She had retired, but she said, "Send me two copies of it." This was about a five- or six-page report. So, we sent two copies, and she went through it and sent one copy back, and it looked like two armies had fought to the death in red ink on what I had written. And I learned, okay, I cannot write as well as I thought, and then made the decision to improve. Next thing George Holman comes in, he says, "You know, I think you need to work on your presentation skills. There is a Toastmasters group forming across the street and meeting at a restaurant near Amoco Research. He said, I want you to join that, and I'll go with you, and I'll join." And I did that for five years, and my presentation ability went up sharply after that. Learning to get your point across in a way that lets people know that you are trying to help them, not criticize them, is one of the keys to communication. [Learning to listen is the main objective in communication.]

22:18 NOTEWORTHY TECHNICAL CHALLENGES – SOLUTIONS AND ANSWERS

Miskimins:

What are some of the biggest technical challenges you experienced in your career?

King:

This is where we get to solutions and answers. I rarely look directly for the answers. I look for a cause and then a solution. Sometimes, in looking for a solution, you find a definite answer, but what we tried to do was to get the wells back online as soon as we could because that makes a major difference in production operations. Focus on getting the well working as cheaply as we could but still stay within the bounds of well integrity. If you look at all those things, you come back to the question of how do

you really solve a problem? One issue I worked on very early in my career was foam fracturing. When foam fracturing was first introduced, I rigged up the equipment I needed and, developed a dynamic fluid loss coefficient for foam fracturing, and identified the conditions that impacted losses from the foam fluid. The first step for me was to identify what is causing a problem, and what is the quickest and best way to control it. I have also worked on coatings and liners we could put inside tubing and casing that would minimize corrosion. Corrosion is still one of the most damaging problems that we have in the industry. Inexpensive coatings seem to be a solution, and] we ended up lining several wells with different types of liners, finding a good solution, and then pushing it further, using some of the lined pipe either over the full well or in segmented form [for isolated areas. Another solution-based approach] when we were just getting into deep water completions was the question of how long sand control would last in these expensive deep-water wells. This task illustrates how I approach a problem. I came up with a template that I could put relative information for all the wells in a field, which failed, how they failed, and what type of completion was used. It was a simple spreadsheet. I reached out to forty engineers in different companies. I asked them to fill out this template without a well name, company name, field name, or exact location. There were no contracts, no lawyers, and no money changed hands. This was purely voluntary, and I got forty engineers to send the information. I ended up with 2200 examples of wells with data that could identify problems that lead to failures. From that, I was able to generate a life expectancy for that type of completion and a reason why it failed. Failures can be separated into early time failures, generally a problem in installation, and [the others were operational failures related to formations of production methods. Wells wear as they are produced, and the failure risk and causes are like an automobile wearing with use. Lemon laws for early car failures are the result of construction or quality problems – an outcome like early failures in wells. With cars, you have a warranty, but when manufacturers set a time or milage limit, you better get rid of it because you're going to have a lot of breakdowns. Manufacturers know the limits. The same thing is true with sand control completions.

I like problems that fall into the categories of the weird and the unusual and problems that do not have an easy solution. For example, when I started working on fracture-driven interactions and trying to nail down the causes and the avoidance methods, I found other people willing to work as a team, including Ali Daneshy and Mike Rainbolt, and together, we made breakthroughs that might not have been possible working alone. Ali Daneshy and I organized a cross-company meeting for information sharing that took us to a better understanding of the cause, and how to minimize it.] We quickly realized it had] multi causes, and forced us to widen the search for causes. The industry now has a pretty good handle on the why, the where, and then how to minimize the problem.

As multi-fractured horizontal well completions increased, the industry started seeing casing deformation damage and occasionally casing failures. We again started looking for causes and defining possible answers. We put a good SPE work group together under the well integrity banner and have defined several approaches to the problem. So, that is what I am working on right now. With team cooperation for about the last three or four years, we found several answers but still are searching for solutions. There is always room for improvement.

Miskimins:

There absolutely is.

27:18 INNOVATION AND DISCOVERY WITH MY COLLEAGUES

Miskimins:

So, do you recall any significant experiences working with colleagues that you can share?

