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&
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ORAL HISTORY

COMPUTERWORLD HONORS PROGRAM
INTERNATIONAL ARCHIVES

Transcript of a Video History Interview with
John McDonald & Don Stredney
Co-Founders, McDonald & Stredney

Recipients of the 1996 Cray Research Leadership Award for Breakthrough Science

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DSM: Dr. McDonald, why don't you tell us a little bit about your background and how you decided to enter the practice of medicine?

John McDonald: Well, many people decide upon entering the practice of medicine by looking at and visiting doctors and their office and what have you, and others decide basically late in their graduate careers after college. My father always said that I told him from the time I was about five or six years old that I was going to be a doctor. Why? I have no idea, to tell you the truth. Perhaps it was once after the doctor came to my home. At that time, doctors often made home visits. I was quite impressed to see this man dressed in a dark suit and carrying a black leather bag. And I was quite fascinated with all the instruments and various vials of medication he had in it. At that age it captured my imagination. So maybe that was why I thought I wanted to be a doctor. For some strange reason, I held onto that decision from that time on. Whenever anyone asked me what was I going to do, I said I was going to be a physician.

DSM: You grew up in Iowa?

JM: I grew up in Iowa, which is right smack in the middle of the United States. It is a wonderful state with a very, very high index of education. I grew up very near Iowa City, Iowa where the university is, and I always looked upon it as the place for higher education, which is what I ended up doing subsequently.

I went to high school in Oskaloosa, Iowa, a small city of only some 15,000 people. It's an Indian name. Many of the cities in Iowa were named after Indians and Indian tribes. I decided that I wanted to look into going to the University of Iowa after seeing many of the football games on weekends and being quite excited about Big 10 football in high school. I was fortunate enough to be in Little All-American in football when I was in high school, so I had the opportunity to look at five or so colleges around the country. Some of them were in the southwest, and some were in the northwest part of the country. But I decided not to travel out of state, so I went only some sixty to eighty miles to Iowa City and interviewed there. I took a couple tests for what was called then the Niochinic Scholarship. Niochinic was a leader in football, basketball, track and baseball when he was in college in the early 40s. He got straight B+s when he was in school and also led in all those sports. He subsequently died in World War II and they established a scholarship for him, and they gave five a year. So I was fortunate enough to be one of the five in the state of Iowa who received that scholarship. It was wonderful because it paid for all of the tuition, all of your basic requirements – housing included, as long as you participated in one sport. I participated in football and track, and then subsequently, track only.

I entered medical school after my liberal arts studies were finished. I also decided to stay at the University of Iowa for the same reason. I felt comfortable there, and I didn't want to go anywhere else.

DSM: So you were interested in high school in science and things scientific? Clearly you were an athlete as well as a student. Which was more important to you growing up?

JM: I think probably what was more important to me always was the fascination of science. Sports were very important because they were the things that you did to keep active, and to keep in touch with your peers and in shape and what have you. But it was always science that fascinated me, and I had some really excellent teachers in high school who stimulated that. Many often reflect back to one or more teachers who stimulated and helped sort of get our interest whetted in regard to various aspects. I remember very specifically one of my science teachers was that type of person. He was a person who had something to say about everything. He had a very positive attitude and he was someone liked by everyone in school. I think he had a lot to do with my decision in regard to staying in science and doing well in science, also.

DSM: So he really inspired you and led you, did you have science clubs or things that you were in with him?

JM: Yes, we had science clubs and all sorts of different clubs. I was very fortunate because our school was really quite diversified. Those of us who were in athletics even participated in the thespian clubs, so we were in plays even. So it was a school where you were expected to really do lots of things, not just one thing. So from that standpoint, it was really a wonderful place to grow up and to learn all about life.

DSM: Do you come from a large family, do you have any siblings?

JM: No, I came from a small family, and I was really raised by my grandparents. I'm very close to my father but not my mother, and I had one brother only who was nearly ten years older than I was, so it was not a close relationship. In many ways, it was like growing up on my own.

