

Q: How did you get in the MRI field? What was your educational background?

Dwight Nishimura: My background is in electrical engineering. My work was actually originally in x-ray imaging. I got my PhD in Electrical Engineering at Stanford at the end of 1983 and my advisor was Al Macovski. I had done work on signal processing methods for x-ray imaging, mainly digital subtraction angiography, which was really big at the time. And then around that time Al Macovski was transitioning his research group over to MRI. In fact, in '82-'83 he spent a year in London learning about MRI. When he returned from London, I was finishing up and he asked me to stay on as a research associate. He was excited because he was going to get a research MRI system from GE, and it was going to be housed in electrical engineering. This would be a first, to have a scanner like this available, especially in 1983. I was flattered and I elected to stay. So I've been doing work in medical imaging since the early 1980s, first in x-ray, but then in MRI for about the last 40 years.

I don't remember having any long-term career plans at that time. I never anticipated that I would stay in medical imaging or MRI, but I just thought it was interesting back then. For someone with an EE background, it turns out MRI was a great fit and so there was no turning back for me. I've never really thought about leaving the field.

What I do now basically is a lot of pulse sequence development and image reconstruction. In terms of applications, it has been mainly focused on cardiovascular applications.

Q: Then is it accurate to say that you never planned to go into MR research from the beginning, but it just sort-of happened that way?

Dwight Nishimura: Well, you know, it kind of fell into our laps. There was a lot of work in, of course, CT and digital x-ray at that time was pretty nascent. And then, MRI was kind of this mysterious thing. But I would later go on to teach a class in Fourier transforms, and so MRI was just almost ideally suited for someone with an electrical engineering background—over and above electromagnetism, all the signal processing, and the Fourier-based analysis of MRI. We really had the right background for that.

Q: Which of your scientific contributions are you best known for?

Dwight Nishimura: I think we were one of the earliest groups working in magnetic resonance angiography. We developed a lot of the early techniques that were used. I think one of the major things I contributed was developing a selective tagging approach for doing angiography. This time-of-flight based paradigm gets used now for perfusion imaging more so than for angiography, but we were, very early on, working on that.

We were also very interested in—and this goes back to our days in x-ray imaging—non-invasive coronary imaging. We were one of the first groups to come up with an MR-based approach to image the coronary arteries completely non-invasively. At the time, it hadn't been done before. We weren't even sure if we would be able to see the coronary arteries. So that was actually, I think, a pretty major step—when we at least demonstrated the ability to do that.

Q: When was your first SMRM/SMRI/ISMRM Annual Meeting? What is your memory of it?

Dwight Nishimura: I go back to the days when it was called the SMRM, before the “I”. My first meeting was when I was doing my dissertation towards the end of 1983. It was held in the Grand Ballroom of the Fairmont Hotel in San Francisco, on Nob Hill. I went back to look at the program—it was interesting—it was mainly in that one room. The first two days, Monday and Tuesday, it was held in that ballroom. There were no parallel sessions. On Wednesday and Thursday, and I think Friday as well, they had parallel sessions across the street at the Mark Hopkins Hotel. But there were only two parallel sessions. I would imagine there were maybe a couple-hundred people in attendance.

For me, coming from x-ray, I was still trying to learn a lot of things. There were so many things I didn't understand. There weren't really any educational programs. Everything was so new, so in some sense, the main meeting was, for a lot of people, an educational program. I think there was one noon-time tutorial on physical principles or something, but it was not nearly the kind of educational programs that we have now.

The second annual SMRM meeting was held in San Francisco in August so it was convenient to attend. Again, I was wrapping up my dissertation so I was trying to ramp up my understanding of MRI. It certainly made sense for me to attend the SMRM meeting and try to get a feel for the field at that time. I became a Member shortly thereafter. I've been to nearly all of the SMRM / ISMRM meetings ever since.

Q: Back then,

- **were there many trainees (or they were all mostly senior researchers)?**

Dwight Nishimura: My impression is that there were not that many trainees back then. I certainly don't remember there being that many. It did seem that a good fraction of the speakers were more senior researchers, mainly from the US, UK, maybe Japan and Canada. Remember, there were only a few MRI scanners around the world. There were spectroscopy people there too, who may not have been doing whole-body scanning. But my definite impression was that there were more senior researchers in attendance.

- **how easy/hard was it to get involved in SMRI/SMRM/ISMRM activities as a trainee?**

Dwight Nishimura: Back in the 1980s, at least for SMRM activities, I did not get the impression that trainees were involved. It certainly didn't seem like that was an option. At that time there was another society as well: SMRI. I think maybe it was a little different for that society. SMRI certainly seemed to be a little more open to it or at least more willing to let younger people get more involved. I attended both the SMRM and the SMRI meetings, but I was a little more involved with the SMRI.