King:

Well, there are a few that I can share. When I broke in, in 1971 with Amoco, there were still a lot of World War II veterans, and a few had been in Korea. These guys were on the ornery side, and many of them had survived combat. After the war, many of them had come into the Oil and Gas Industry. These folks were great to work with, although they tended to let you make a mistake that they saw coming and then laugh at you. You quickly learned to laugh at yourself. There were practical jokes that these World War II guys played on each other that were just so far out there that you could not do them today. But in terms of working together, I did get the opportunity to work with several successful and respected engineers who were respected for what they accomplished, which I think is the way we ought to look at engineering. It's not the education that you have, either formal or literal; it's what you do with it. You approach a problem; you solve that problem. I got to see a lot of problems solved and technology advanced, many times in well directed experiments and a few times quite by accident.

In fracturing, for example, Mike Smith was really great when he came into Amoco and later had a fantastic fracturing career in NSI. One time, he was running the newly developed Amoco downhole television camera while I was along as a helper. With a downhole television camera, we can see fractures in open-hole formations. While Mike was looking at the vertical fractures, he remarked, “If you read the patent that Amoco had on fracturing, it's on horizontal fractures in vertical wells.” One reason the camera was developed was the fracturing patent was running out, and some of the hierarchy in Amoco insisted that fractures were still horizontal. So, they were trying to get another patent or extend this one, and then they found out most fractures are vertical. That deflated some expectations, but we got a lot of useful information out of that as well.

That's just one story. But working with George Holman and the field foreman that he knew was my best education. When I was sent out to work or to observe, George always said, “Just go observe.” His advice was that education comes from observation and is enriched when you ask a few questions. On one occasion, there was a job out in West Texas where I met a field foreman known for being exceptionally successful at getting jobs done with minimal delays]. When I asked how he did it, he laid out his workover brief, showing his additions. On the worksheet, he had identified every place where a problem might arise, what could be done to prevent or recover from it, and where the tools and the specialist were located. For example, if you get the tools stuck, who is the expert, where is the needed fishing tool, and how long would it take? He had this whole list built up of the problems that might occur, where the equipment was to get him out of that problem, and who was the best at running it. That is one of the illustrations of working with people. The field foremen that I met were very good about reasoning towards an idea about what was happening downhole and about what was really creating a problem. This knowledge was usually better than anything from the engineers in the office. The best engineers I have known got out to the field and talked to people.

31:31 DESPERATION IS THE TRUE MOTHER OF INVENTION

Miskimins:

So, what milestones in the industry do you think had the biggest impact on the industry?

King:

The biggest milestones that I can tell you are the late 1970s when some countries stopped exporting their oil into the United States. When I went to work for Amoco, oil was, I think, 2 dollars and 65 cents a barrel. In the embargo, it went up, and when it reached 8 or 9 dollars a barrel, producers thought they were in heaven. But really, what has been the most, I would say, impactful things that have happened is this cyclic sinusoidal curve of boom, bust, boom, bust, boom, bust. I wrote an article one time for the petroleum magazine, JPT. It was based on the question, "Is it a terrible thing to have a bust event in the oil business." Well, in the long term, it is not. You must slow down and start putting technology to work to help you cut your costs and/or improve your production. When it is going full blast, you are throwing money at things, and you get into problems. But when you must slow down, then your back is to the wall, and people are about to get laid off, that's [the best time to search for a solution].

An example that I had with this came in Liberal, Kansas, where Vance Norton, another Amoco field foreman, called and said, "I want you to come up to a meeting that we're going to have with all of our suppliers." The giant gas field was declining rapidly, and new well costs were too high to be profitable. Vance put up a cost sheet on the screen and said, "This is our cost to drill a well]. He added, "We have drilled the last well we're going to drill at this price." To all these competitive service vendors, he said, if you want Amoco to drill another well, we've got to get that price down to this, and it was about a 20% reduction, which is significant. Well, after a little bit of pushback, they realized they and Amoco had to make this work because Amoco would sell out, and jobs would be lost. The talk quickly turned to being inventive, and solutions started forming. From this experience, I began to realize that the most inventive people in the oil industry are field foremen. The people who see the problem close up. And I saw that well price go down by about 35% over time. The solution included one company delivering orders filled by several different companies, another company handling maintenance, and another providing equipment from different suppliers. So, one delivery was coming out instead of 15 trucks. They became inventive when their backs were against the wall. People will tell you that necessity is the mother of intervention. I don't believe that. Desperation is the true mother of invention.

Miskimins:

That's a good, very good point. Very good saying.

