

CERAMIC TECH CHAT

Episode 44

Title – “Focusing on the fundamentals: Rajendra Bordia”

INTRO

De Guire: “I’m Eileen De Guire, and this is Ceramic Tech Chat.

The core of any professional society is its members. As such, when making decisions about the society’s future, it is important for leadership to talk with the people they’re representing.”

Bordia: “The approach that I’ve taken is that I have been listening mostly and talk to a fairly broad spectrum of our membership, to staff members, from people who are on the principal committees, the Division leadership, and trying to sort of listen to what the needs are that people believe we should be focusing on. And there are some good ideas that have come from those discussions, and now we have to sort of develop a plan that can sort of address some of the important needs.”

De Guire: “That’s Rajendra Bordia, this year’s president of The American Ceramic Society. Raj is the George J. Bishop, III Chair Professor of Ceramics and Materials Engineering at Clemson University in South Carolina. His research focuses on how processing conditions affect the final microstructure and properties of ceramics, with a specific focus on thermal processing methods.

In today’s episode, Raj will share his somewhat unplanned pathway from mechanical into ceramic engineering, including working several years in industry before transitioning to academia, and what he hopes to achieve during his year as president.”

(music)

SECTION 1

De Guire: “Can you tell us a little bit about your education and how you discovered ceramic engineering?”

Bordia: “That was an interesting story. Some of it planned, some of it not planned, as these things happen in life. But I was relatively good in mathematics, and in general, the trajectory in India was that if you’re good in mathematics, you ended up in engineering. So that’s what I ended up doing. I went to the Indian Institute of Technology in Kanpur. It was transformative for me in many, many ways. There I studied mechanical engineering, and it was wonderful. Mechanical engineering was a great education, very broad paced, very solid in terms of the fundamentals of engineering sciences. And there I had a few

courses on materials. They were sort of more on the mechanical aspects of materials. And those intrigued me; I liked them quite a bit.

I had a wonderful mentor there, professor Gupta. He really was a terrific mentor who guided me through the studies, helped me determine what kind of things I wanted to do. And I ended up actually working with him for an extended period of time and got to know him quite well. As a result of it, I sort of got a first-hand experience of what it means to be a faculty member. What are the kind of things they do, what are the consequences of their activities, particularly in terms of mentoring students, transforming their lives, etc. And also it turns out that my elder brother was also a faculty member. Once I sort of started thinking about that as a professional career, I also paid more attention to what my brother was also doing and kind of things, impacts that he had on people's lives. So it was during, actually, during those years and halfway through my undergraduate education that I had decided that that is going to be the profession for me."

De Guire: "Academics?"

Bordia: "Academics. Faculty positions, yeah."

De Guire: "Okay. So, that transition from mechanical engineering to ceramic engineering, what was it about ceramic engineering that pulled you in?"

Bordia: "So that transition was not as planned. So when I decided that I wanted to be a faculty member, I then went to my mentors and asked them, 'What do I need to do to be a professor?' And they advised me that I needed to get a Ph.D., and they advised me that I should get one from a U.S. institution. They guided me through the application processes, helped me decide on the universities to apply, etc. And again, since my undergraduate was in mechanical, I was applying to only mechanical engineering Ph.D. programs.

So, I applied to them, and at Cornell University, you have to write a personal statement, and there I wrote that I was interested in the mechanical properties of materials. And at Cornell University, they transferred my application from the mechanical engineering to the materials science and engineering, saying that that particular topic was more of an interest to that department rather than mechanical engineering. And then Cornell Materials Science and Engineering offered me a research assistantship. My mentors told me that it was a great university to go to, which again I had not heard of at that point. So I ended up in Cornell University in the materials science and engineering department. And that was again a very good experience.