DSM: So when you went to the university, you knew that you wanted to stay in the sciences. Did you pursue a path where you never questioned that, or was there a time where you didn't know if that was the right path, or did you just stick with your dream throughout the whole time?

JM: I pretty much stuck with it the whole time. I was interested in completing pre-med. I went into a pre-med program when I entered college and I passed several of the requirements at the University of Iowa when I went there. I never really deviated from my interest in science, and I took all the prerequisites, organic chemistry and chemistry, and of course all the zoology courses and everything as early on as I could.

DSM: What about in the summers, did you begin experimenting with working in hospitals and things like that over the summer?

JM: No not really, but I had interesting summer jobs. I worked as a lab assistant in a laboratory setting in my hometown. The summer job was the laboratory and that enabled me to interact with some PhDs who were in science, and that really was fascinating for me and a good learning experience, so I enjoyed that quite a bit.

Also, one of my co-colleagues in that particular job was a person who had already been admitted to medical school. So it was really fun to be able to work in that environment. I talked to him a little bit about what to expect in the field. You hear lots of stories about medical school, like half the people flunking out the first year and that you wouldn't make it through anatomy class. It was fun to have someone that you could talk to about those sorts of things.

DSM: When you entered medical school and going through those killer first set of courses, did you find it difficult to get started there, or had you prepared mentally for what was lying ahead?

JM: I was not prepared for the amount of studying that was necessary, that's for sure. But I'm not sure anyone really is. I remember in one of our early courses, our Histology professor asking us to look to the left, and the right, and one of those two people wouldn't be there by the end of the semester. So there were all sorts of threatening things like that going on. It was the type of thing that you were expected to assimilate just really an enormous amount of information in a short time. You were expected to memorize it and to be able to recall it, specifically, at targeted times for tests, etcetera, etcetera.

Then you were supposed be able to put it in all in the back of your mind and forget it, basically. So that type of thing I was used to doing in some of my pre-medicine courses, such as chemistry. You know, memorizing long chains of different types of formulas and being able to recall those from memory and be able to find solutions to problems that were given on tests and what have you. But I think more than anything else, it was the intensity of the exams and the frequency and all the data we had to assimilate that was the tough thing.

DSM: Looking back do you think that was an important part of your training or something that was more of a weeding out mechanism? Now that you're a doctor and you look back at those early days, were they good preparation?

JM: I think they were good preparation. Medical preparation has changed drastically since the time I was in medical school. I think it hasn't changed so much from the foundation stones. There's still the basic pharmacology, physiology, anatomy and what have you knowledge that one has to have to be able to understand medicine, and to be able to understand and to work with patients and to treat patients, and that was wonderful. Especially I recall the introduction to the clinical sciences, which was in our third and fourth year. That was a time during which I blossomed, because that's when we started interacting with patients. And at that time, patients were often on wards that contained twenty and thirty people that were only separated by just little curtains. So I remember very vividly having some of the great people in medicine at the University of Iowa take me with them to talk to patients, show me how they took histories, and I listened to them early in the morning, late in the evening, doing this. It was a really wonderful way to learn. It was a very personable way to learn. I'm not so sure that we do such a good job with that these days, because things are rush, rush, and I'm not sure that we take the time that we did early on.

DSM: How did you being deciding those areas that you want to specialize in, in your medical training?

JM: It wasn't really until the last year of medical school. As you know, in the last year of medical school you have to decide upon an internship and that's a year that you practice and do lots of different types of things, or you sort of center on one aspect of what you're going to do. I think it was only in the fall of my last year in medical school that I began to think, what would I be happiest doing? It turned out that what I chose was especially where the residents seemed to be, the sharpest, the best, and the friendliest, and seemed to have the best time and enjoy what they were doing.

I was always quite amazed that I picked the specialty of OBGYN first because it seemed that that group of people seemed really happy in what they were doing. Whereas many of the other residents were complaining, were not happy, had big furrows on their foreheads, they were worried, they were upset. So I picked the specialty of OBGYN.