35:15 GETTING INVOLVED WITH SPE & AIME – VISIONS FOR THE FUTURE

Miskimins:

When did you first hear about AIME or SPE, and how did your involvement progress over the years?

King:

Again, I go back to George Holman; I must come back to him on most things I have learned about working with or managing people. When I started really getting interested in the requirement of getting an engineering degree, George suggested that I could go to the University of Tulsa, so I did it at night. I worked full-time for Amoco. And he said, "Okay, you get some engineering classes in; it's time for you to join SPE." Well, when your boss tells you that, you join it, but as I joined, I started seeing the opportunity to be with a bunch of engineers from different companies. Since that time, many of them have become friends, and a lot of them have called me for information and when I saw something they might use, I would call them. Incredible things happen when you get this group of smart people coming

together, and that is what SPE does. It brings the technology and ability to freely talk to different people. And that is why I see interest in coming to the specialty meetings and the fall meetings. The thing we need more of in the SPE and AIME as well is that we need to talk more about failures. There is an old quote that everything you need to know to succeed is contained in your failures. If we hide the failures, we lose the knowledge of solutions that can make us succeed. We need to find a way to talk about failures and truly learn from them.

The corrosion guys do this in NACE, and they do it beautifully. But in SPE, we only talk about successes. And the only time we talk about failures in SPE is when, we had a failure, but we have got this solution that fixed it. Well, let us think about a failure; the first thing you need to do is figure out what caused it. And a lot of times, we don't. So that's where you have to step back and dig deeper. What I would really like—is if we had meetings like we used to have at Amoco and again at Apache, where we called them train wreck sessions. All right. They were closed door. You had to bring your presentation. And generally, these are inter-companies, not intra-companies. You had to bring your presentation of a failure that you had been part of, and everybody presented their failures. But everybody admitted, "We've had a failure." Inside a company, those work beautifully. I will guarantee you there is more information that changes hands there than anyplace else.

38:14 ONE OF MY FAVORITE THINGS TO DO – ADVICE FOR NEW GRADUATES

Miskimins:

So, how do you see the societies benefiting people in the industry today?

King:

They're giving them a platform to speak, to listen, and to be trained or, and to train. If you ask me what is one of my favorite things to do, it's train. I come from a line of teachers on one side. My mother, my sister, brother-in-law. We had a lot of teachers. And I told my mother I'd never be a teacher because, dang, guys, you don't make any money. Well, then I got into it, and my mother was ribbing me when she found out that I was doing a lot of training. I said, yeah, Mom, but I make a whole lot more money than a public school teacher does, and I do not have to put up with the non-disciplined crowd. But if you're not training, and if you know something that will help, and you're not sharing it, what good are you?

Miskimins:

So, if you were to recommend SPE to a new graduate, how would you tell him or her about it?

King:

I would tell them that formal training is a very nice thing to have. However; literal experience and the experiences you borrow from other people or learn about from other people? Now that is a gold mine.

39:45 HOW TO ATTRACT YOUNG PEOPLE TO THE OIL & GAS INDUSTRY

Miskimins:

So, in your opinion, what can we do to attract more young people to the industry these days?

King:

Basically, we have to show them why they need to join. Oil and gas have gotten a little bit of a black eye, well, a lot of black eyes, mostly undeserved, from people who do not understand energy. We need to educate, starting in the school system, about energy and then go from there, making sure that people understand that there is a difference between a generated energy like electricity that comes from gas and the gas itself. A lot of people will drive around with license tags on their cars or bumper stickers, bad-mouthing the oil and gas industry while driving an electric car. And then you see them when the hurricane comes through, complaining about lack of power. There is a picture that my wife showed me that was on one of the internet's sites. It's a guy with a Tesla at a gasoline station filling up five-gallon jugs of gasoline to run his generator to charge his Tesla. I love that picture. People need to know that about 80% of the total power needs in the US still come from fossil fuels.

41:06 REFLECTIONS ON A CAREER IN THE OIL & GAS INDUSTRY

Miskimins:

What has made working in this field meaningful to you, and what's been your favorite part of working in
the oil and gas industry?