I spent a fair amount of time in my first two years, I took lot of extra classes to learn about materials science and engineering. I also sort of early on was able to talk to the professors there, and professor Rishi Raj, who was a faculty member there, offered me a position in his research group. He was sort of at that point working both on metals and ceramics, and it was not quite clear as to which topic I was going to work on, but he sort of looked at what were the kind of things that I have interest in, or what I have been educated in and

what my expertise was, and he offered me this project on essentially processing of ceramics. So that was my sort of first entry into ceramics.

And then, of course, I had learned quite a bit more about ceramics at Cornell. I had other teachers who taught me. In addition to Rishi Raj, there was professor David Kohlstedt and professor Barry Carter, from whom I also learned about ceramics. And I got actually, as I went into it, I got more and more intrigued and interested in it. The wide spectrum of applications in the ceramics I used was of interest. And, you know, it was completely brand-new topic for me. I mean, I knew about metals and polymers, but this was brand new. So that also gave me a really good motivation to focus on it and study it. And as I studied it more and more, I became more interested.”

De Guire: “So, you mentioned that as early as your undergraduate years, you were interested in being a professor. But you didn’t start off as a professor. You started off at DuPont. Can you tell us a little bit about that experience, and then how that eventually turned into becoming a professor.”

Bordia: “Right. Yeah, this was, again, partly an accident, but once again turned out to be very good. So, after I finish my Ph.D., and this was during the time then when people went to a faculty position directly after Ph.D. There was still not, in our field at least, there was not this culture of postdocs. So, I had to apply to several universities for a faculty position. And as a backup, I also applied to some companies in the research and development divisions. And I just didn’t quite understand that the time constants for the two are very different. So I did get offers from some industries very quickly after application and the interviews and all that stuff, and the faculty decisions were taking a lot longer. So, although I’d been shortlisted at a few places, the industrial companies from which I got offers, they were forcing me to make a decision. They were sort of saying that you need to decide, kind of thing.

I chose DuPont because there was one person that I had lot of respect for, and that person was trying to recruit me to DuPont, and I wanted to have the opportunity to work with him. This is Dr. George W. Scherer, another member of our Society. And it was really George who was the main draw for me to work at DuPont. And, as I said, the faculty committees had not made their decisions, so I had to make a choice, and I ended up working at DuPont in the Center of Research and Development. And I think again it turned out to be a phenomenal move for me because those six years that I was at DuPont were, from a research point of view, highly productive.

In DuPont in those days, they had these large research centers where essentially you had access to all the facilities that you could imagine. You didn’t have to write proposals. You had the top-notch scientists that you would work with. So, as a result of it, it was very, very productive because the only thing you had to worry about is to come up with topics that you want to work on, find the right people and do the work, kind of things. So no other bureaucratic or administrative duties. So that turned out to be very productive. I had a very significant and important-for-my-career collaboration with George Scherer primarily but also other people at DuPont.

And also DuPont actually gave me the critical element again of my professional career, which was to identify relevant problems. I was in the Center of Research and Development at DuPont, and at that time, the culture of that department was that you do good science and you publish. However, you always had to keep in mind as to what businesses might be interested in that research. Talk to them, discuss with them as to what are the kind of problems that are of interest to them, and then from those problems draw some fundamental topics that you could work on.

That was the approach at DuPont, and that was really quite good for me as a starting off my independent professional career. So, I used to say at that time that, you know, and even now, that you could just walk across the street in our Center of Research and Development, go to meet colleagues who are working on the product side, have just one afternoon of conversation, and then you would come up with ideas that you could work on for the next two years.

So, it was just phenomenal there. So, that is what, as I said again, turned out to be very good move for me.”

De Guire: “Yeah. And the culture you described there, it sounds like it would be ideal for really learning how to be creative as a researcher and have the freedom to ask questions and develop out your ideas without the pressure of will it get funding.”

Bordia: “Exactly.”

De Guire: “You know, those two go hand in hand, but the skills don’t develop evenly sometimes.”

Bordia: “Right. Yeah, and DuPont gave me the chance and opportunity to develop those skills, and yeah, exactly.”