Q: What were the key differences between the SMRM and SMRI?

Dwight Nishimura: I attended both for a number of years in the '80s. The SMRM meeting was held in late summer. The SMRI was held in winter, around February, so you got to attend both meetings. SMRI was much smaller and had a more clinical focus, whereas SMRM had certainly a clinical component, but also a major scientific component, like, for example, spectroscopy. SMRI was smaller, so for someone young, you felt like you could stand out more at SMRI. Maybe SMRM had more "meat", but there were good things at both meetings. Because the field was moving so fast—I mean, that still hasn't changed—but certainly it was moving fast back then, and so even those six months mattered.

Q: Do you feel that the pace of new ground-breaking advancements in MR has changed, or is it still the same?

Dwight Nishimura: It's an interesting question because there was certainly a period of time when I felt like, whenever I went to the meeting, there were one or two things that really stood out. I'd think, "wow, that's really ground-breaking" or "that really creates a whole new area". For example, when the first fMRI study was shown, that really stood out. With some of the angiography work, there were usually one or two presentations that really stood out; for example, when 2D time-of-flight was presented. There's still a lot of ground-breaking work that's going on. That's reflected by the fact that there are so many abstracts that continue to be contributed every year. MR feels much broader now, and it's harder to keep track of everything that goes on. So it's probably a little different, but I think it remains very vibrant even to this day. MR is really one of the most amazing areas. It's been around for a while, but it continues to be a very rich area.

Q: What do you think about the hybrid virtual format of recent years?

Dwight Nishimura: There are pros and cons. Logistically, the virtual format is easier. It's cheaper, there's no travel, and you can play back certain talks at different speeds, which is nice.

But obviously, it is harder to network and the random access of things clearly is not the same. I give a lot of credit to the whole society and all the people who've had to deal with the hiccups and the complications, while trying to satisfy so many people. It's been a no-win situation, so the society has done well with what it's been able to do. Overall, I think in-person is preferable. It takes a lot more discipline, when you're attending remotely, to experience the meeting.

Q: What is some of the work that you've presented at the meetings that you particularly remember?

Dwight Nishimura: I chuckle because there're different ways I can go with this one. Perhaps the most memorable was at the 1988 SMRM meeting in San Francisco when we presented our initial idea on how to do minimally invasive coronary imaging. As I mentioned, at that time, no one had even demonstrated it. We'd been wanting to do it with x-ray imaging using intravenous contrast injections, but it looked like with MRI you could also do it completely non-invasively. So we had this selective tagging approach that we called SIR (selective inversion recovery) and presented a version of this idea.

SIR did quite well with the carotids and I presented that in the first part of my talk. And then I talked about adapting the method for coronary imaging, and I showed this image. Well, you really had to squint and it looked like noise, but there was some faint signal that looked like a coronary artery. I wasn't claiming it to be a definitive result. I was just trying to show, "this is what we're trying to do". Back then, it was not uncommon to show preliminary speculative results. You wouldn't show those types of results today. So I thought I gave an innocent talk, but apparently, and to my surprise and consternation, it turned out to be rather controversial. I didn't hear all the discussion directly, but I was told there was criticism that my presentation was too preliminary. I was young at the time and I had just joined the Stanford faculty. In retrospect, the criticism was understandable but hearing about this criticism was quite discouraging.

Anyway, it turned out that a year or two later we actually got coronary results that were a lot more convincing using the same method, and the key was to do it in a breath hold so that you control for respiratory-based heart motion. Those results got attention, and helped lead to a whole new effort on trying to do coronary imaging with MR. I can laugh now when I think back on that SMRM, but it was a rough moment.

Q: What were the challenges 30 years ago VS now that the field evolved?

Dwight Nishimura: The instrumentation was a big limitation. Gradients were not that strong nor that fast or accurate. Also, there were no receiver coil arrays for scan acceleration. So getting a

pulse sequence to work well was definitely more challenging, especially because of gradient eddy currents. If you were trying to do anything fancy with gradients—for example, phase contrast—it wouldn't work very well because of eddy currents. You couldn't image with very short TRs. Also 3D scanning—if done at all—was pretty rudimentary. The other thing is that some of the basic tools—like RF pulse design and image reconstruction—still needed quite a bit of attention. And of course, computing resources were modest by today's standards. So you could come up with an idea, but getting it implemented was trickier because you had to deal with more imperfections such as gradient-related issues, and possible scan-time issues.