King:

I'm a very curious person. I like the comradery that we have in the industry. And then I like to work on something and see what I've worked on, actually accomplish what I set out to do. It's like the time that I did the sand control study, and it's, they didn't, they didn't understand really how to program the economics and how long are these sand controls going to last in deep water? Well, I got some information that allowed them to do that. And I, I've heard that it saved several companies many millions of dollars, tens and probably hundreds of millions of dollars to have that information and say, okay, let's go to a frack pack rather than a, just a casing gravel pack. And then there weren't a lot of other people, you know, David Norman and everybody else that was in that movement at the time, really trying to convince people that we could really do something like this. But the reason why I keep doing it is the challenge. Give me a challenge. Tell, tell me a problem that there's no solution to and that people find impossible. And I will start mentally chewing on that. And I might not be able to solve it, but in some cases, I have.

Miskimins:

So, do you have any regrets regarding the career you chose and where it's taken you, or anything that you wish you could have done differently?

King:

I wish I had studied harder in school so I would not have to do it the hard way rather than knowing how to do it the easier way. But as far as regret of the path I've taken, absolutely no. None whatsoever.

43:29 A CAREER HIGHLIGHT – THE VALHALL FIELD

Miskimins:

What's your favorite memory or project during your career?

King:

Had to be the Valhall development in the Norwegian North Sea sector. In the late 60s or early 70's, Amoco, or Pan-American at the time, drilled two wells in what has become the Valhall field. When they did a flow test on it, the chalk flowed back up the drill pipe, plugged the drill pipe, and they had to recover two wet strings of oil-based mud. If you know the environmental aspects of that area, even back in the sixties and seventies, you got an idea of, oh man, this is a problem. The oil was there, but the porosity of the rock was 45 to 48%, essentially calcium-based coccolith fragments surrounded by oil. It was simply chalk fragments swimming in a pool of oil, but you could not produce the oil without producing the chalk. So again, nobody was really proposing anything. And so, I stuck my hand in the air and said, "Hey, let me try that." I started working on that in about 1977 and put together some equipment that, as far as I know, had not been built at the time. It was a biaxial cell, not a triaxial, but it allowed me to put pressure on the outside of the core while I was flowing through the core with a movable ram on the end that would push in on the core. One of the first things I did was duplicate what happened in the field. I pushed chalk into all the flow lines of this equipment, and I spent two weeks cleaning it out or just replacing the lines, but okay, wait a minute, I have got something here. And so, I started experimenting with screens and things like gravel packs, et cetera and finally found out that a pack of 20/40 mesh gravel would stop the chalk and let you produce the oil. But when water came through there, you had to change the conditions. So, we found a lot of things that impacted production and finally found a way to produce the oil without most of the chalk moving. In the first trial, we did a gravel pack, and sure enough, it would work, but it was not productive enough. This is now up into the eighties by the time that we were having small successes. At that point, Mike Smith, Phil Pattillo, and Ken Nolte got involved and came up with a special frac pack. So, with a good amount of work in the lab and in the field, Valhall moved into production mode. Some seventeen years after the first well was drilled, Amoco started doing horizontal multi-fracked tip screen out wells and reached peak production. It took a lot of engineers and a lot of time. Amoco and the Norwegian segment were succeeding, and I made some great friends during that time.

46:53 THE ONLY BLONDES IN CHINA – AN UNFORGETTABLE TRIP IN THE 80s

Miskimins:

What about your favorite travels? Where's the most fun you've had traveling?

King:

I would have to say that it was in China in 1985; they just opened to tourists. Every time I go somewhere interesting, my wife wants to go. Now, if I am headed to somewhere that I do not want to go, she stays home. Let me just project a little bit. Put a map of the world out, put five plastic overlays over it, and with each overlay, you color in areas of pestilence, deserts, frigid conditions, hostile governments, and hordes of insects. When you are finished, look at the darkest places on the map, and that is where you find oil. Okay, so back to China. So here we go to China, and my wife is a blonde; the color comes out of a bottle, but she is still and remains a blonde. Another couple, Jim Lee (the artificial lift guru) and his wife Pat, were on the same trip. So, we were running around, just the four of us. And Pat is also blond. Well, China was just opening, and their people obviously had not seen many blondes.