I can remember that my mentor in anesthesiology was always very upset about that. He was the chairman at the time, and he told me that it was a great loss to anesthesiology. After finishing my OBGYN residency, I decided to do an anesthesiology residency. He had then moved to San Francisco at the University of California, taking over as chairman there, so he was quite pleased to hear from me that I was going to go into the specialty of anesthesiology. I did that primarily because my chairman of OBGYN talked me into the fact that patients needed help in this area, and that this was an area of the practice specially that really was not well monitored and was not really well supported. So I decided upon that as a duel specialty.

DSM: So you looked ahead to a career that would involve primarily research as well as clinical work. Was that your hope that you would stay in that area as you have, or did you not have that dream at the time?

JM: Not at the time. At the time, I was really thinking in terms of a completing a residency and really practicing. I didn't really even conceive of the fact that I was going to stay in academic medicine, or in a teaching institute for the most part. I really ended up deciding only after being in a second residency, because by that time, it's been five years, six if you count the internship, of really preparing, and by that time, I was being told that I was only one of two people in the entire country who had that type of credentials, that I really should think about academic medicine. Furthermore, it was very obvious, because I was really wooed by four national institutions around the country wanting me to come there and teach after I finished my residency. The list included Harvard and the University of Miami, the University of Washington, University of Southern California, just to name a few medical centers. So I had more than many offers to when I finished. So it became obvious to me that perhaps I really ought to think about that type of thing. That maybe this was something I should consider.

DSM: So how did you make your decision as to what you were going to do?

JM: I made a decision that I wanted to stay in academics and teaching because I felt that by doing this, I could really touch the lives of thousands of young men and women over a period of years. I could teach them how to take good care of patients, and how to hold a high standard with regard to patients, rather than treating individual patients, which may also end up a few thousand patients in my entire lifetime. But if you would say you were going to touch the lives of several thousand doctors and then they in turn would touch the lives of several thousand patients, that was quite a multiplying factor. So it became evident to me that that's the path I should follow, plus there was an obvious need for it. Because there was an obvious need for it, I felt it was very logical that I should do that. So I did do that, and it's worked out very nicely because not only was there a big need for it, but I found a tremendous amount of satisfaction in teaching young people and working with young people in medicine over the years.

DSM: I wanted to ask was whether during medical school you began to have a fascination with technology, or what your relation to technical tools and things was, as you were a student and a researcher.

JM: Let me tell you that fascinating story. I don't know if you're too young to remember the Bay of Pigs incident, and the mental trauma at that period of time, but if you do, you remember that many of us were glued to the TV tube in and around that time. It was just about a month before that time, that I had decided to build my first stereo set. I had decided to do this in medical school. You can imagine by that time I must have been doing pretty well and I had a lot of my studying behind me, and this was in fact in my last year of medical school. I was feeling pretty comfortable that I was going to graduate, that was going to become a doctor. And at that time I became fascinated by music and by sounds. I had played in the band and the orchestra when I was in high school. I always had friends who were musicians. I always enjoyed the opera at the University of Iowa, and I really liked music. So around that time, stereo came out and it was quite a thing to put a speaker on your left side and right side and run the sound of a train across you, so you can hear that.

I built my first stereo receiver myself. I bought a kit, and it was called a heath kit. I put it together and soldered everything together during the time of the Bay of Pigs. And it was around that time that I began to realize I was fascinated by technology, because I loved putting together all those little resistors and capacitors in, cutting the right length and soldering them and making sure it works.

Then the most amazing thing is that after doing that for somewhat thirty-forty hours, and sometimes five, six days in a row with only eating, and going to see a few patients in between, and keeping my medical studies up, and watching TV late into the evening about the Bay of Pigs crisis, I plugged it in, and lo and behold it didn't blow up, and actually music came over and it was in stereo. It really was amazing to me, and I scratched my head and said to myself, technology is really where it's at.

I think that was the time that I really decided I loved technology. So from that time on, I have wanted to and been involved in some of the most "envelope-pushing" type of technology that there has been. So I ended up getting not only a stereo set but also a tweeter and a woofer and all sorts of different things. Then when the first really good combination TV and stereos came out, I had one of those.