Q: How has the ISMRM impacted your career?

Dwight Nishimura: I was elected to the board of the SMRI. Back in the early 1990s, I think it was harder to get onto the board of the SMRM—you had to be a little more senior. So, for someone like me who was still an assistant professor at the time, I was thrilled to have a chance to serve on the SMRI board.

I was on the board when the merger took place, and that resulted in a large combined board with both SMRI and SMRM board members. At that time, companies wanted to cut back on their contributions to the societies, so there was real financial stress. That fact made the merger necessary. There was a lot of turmoil. But I was happy to have had a chance to serve on the board to see how the society operated, and I had a chance to be on some committees. Of course, many of the people that I met have been lifelong colleagues and really good friends. The opportunities that were given to me then because I was on the board meant a lot to me.

I think the society is really good now at getting younger people more involved earlier. I think that's terrific. I didn't get to serve on the AMPC until relatively late—about five years ago. Jim Pipe asked me if I would like to join. I said “Maybe I'm too old.” I looked at the composition of the committee, and I thought, “These are much younger people than I am.” But he said “no, we like to have it balanced”. That was not always the case. I think in the early days there were more senior people on the AMPC. So when I joined the AMPC and saw the positive effect of having the younger generation there as well, I thought that was fantastic.

Q: You used the word “turmoil”, but what was involved in merging the SMRI and SMRM together?

Dwight Nishimura: My understanding is that there were financial pressures from the companies. There were other people who were right in the middle of that merger and actually

worked out whatever had to be worked out between SMRM and SMRI —merging the offices and things like that.

The sponsor companies said, “We cannot support both societies” and so it made sense for that merger to occur. But, despite this, there was still a lot of financial pressure on the society.

And then, there was a “big” question, “What should the merger name be?” It was controversial and for a few years, we adopted a generic name: SMR (Society of Magnetic Resonance). Everyone had an opinion. I remember Bob Balaban, who was President of the merged society at that time, brought forth the brilliant idea of naming the society ISMRM, adding “International” to highlight the global nature of the society, and that whole controversy went away. We had bigger issues to worry about.

Q: In 2018, you received the ISMRM Gold Medal. It was awarded for angiography, fast imaging pulse sequences, image reconstruction, and MR education. What does this achievement mean to you?

Dwight Nishimura: It was very moving when the President, Dan Sodickson, called me to notify me of the award. The whole ceremony, the whole event was just wonderful. It’s almost cliché but it has such a profound effect. It really makes you think about who you’re grateful for.

You realize that there are a whole slew of people who have helped you immensely in your career—my wife, family, friends, all the colleagues, all the students that I have had the privilege of working with, my mentor Al Macovski. I thought of many people I hadn’t thought of in a while—one random example, James MacFall. Very early on, I spent a week at GE and he generously took time out of his schedule to have me tag along. I learned a lot from him.

So I had many different thoughts go through my mind but the dominant thought was gratitude.

Q: Do you have any advice you can give to young MRI researchers on how to make new ground-breaking research?

Dwight Nishimura: There are a number of ways that improve your chances, or position yourself better for doing significant research. Some of these things I think are probably well known, so if people already know them, let me just reinforce them.

1. Work on important problems.

Related to this is having a good clinical collaborator, if you’re a technical person. That is very important because they keep you honest, and they keep you working on things that are really going to be useful. They have the insight on what would be clinically useful.

2. Challenge conventional wisdoms.

A prime example of that is sub-Nyquist sampling. That seems to be preposterous, right, with compressed sense and things like that. But if you're open to saying, "why does it have to be done that way?" especially with MRI because there's so much flexibility, that can often lead to interesting things.

There's so many ways you can go about doing this, and one way is to have open-ended brainstorming sessions, where it's okay to say anything that would be considered "dumb". Because, often, that could trigger something else that leads to something else, so it helps you break free and maybe see new possibilities. Some of the things I've done, looking back, were really quite dumb. I had some weird conjectures and I got really excited about them, but they often turned out to be just wrong. But those were nonetheless interesting experiences to go through.

3. Embrace the uncertainty.

Students don't like it when I say this. They get a little uneasy, but serendipity happens a lot more often than you might imagine. Sometimes you need to embrace, and focus on the uncertainty and the confusion. I'll give an example: this has happened a number of times. If you encounter an annoying but mysterious artefact in the image, there may be a tendency to say, "I wish it weren't there", or "I just needed this image for something else, but it has this weird artefact, which I didn't expect". Well, if you investigate that artifact, there may actually be something very interesting going on and it could lead to a deeper understanding. Some of these artefacts might be subtle but, these days, such subtle artefacts could be really important.