AMERICAN INSTITUTE OF MINING,
METALLURGICAL, AND PETROLEUM ENGINEERS

ORAL HISTORY PROGRAM

Rodney R. (Rod) Boyer: The Ti Guy

2022

PREFACE

The following oral history is the result of recorded interviews with Rodney Boyer conducted by Adam Pilchak on December 9, 2021 and March 31, 2022. This interview is part of the AIME Oral History Program.

ABSTRACT

Rodney Boyer, affectionately known as “The Ti Guy” has done more for titanium research and use in the aerospace industry than most. Boyer grew up in Washington State, inspired by the aerospace industry there and his dislike for manual labor in the pulp mills, he decided to become an engineer. Under the guidance of his mentors, Boyer pursued his Masters in metallurgical engineering at the University of Washington. Through the serendipity of a few layoffs at his initial jobs in industry, he landed at Boeing, enjoying a successful 30-year partnership with mentor and fellow TMS member, Jim Williams. Boyer is a legendary contributor to knowledge in the field, having authored the popular Materials Properties Handbook Titanium Alloys. He is a Fellow of TMS, ASM International, and Boeing and was named Puget Sound Industrial Engineer of the Year in 2019. He also received an Honorary Professorship at the University of Shanghai for Science and Technology from 2018-2020.

Readers are asked to bear in mind that they are reading a transcript of the spoken word, rather than written prose. The following transcript has been reviewed, edited, and approved by the narrator.

TABLE OF CONTENTS

00:23 Growing Up in Aberdeen, Washington – Family & Deciding To Be An Engineer

Adam Pilchak:

Hello, this is Adam Pilchak. I am currently the Director of Aerospace materials at Materials Resources, LLC. And, today I have the distinct pleasure of interviewing Rod Boyer for AIME's oral history project. The date is March 31st, 2022, and this is a second interview following up from another one we did December 9th, 2021. Rod Boyer is a longtime member of AIME and TMS and had many, many contributions to the field of titanium metallurgy and the aerospace industry. He finished his distinguished career as a consultant under his business, RBTi Consulting. Today we're going to talk a little bit about his experiences throughout his career and during his time growing up. Can you tell me about where you grew up?

Rodney Boyer:

I grew up in a city called Aberdeen in the state of Washington, a two-hour drive from Seattle. Well, I had one brother and a sister, and they were the youngest, and they're all gone. I worked at a pulp mill Monday through Friday, then I got three days off. Then the next week I worked swing shift, and then the next week I moved to graveyard shift. I didn't really appreciate that very well. So, that's when I knew I was going to be an engineer.

01:44 Learning To Be An Engineer – From Community College To The University of Washington

Rodney Boyer:

I worked for a year and a half after I got the degree at Grace Harbor Junior College. That's when I decided I don't want a nine to five job or eight hours every day. And, I finally got a chance to get into University of Washington. I got my Bachelor's in 1963 in metallurgical engineering.

Adam Pilchak:

What made you choose the University of Washington?

Rodney Boyer:

They had a good engineering school, and it was relatively close and not as expensive as some of the others. So, that's what took me there.

02:17 Metallurgical Memories and Influences

Adam Pilchak:

Were there any particular professors there that were very memorable to you? Anyone that influenced you in any particular way?

Rodney Boyer:

Probably my thesis advisor, Dr. Douglas Polonis. I remember on a blackboard; he could draw almost a perfect circle.

Adam Pilchak:

That's quite a feat.

Rodney Boyer:

I had a professor when I had a lab, I got put into trying to get single crystal zirconia. I took it through the cycle, and it got contaminated. And, I sarcastically said, “Geez, it looks like we rusted it.” And, I had a little thing about, maybe, an eighth of an inch thick, a little cross section of the circular rod that we were using to change the temperature from one end to the other. And, the professor, he saved a slice of that thing, and he had it on his desk for about 30 years. He came to an ASM meeting. I think I was talking at the end of the thing. He gave me that little piece that he had sitting on his desk for 30 years, and he even remembered what it was from; I was kind of amazed with that.

Adam Pilchak:

You shared the same advisor as Jim Williams. Any other memorable classmates from that time?

Rodney Boyer:

The only one I can remember is a guy who was in my high school class; he is the one who told me to take metallurgy. We had quite a few good students, but Jim was the best.

03:49 Into the Workforce – A Career Path Leading to Boeing

Adam Pilchak:

Out of grad school, did you go straight to Boeing or did you have any other jobs first?

Rodney Boyer:

I got an invitation to work from Makes for Rockets Totaling Rocket Motors. I started there in 1965, and apparently, they pissed off the Navy. They started into layoffs, and my understanding is it went from 20,000 to about 2,000 people in a couple of years. So, I got out of there.