The Chinese government wanted foreigners to shop at the Friendship Store, which the wives went through quickly, and then wanted to visit the local shopping district in Beijing. So, the four of us go right down through the Chinese shopping district, with all the Chinese folks staring at the blonds. Several stories came out of that. But seeing the reaction of the Chinese people, who were just as sweet as they could be, with people like my wife and Pat, well, that was hilarious. The blond women were just surrounded. And small groups of college students would follow them around, trying to practice their English. This story was brief, but the visit and the shopping were friendly. There are a great many more stories, but this can get into a two-glass-of-wine story, so we cannot go into it here, but I guarantee, I loved that trip. We got to see a lot of things about China and its history and culture. Really, wherever we have gone, the people have been wonderful.

49:30 VIEWS ON FORMAL VS. SELF-EDUCATION

Miskimins:

So, you believe in the quote by Jim Rohn, quote A formal education will make you a living, while self-education will make you a fortune unquote. Can you expand on that a little bit?

King:

You know, I have seen a lot of book-smart people coming out with PhDs that knew how to solve the problem to get an answer but failed miserably when faced with a challenge where information is not exact, and the unknown appears to be in control. People lacking imagination and experience are often unwilling to reach in and unscramble the nest of information that you do get out of life. I taught at night at the University of Tulsa after I received my master's degree for eleven years. I taught senior and graduate level courses, mostly in well completions. And Kermit Brown, when he retired, specifically asked for me to teach his completions and workover course. My course tests were never to derive the equation. I understood the need but hated the practice. My tests were a well file with a field map and assorted information about each of about 20 to 40 wells. Everybody got a three- or four-page folder of the wells in that field with geological data, well construction diagrams, completion specifics, water tables, etc. I'd have five wells assigned to each student out of forty in the field. The test was to examine each of your five wells, find if there was a problem, and what created low production. If there was a problem, how would you fix it? Sometimes, it required a workover explanation and a calculation required if you had to do calculations, and if it required four pieces of information, I gave them three, and they would have to estimate the fourth from other information in the map or well schematic. I had people with C averages coming in and making A's; I had people with A averages coming in and flunking because they could not make the connection to what was actually wrong. Sometimes, I put a well in that did not have anything wrong. I've included buildup tests, pressure tests, and collapsed pipe. The goal? How good are you at converting random information into recognition of what is happening.

Was I a good Teacher? Well, a funny but revealing story came out of the test results that really made me think. I had a very good friend from Iran. His folks had to leave when the Shah fell. But he had been a field foreman in Iran before he came to the US and settled near Tulsa. He earned his PhD in engineering at the University of Tulsa and is an incredibly sharp and observant guy. I was handing a test back one night that I had graded, and most of the students had scored very low. I said, Ali, what is wrong here? I know they're smarter than that. He said, “It's the way you teach.” I said, “Okay, what do you mean?” He says, “You have got to remember that the experience level of some of the younger people coming into here came from certain families, where they have never worked with their hands. They do not know what a J Slot Packer is; they don't know how to set a plug or why a kickoff is needed

for milling out of the pipe." So, now a little wiser, I started going around to the manufacturing places in Tulsa and borrowing their scale model plugs, packers, mills, and other equipment. I showed students the basics of simple operations and then how a J set and unset, how a packer could set by just compression, and how test scores went up. So, when you have a failure, you've got to figure out what caused it. And that's true in tests as well as it's true in the industry.

54:12 "GET OUT TO THE FIELD" – ADVICE FOR TODAY'S YOUNG ENGINEERS

Miskimins:

What advice would you have for today's young leaders in the engineering profession?

King:

Get out to the field. You can sit in the office and imagine what's going on, but you'll never know what's going on until you get out to the field. Make friends out there. Do not go out there with, I have a PhD, or I have a four-point average. That doesn't impress them at all. It is amazing what you can learn from an experienced person who can solve problems with ease and may not have completed high school. Learn from them. I have had plenty of summer students over the years, and I think that if I ever do that again, I will never hire anybody who has a 4.0 average because I have had problems with some very book-smart students who have trouble applying a solution to a mechanical or chemical problem. You need to have imagination beyond the book, and you need to be presented with a problem to which the answer is not in the back of the book and for which the equation has never been written. That is your start of education.

55:30 GUIDING PRINCIPLES AND PASSING INFORMATION ALONG

Miskimins:

So, you stated some personal objectives as follows. One, always remain curious, unafraid of failure, and willing to learn from it. Two, try to help anyone who calls on you for technical assistance or learning tools. And three, teach when you can. This is the very best way for you to learn. How and when did you develop these?