Most recently in my house, this past summer, I put together the first what's called AC3 sound, which is a new type of sound that even the theaters don't have currently. It's basically a five-track sound and you hear it with all these eight speakers. Each time a sound occurs, a chip sends that sound to that individual speaker, and it's all coded on the laserdisc. It's really quite fascinating. I have that in the living room now. There are only four laserdisc movies on AC3 sound so far, but I just love keeping up with technology, and I love the technological aspect of it.

So to answer your question, I really made the realization at that time, and since then, I've felt that that's where it's at. As early as 1978, when I first came to Columbus, Ohio, I became interested in computers. At that time, as you remember, computers were really only the IBM machine, with a simple floppy disk that was very, very, slow and so that's where I started. Every year I kept up with a new computer practically, and I moved up to a higher platform. As you know, by today we have not only computers, but we have access to the Internet, World Wide Web, and we have abilities to interface with colleagues in other parts of the world.

When I went to Poland seven years ago, and gave lectures there, prior to the time that the Iron Curtain fell, they were most fascinated with us in the United States, in our computers. One of the things they wanted to know from us was, what was the situation in computers, and was it here to stay, and what was our prediction? So technology to me has always been fascinating. I've always wondered how it could be utilized in a fashion which would help in teaching. I think that was one of the things I always wanted to do. So very early on, we did some recordings of patients. I wanted to have the students hear what the sound of their voice was like, because it was a special thing to really hear a patient tell how much of a problem she had, rather than just reading it in a cleaner medium. It meant much because it was a captured part of humanity that you couldn't have otherwise.

And then way beyond that of course comes the camera and the recording of the actual feelings and the facial expressions and what have you, and that was the next thing I added. So now we also do actual recordings of patients when they're talking about pain that they have and different kinds of things. I did a recording this morning of a lady who drove four hours from Michigan, to see me for a problem with pain she had. We recorded about a three-minute clip of her anguish that she had, seeing twelve different doctors, none of them being able to diagnose her pain, and all of them telling her that her pain was in her head. She broke down and cried right on camera because she had such an emotional feeling about that type of thing. So I've always been fascinated by technology and putting it together and sort of trying to figure out how it would help and improve teaching.

DSM: This is really the critical area we need to talk about, going up to the virtual reality experiences of recent times. But when you said you came here in '78, and you came with a specialty, an unusual background of OBGYN and anesthesiology and an interest in technology, so you were an innovator in maybe three different areas, and that's an unusual combination. What was the response from your colleagues in your environment to you being innovative and using particular information technology as part of what you were going to do here?

JM: Well I think some of it was rather fascination and curiosity more than anything else. Perhaps they were thinking that this is a strange type of person – who wants to do these types of things? I remember when I first came, one of the things I asked the Dean was that I had to have different types of walkie-talkies that could be carried and be placed on the belt so we could communicate around the operating room. I researched and found that RCA had these, and that by putting a loop of wire in the ceilings, we could make an antenna that would broadcast. We could pick up all the sounds of people, and we could actually use it like a walkie-talkie. It was amazing that it really worked.

It was a good method of communication. I think it helped considerably in regard to getting my colleagues, physicians, into rooms quickly when there were problems. We have situations in anesthesiology that come up as a surprise and as an emergency. Often times we need more manpower in certain areas, and so this really enabled us to mobilize people quicker, much as radiotelephones are used in the battlefield to mobilize people to make movements in different areas. It worked very well, and for the most part, people did see that there was a great utility in using technology that way. Now it's become quite a natural thing.

In fact, in most operating rooms where they don't have good communications and sometimes twenty-thirty operating rooms, it's like a catacomb and you can get lost quite easily and people can get lost as they move into those areas. So you really need something you can carry on your waist to be able to communicate quickly, so it's used quite frequently.

DSM: How did you start using the personal computer? You said that you'd began getting those early on, why did you think that this was going to be useful to you? Was it just a toy or did you see a real series of applications that you wanted to apply it to?