I got a job down in California. And then, they had a layoff, and I'd only been there a couple months. And, their policy was, if you hadn't been there three months, you were automatically laid off. It just happened that I had an application in at Boeing. Just about the time that these guys laid me off, I got a telegram offer from Boeing. I had that offer, so I gave myself a week to look for a job. And, I took the offer and drove up to Seattle and went to Boeing.

04:51 The Boeing Years – Working With Jim Williams

Rodney Boyer:

Jim was really [the one who] got me into becoming useful. I worked with him in the research on titanium when I started the supersonic. And so, I became an electron microscope guy. Jim and I did a lot of two or three years on that.

And then, I became a metallurgical engineer after that program faded. I worked on failure analysis and met lab and electron microscopy.

05:22 The Boeing Years – Traveling the World As a Lead Engineer

Rodney Boyer:

The mid-seventies, when I started being the lead engineer, that opened up the door for me to do a lot of traveling, approve processes and approve new suppliers, approve castings, forgings, all that kind of stuff. I've been to every part of the world, except south America. But, I got trips to Australia and New Zealand, all over the U.S, all over Europe. I got to Moscow and St. Petersburg. Anyway, I've been all over the world, even in Africa.

05:57 The Boeing Years – Memorable Projects & Achievements

Adam Pilchak:

What were some of the most memorable programs for you that you worked on?

Rodney Boyer:

Well, I worked on the SST with Jim.

Adam Pilchak:

That's the supersonic transport?

Rodney Boyer:

Yeah. I got a lot of articles, but this is probably my biggest effort. I think it took about three or four years to get there.

Adam Pilchak:

Every titanium metallurgist on the planet appreciates that book right there, Rod, no doubt!

06:22 Talking About Titanium – Becoming the "Ti Guy"

Rodney Boyer:

When I became the titanium lead engineer, that just really set me off. I was already pretty familiar with titanium and had a fair amount of information about it. But, that was really the start of my career because, between Boeing and my consulting work, I was in titanium for probably about 50 years.

06:44 Talking About Titanium – Characteristics & Applications

Adam Pilchak:

Titanium, what's unique about it, and some of its interesting characteristics and applications?

Rodney Boyer:

Titanium is a unique material, but it's very expensive. And so, I'm constantly doing work there so we can reduce the expense, because it's an excellent weight saving component. In addition, a low modulus has advantages for springs, and it's an excellent material for aerospace, chemical, petrochemical, biomedical architecture, and special niche stuff.

In aerospace, the primary thing they're competing against is aluminum and steel. You have to have a really good process to replace aluminum because aluminum's got a weight advantage. Against steel. titanium has an advantage of about 40% in density, but it, again, is expensive to work with. So that's where most of the work is done is developing alloys processing which enable us to get there.

07:48 Talking About Titanium – Rationale For Use

Adam Pilchak:

So, given that titanium is so expensive, you must need good rationale for its use. You mentioned certainly weight savings over steels and the low modulus to help with springs. Are there any other reasons one might consider using titanium in aerospace applications?

Rodney Boyer:

Temperature, you can go a lot higher in temperature with titanium than you can aluminum. With steel, you are fighting the fact that the steel is lower than the titanium. And, that's why we have to develop better alloys or processing means to get the higher strength so that you can make the gain and improve the life of the alloy.

Steel and aluminum have pretty good corrosion problems, and titanium is excellent. But, we've got to develop ways to now tie them together, so we can take care of that weight advantage.
Composite's compatibility is another big factor; more composites are going into aircraft. And, titanium is compatible with the composites, much more so than the aluminum. Sometimes you just use a joint or joining it against aluminum or steel against composites. If they can do it with titanium or aluminum, it's probably the cheapest way to go.

You've got the lower modulus, so that means you can go longer time in service and reduce weight.
And, we use a lot of titanium in springs.

With stainless steel, you can bury that in the ocean, and it will eventually, after a number of years, even the stainless-steel pits, whereas the titanium does not. You just have to be careful about making sure that you haven't got abrasion going on or something someplace which will reduce or eliminate the oxide and corrosion proceeds.

With operating temperature, titanium is obviously better than the aluminum. It's not as good in aerospace applications, [it's just] a standard alloy. You can't use it for a very high strength because the strength will just be reduced by the heat. But, we've developed higher temperature alloys with additional modifications so that the oxide can compete with the steels up to about generally 1100, but they're alloys which go to 1200. Some we use for a short time at high temperatures: titanium, 15 vanadium, 3 aluminum, 3 chrome.