King:

I developed the concept that mistakes are necessary to increase your learning. I made a lot of mistakes because I thought I knew a lot more than I did. And George Holman would not let me forget it, so just wait a minute and think - what caused that failure? Now, you go from there, and you help people because you can learn from their mistakes and their successes. I enjoy training because I learn as much (or more) from the students as they learn from me, especially the questions they will ask. And it has developed at least one thing about the way I think about things. We have all heard the expression, "Well, I know it; I just can't explain it." HOWEVER, If you cannot explain it, you do not know it. That is the bottom line of why I am curious – I want to be able to explain why something works or does not. I do not learn like most people do by just reading it. I can get an idea of what they are talking about, but it does not explain it to me. I have to take that apart line by line. It will take me half a day sometimes to read an SPE paper and truly understand it. And some of them, I never do understand. Because some technical papers are not well written – to be honest, most are not. Engineers write and speak in third person boring. It is not a good thing. When it takes me a half day to understand a technical paper, I put

my notes on a PowerPoint slide. When I am finished, I have something that I can show people who do not know any more than I did about it and bring them up to speed a lot faster. And I have done that since the 1970s.

When BP bought Amoco, and we knew that the Tulsa lab would be closed, I took all my paper view graphs and 35-millimeter slides to our reprographics department, which Amoco was going to shut down within the month. Everybody was panicked, and nobody was sending them anything. I took them everything I had. I outspent my budget by probably twenty-fold. I got everything converted to electronic. Well, nobody ever checked my budget. When you are selling a company, it is closing, they have got to pay them anyway. But I've kept all that. And right now, I think I have something like 14,000 SPE papers that are in my collection and about 15,000 to 17,000 PowerPoint slides in two or three hundred little modules that I can go through quickly. I have training modules on many completion, production, and stimulation subjects, so I can put presentations together quickly with just a little updating. If a college professor asks me can you help me get a course started? I can and have done it for several universities. I will send them five or 600 slides with more available. I do not charge anything for that. I am just passing the information along.

Miskimins:

I'm sure people appreciate that very much.

King:

They have expressed that, yes.

59:29 A MEMORABLE FIELD TEST IN CASPER

Miskimins:

So, George, is there anything else you'd like to discuss or share?

King:

Well, understanding that you're from the Casper, Wyoming, area, I do have one. In the late eighties and early nineties, we were developing gas fields up in Wyoming and Utah, with the mammoth Anschutz Ranch being one of them. We started having problems with completions. We could not break the completions down to just do a cleanup on it because we weren't fracturing them yet. We were going to wait to fracture until we pulled the condensate down and then drew the gas down. But it was the largest nitrogen injection project in the world at that time to just keep the pressure up. Well, we started having problems with completions that we had not had problems with before. So, again, we had nobody to investigate. So, they said, hey, try this one. I made some friends there and called the perforating company and asked if we could do some test shooting above ground. We went up to the Casper city dump and poured thirty, 4-foot diameter culverts full of cement with the casing down through the middle of it. Different sizes of casing. We had some dual and triple strings and several types of perforating guns. We got all the perforating companies that were supplying charges and had them load some guns, come out there, and test. We did find some problems with one company's charges that they were a little bit off-center when they were being constructed, so we weren't getting good penetration. So, we found the solution to that. But we had a lot of fun shooting guns off in the Casper City dump. Some of these guns, and there were all sizes of guns, from four-inch guns down to

the two and three eight-inch guns, and as these smaller guns would shoot, the recoil off this would blow these guns in the air. We launched some perforating guns about 70 feet in the air. Now, I am glad OSHA was not on site for this, but this was a field test that was actually very, very successful at demonstrating performance, finding the cause of the problem, and then demonstrating how we were going to do this. And afterward, left a lot of debris in the Casper city dump. If excavated, that mass of pipe and concrete would make me wonder if there was a war there. Nonetheless, nobody in Casper minded too much, evidently, because we did not hear anything negative about it. So, we solved the problem by doing the field work instead of just trying to figure it out in a laboratory. And I guess that is a good endpoint.

Miskimins:

That's, that's a great story. And, as a Wyoming kid, yes. I very much appreciate that. So truly, what a fascinating career in life you've had. And it's been a pleasure to spend this time with you. So, thank you again very much for your willingness to share your story with AIME.

King:

And thank you very much for being interested enough to listen.

Miskimins:

My pleasure.