De Guire: “That’s wonderful. Yeah, great story.”

(music)

SECTION 2

De Guire: “So then you eventually did become a professor and a mentor. So, what is your approach to being a professor and a mentor? What are your goals when you work with students?”

Bordia: “The goals and approach are different when you are interacting with undergraduate students versus researchers who are working with you. And so, classroom versus personal education are different. In the classroom, I think what I try to do is to help the students realize why they are on this journey. Because many times actually we find that the students are not very sure as to why they have to study all the fundamentals and the basics,

etc., etc. So, this idea of being able to connect what they have learned in maybe even their high school or in their early colleges to the kind of things that they are going to be working on and they'll be interested in and for which we are training them in their junior and senior years. I find that to be quite important, so that they see this connection between what they have learned, what they are learning, and how it will be used later on.

So in the classes that I teach, I try to make those connections for them. Most of these students change their jobs multiple times, so it's good for them to have a fundamental base on which they can build these different opportunities and careers."

De Guire: "Right, and keep going back to and drawing from."

Bordia: "Yeah, exactly. So, that's my approach in the classroom. Now, also, we have several undergraduate students who work with us. So, that becomes a different category because the way I think of researchers as, essentially, the goal that eventually they will become knowledge creators. The undergraduate students in the classroom, for example, are mostly in the domain of knowledge consumers. At that level, you need to train them how to properly consume the knowledge in terms of what is its relevance, what is its authenticity, how to figure out what is the real versus nonreal kind of thing. So, those are all important topics that they need to understand well as undergraduate students.

As researchers, they need to start developing the skills to develop new knowledge. And that starts all the way from undergraduate researchers. So their focus is a lot more on things like how to do the experiments, how to analyze the results, what does it mean. Later on in their career, we also try to sort of involve them in the decision making of what kind of experiments to run, what additional domains or topics they need to understand and learn about to bring back to their research."

De Guire: "I remember when I was at that time of my life, I remember very clearly working with an older young person to design experiments and just really starting to understand for the first time how difficult it is to design an experiment where you isolate the variable, so you test the thing you really think you're testing. Making that transition from a lab class where it's all designed for you, you don't even realize you've isolated the variable, but then when you have to do it, then this older student would say, 'Well, you know, what are you really testing there? You're testing five things. You're not gonna learn anything.' It was really a valuable lesson.

So, what specific studies are you currently working on? What is your research program?"

Bordia: "So, actually, I started off my graduate research on looking at some fundamental problems in the processing of ceramics. And throughout my career, actually, I've stayed in that field. So, I've stayed in the broad area of trying to understand processing of ceramics in an effort to control the microstructure, which then controls the properties, of course."

De Guire: "So when you say 'processing,' are you thinking more of thermal processing or forming or kind of all of it?"

Bordia: “The focus really is on thermal processing. So, we of course use the green state processing to make the components or samples that we then do the thermal processing on. But our focus of the research in the group is mostly on thermal processing. Although, more recently, there’s starting to be a little bit more attention to things like additive manufacturing or green state processing.”

De Guire: “Okay. So, things like sintering and transport mechanisms and such.”

Bordia: “Right.”

De Guire: “That’s a very rich field to work in. The questions just keep coming, and they’re so important.”

Bordia: “Yeah.”

De Guire: “So your research group is actually quite large. Can you tell us a little bit about how you set priorities and guide students through the completion of their degrees?”

Bordia: “Almost always when I have a new student join my group, within the first six months, they will come and ask me, ‘How long will it take for me to get my Ph.D.?’ And I give them only this one answer. I tell them that as a Ph.D. student, I am training you to be my colleague. So, in your journey, I need to see two transitions, two milestones.