I didn't mention the space limitations. We had part on a 757 where the wing design is set. And then, they come to build a part of the wing, and they find that the aluminum that they're trying to use isn't strong enough. And, this higher strength, low modulus allows the titanium to be used in those kinds of conditions. And, they survive quite well.

10:56 Talking About Titanium – Use in Landing Gear

Adam Pilchak:

It's been said that you're responsible for putting more titanium into the air than anyone else. One of the largest structures, one of the most important ones that you've done is introduced titanium landing gear, gigantic structures, where they're very difficult to produce and process. What kind of challenges did you encounter when trying to field titanium landing gear?

Rodney Boyer:

One of my prime development of the Ti-10V-2Fe-3Al alloy, which can be heat treated to 180 Ksi yield strength it's melting difficulties, et cetera, with that strength level, you can't tolerate very much anything, or it'll generate a crack. But, we had a few years of experience with a Spitfire VII, and its smaller parts.

And, the landing gear guy for the 777 actually selected it. He saw the properties. And, people were really anxious about it at first because of melting problems, defects, this kind of thing, because at that high strength, they're going to be big factors. We really jumped in, and you can see that all those named things are titanium 10-2-3 parts. And, they show how we get that weight savings.

Adam Pilchak:

And, which alloy was that, Rod, that you said that you developed that reduced that weight?

Rodney Boyer:

Ten, two, three.

12:19 Talking About Titanium – Use in the SR-71

Adam Pilchak:

Did you work on the SR-71 program?

Rodney Boyer:

No, that’s data that I've gotten from Lockheed. We needed an alloy which could fly at high altitude for a spy mission. SR-71 was the first supersonic titanium of note. And, it's also resulted in the fastest and highest spying attributes. This is because they developed a beta alloy, what we call a beta alloy, which has got a higher beta content, so that you can strengthen it. So, when titanium was used on the airframe and all the wing and skin structure, that airplane flies at 3.5 Mach at about 85,000 feet. And, it's painted with radar absorbing black paint. I've talked to SR-71 pilots, and they say, they go over Russia, they fire a rocket, and they just turn on the fuel and outrun the thing. So, they work very well.

13:22 Talking About Titanium – Contributions to the Aerospace Industry

Adam Pilchak:

There's probably a small number of people on the planet that have taken an alloy from the development

phase to putting it on an airplane. You did that multiple times?

Rodney Boyer:

Yes.
Adam Pilchak:

That's incredible!

Rodney Boyer:

And, I'm not the smartest guy in the world, but I seem to have a knack for picking things at work. That was my bubble, to be able to develop new materials [during the] seventies, eighties, and, probably, at least the early nineties. I think I did more for the titanium industry and the aerospace industry than anybody. I developed several new alloys for strength, for super plastic forming, for formability, castings. I developed more products than anybody I've seen yet.

Adam Pilchak:

Is there one accomplishment, you know, one thing that you have flying that you're like, ah, that's the one, you know, that's the most important one I did.

Rodney Boyer:

Yeah, I took beta 3 and made springs out of it. And that's with the fact that you got half the modulus, and that means you need half the coils. So, now you can actually make them cheaper than steel. Ever since I developed that, we've used titanium springs and landing gears.

14:40 Talking About Titanium – Technical Society Memberships and Recognitions

Adam Pilchak:

So, Rod, were you a member of any technical societies?
Rodney Boyer:

Oh, god, yes. I was always in ASM and TMS and AIME. I was definitely involved, and I was probably most heavily involved with ASM.

Adam Pilchak:

On some of the committees, maybe?

Rodney Boyer:

I was always also on the board for ASM.

Adam Pilchak:

And, I think you were a member of the TMS titanium committee for a long time, if I'm not mistaken?

Rodney Boyer:

Yeah, that's true, probably 30 years.

Adam Pilchak:

When you stopped being the liaison to the international titanium association -- so, you were a really long-standing liaison between those two organizations -- and, since then, we've struggled to keep somebody in that for more than a year. That was a great service you did back then.

Rodney Boyer:

Well, I appreciate it.

Adam Pilchak:

One award on the list here seems like a little bit of an oddball. So, I'm going to ask about that one first. You've had this wonderful career putting titanium all over aircraft, but in 1994 you received the ASTM Russ Ogden award for contributions to reactive and refractory metals. So, I'm curious about your work with the reactive and refractory metals.

Rodney Boyer:

No, I don't even remember much about that.

Adam Pilchak:

[Laugh] Alright.

Rodney Boyer:

I mean, there's only one system that is really good. And, that's titanium.

Adam Pilchak:

Yes, sir.