And the first one is that right now, I have given you a problem to work on. So it is my problem that you are working on. The first transition that I want to see is when you take ownership of this problem. When it becomes your problem, that’s the first transition. That’s when they start to come up with their own ideas about what they want to do, which are different than what I’ve told them or in addition to what I’ve told them. So, I think that’s a very important transition in their journey.

And the second one I tell them is that since I’m training you to be my colleague, the second milestone is when you teach me something that I don’t know. At that point, you have become my colleague.”

De Guire: “There you go, yeah.”

Bordia: “So, as I said, it’s a journey. In some cases it takes longer, in some cases it’s faster. Each student works on their own pace on these kinds of things. But that’s what I want to see. And for each one of them, the mentoring style is also different because in some cases the students want to be more closely guided, at least in the early stages, initial stages. In other cases, they’re more open to sort of making mistakes and, you know, coming back to me and that kind of stuff.”

De Guire: “I think it’s a very wise approach because the transition from student to nonstudent requires you to really flip your approach to how you live your day. From being told what

to do and this is what comes next to making that transition of like, 'Okay, I know this much, now what do I think we should do?' I think that's a very wise approach. And whether students go into academia or industry, you have to be able to do that."

Bordia: "Yeah."

De Guire: "Wonderful."

(music)

BREAK

De Guire: "Do you want to support the next generation of ceramic and glass materials scientists? ACerS offers a number of ways for both members and nonmembers to support the Society, through volunteer opportunities, various professional networks, and the Ceramic and Glass Industry Foundation. Learn more about these opportunities at www.ceramics.org/get-involved."

SECTION 3

De Guire: "You are, as of now, the president of The American Ceramic Society. Let's hear a little bit first about when did you first learn about The American Ceramic Society and how has it impacted your career."

Bordia: "Well, it has been a very, very positive impact and long association. I gave my first public technical talk at a Basic Science Division meeting. I think it was early '80s, either 1982 or '83."

De Guire: "Okay."

Bordia: "And since then I've been associated with the Society. I think soon thereafter I became a member of it. And I've been mostly, in the early years, I was mostly associated with the Basic Science Division. Later I also joined the Engineering Ceramics Division and the Electronics Division. When I was at DuPont, several of the problems that I was working on were of interest to either our structural ceramics program or the electronic ceramics program. So, at DuPont, I joined these other two Divisions also in addition to Basic Science Division. But by and large my sort of professional home has been Basic Science Division. I used to regularly go to their meetings, the Division meetings, as well as to our Annual Meetings. And then I started slowly, things like programming for the Division. I used to organize symposia for them. We used to have actually a precursor of the PacRim meeting. It was the Pacific Coast meeting."

De Guire: "Yes, correct."

Bordia: "So, once I moved to the University of Washington in Seattle, I helped organize that meeting. So that was sort of my next level of engagement at the Society level, kind of a

thing. And, you know, over the years, the Division and the Society has provided me quite a few wonderful professional growth opportunities, including awards, for example, and also an ability to serve in a voluntary capacity in different committees. For quite some time in the Panel of Fellows, for example. I was also in the Publications Committee for a fair amount of time. Those were two of my main committee-level engagements. And, as I said, rose through the ranks of the Basic Science Division leadership. And then sort of about 10 to 12 years ago, I was also on the Board for the first time.”

De Guire: “Ah, okay, I was wondering about that.”

Bordia: “So, yeah. It has been a long engagement and mostly in programming in the early stages but later on in these committees that I mentioned.”

De Guire: “Okay. So, I’d like to talk a little bit about your plans for your presidential year. Would you mind sharing with our audience what your goals are for this year?”

Bordia: “You know, we should recognize and should all be very proud that it’s a 125-year-old Society. So, obviously it has done things well to be relevant for such a long time and evolving, changing climate, changing scenarios, changing priorities. And that’s the dynamism of the Society, is that it is able to sort of change itself, modulate itself while remaining true to its core mission. It is able to sort of capture on opportunities that are presented and move forward, kind of thing.

So, for any professional Society, the primary purpose is to serve the needs of its members, right? And I think that’s what we need to continue to focus on. For a technical professional society like ours, the needs include, for example, technical content, either in terms of publications or meetings. The other need that the Society serves is professional development opportunities, including, for example, the ability to network, find collaborators, be part of sort of some important decisions of the Society in terms of being a member of committees, contributing to their working. And also having opportunities to be nominated for and selected for awards. So, these are all very important professional development aspects that the Society serves.

In addition to that, we have different categories of members. We have student members, young professionals, corporate members, international members. And in many cases, there’s a lot of overlap in the needs, but there also are individual needs for each one of these groups, which are separate from the others. So, we need to make sure that we are aware of these individual needs and we meet them also at the highest levels.

Similarly, actually, there are some communities that have been underrepresented in our field, and their needs might be slightly different than the needs of the others. So we should also be aware of that and provide those.

So, that is sort of the most important part, is just to serve the professional needs of our members. And I’ll be sort of very consciously focusing on them and see how we can enhance that part of our Society. Because being successful in satisfactorily serving the

needs of our members, all of our members, has an effect on another priority, which is that we need to grow our membership. Because for the financial health of the Society, the number of members, the size of the Society, is quite important. And in order for us to grow the membership, we have to have a value proposition, which satisfy these needs. So, I think the two go hand in hand. If the membership feels that the Society is meeting their needs at the highest level, then they will be our ambassadors to become new members. You know, the junior colleagues in their organizations, their students, post-docs, etc., they will recommend the Society to them.

So, those would be the two sort of overarching priorities, is sort of enhance the services to all of our members and to increase the membership in our Society.

Now, we will be working on some specific focal areas this year. One of them is going to be the development of a new strategic plan, which will sort of guide our actions, be like a roadmap for the next three, four years, starting from 2025. And second thing is that we are also coming up to the end of our contract with Wiley on the publications side. So, we'll be spending fair amount of time looking at that also and see where we go with our journal publications in the future. So, these are sort of two specific things for this particular year.

And, you know, all through my interactions with the Society at all levels, from the Division level to the committees and now on the Board and being in this role of president-elect, for example, I've come to appreciate more and more the high-quality professional staff that we have. So, one important priority will be to absolutely make sure that I support them at the highest level."

De Guire: "Well, thank you, Raj."

Bordia: "You're welcome."

De Guire: "Speaking on behalf of the staff, I can say that we really enjoy working with the members and helping you do your work for the Society."

Bordia: "Great partnership right there."

De Guire: "Well, it sounds like it's going to be a very busy year for you."

Bordia: "And I'm looking forward to that."

De Guire: "So, in the event that you have any free time, what kinds of things do you like to do in your free time?"

Bordia: "So, I definitely enjoy traveling. For me, actually, traveling makes me feel like a child again."

De Guire: "Really!"

Bordia: “So, it sort of brings out the curiosity that sometimes gets dulled down when you are in the same place or same location. But traveling does bring it out. You know, just act of sort of going up to somebody and asking for directions. As adults we don’t do that very much, you do it more as a child. Or sort of just being amazed at something that you’ve seen for the first time. Things like that. So I think traveling brings out that. So that’s the reason I think I like traveling. And actually it turns out that this particular profession and the Society has given me quite a few opportunities for that, to meet new people and travel. So, that’s probably my most enjoyable hobby.”

De Guire: “Okay.”

(music)

CONCLUSION

De Guire: “While planning for the future is important, listening to others and adapting to new opportunities can lead to the most fulfilling and fruitful careers.

I’m Eileen De Guire, and this is Ceramic Tech Chat.”

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“Visit our website at ceramics.org for this episode’s show notes and to learn more about Rajendra Bordia and getting involved with the Society. Ceramic Tech Chat is produced by Lisa McDonald and copyrighted by The American Ceramic Society.

Until next time, I’m Eileen De Guire, and thank you for joining us.”