JM: That's a good question. I think as early as 1983 and it was when I was in Switzerland where we were having a meeting at that time. My sons, who were at that time around 14, 15, 16 years old, were with me and I took them to the windows of the downtown Swiss cities. I saw no computers in any of the windows, and I wanted them to see that. I wanted them to understand that there was a big difference from where they came from. At that time they were growing up in Los Angeles where every storefront would have computers, and they saw none there, and I said, 'Do you see and do you understand the difference between this?' I said, 'Whether you realize this or not, within the next ten to twenty years, this will make the difference in the escalation of our becoming, the most powerful nation from the power of information standpoint. That is where it will happen, not from bombs dropping from planes, and not from tanks shooting huge cannon fire, but it will happen from the information standpoint.' And sure enough, the amazing fall of the Iron Curtain and the use of computers to make sure that that revolution was successful really occurred, and really the excitement and the history of tearing down the Berlin Wall. It all came as a result of information, the use of computers, people accessing and seeing that people did live other ways, that there was another life in another part of the world. The world was able to be strong to the point that people could look across barriers and see other people who are happy in other lands, doing other things. I think that really made a big difference.

I think that from the standpoint of computer use in education, that was always one of my early fascinations. I started using it early on as a utilitarian type of thing, just to tie it into word process, and for the longest time that's what I used it for. Subsequently I began to see it could be used as a teaching interface, and when I began to do some of my first slide talks on the computer, was when I really began to realize how potent it was.

It used to be that when I would want to give a talk to a group of physicians in another part of the country, I would go to various books, read all the new information that was available in the past six months to a year, cut out the different figures that I thought were important, then call people and ask if I could have permission to use those figures. I would take pictures of it and I actually developed the film myself in my house, take pictures on a stand, and then run to the plane with those kodaliths actually hanging inside my coat with a clip. They would be wet still, starting to dry. On the plane I would cut them and put them in slides and then color them with colored pens on the way to Chicago or New York or San Francisco to give a talk. When I first had my computer and I took it along, I realized that I could actually change things and make slides on the computer on the way there. I began to realize that this is it. Now you don't have to worry about anything wet. You don't have to worry about having scissors with you, or colored pens, or anything else. So I began to realize that this was a very, very potent medium indeed.

This past month I gave a talk in Orlando to three different physicians and it was a multi-media presentation with video clips and a CD that I had burnt myself at home with 715 MB of video clips and what have you. And I was able to bring this in with words moving from the right, sounds coming from the left, and video clips coming up from the bottom, and people loved the presentation. They said to me later that this was one of the best presentations they'd ever been to, they felt like they were part of it because they felt sort of enveloped in the whole thing. They enjoyed the lecture tremendously. And that's when I really realized that that this is what it's all about. That's where we have to take medicine today from the standpoint of teaching. No longer do people want to sit and hear a talking head basically and some slides on a screen that don't move or talk, and hear someone drone on about what knowledge there is when you can get that knowledge on the Internet. You can get that knowledge by going online to the National Library of Medicine and reading some of the new information there. They want to hear something that is part entertainment and part knowledge, and what have you woven together in a multimedia presentation. And this is where we're trying to take our department in that regard. This is where I think medical schools will continue to go in the future. This is where I think it'll help to capture the imagination of young people, will keep them excited and interested about medicine.

DSM: As you look back over the time from when you came here and got your first PC, what would you say the steps that you have seen become available that you've taken to move the group here forward toward this vision that you've just outlined?

JM: Oh boy, I don't think I can even remember all of them. There were several. We came from basically a little, tiny disk that had only like 70-100 megs on it, and a machine that was about 75 pounds, and was about three by four feet on desktop, something you wouldn't ever carry around with you, to a what was called a transportable computer, which I first used and I took to Europe with me in 1981. It was about a 47 pound piece of equipment, and I still remember it fit under the seat. I took it all the way to Europe with me, and much to my amazement, I couldn't find any electrical units to hook it into because I had forgotten to bring the converters with me and I didn't want to take a chance on ruining it. So I just carried along this weight until I got to England I could use it.

From there we went from the transportable to the portable computers. Then we moved from the various buses on up to the chips that we use today, and the excitement of the software, including Microsoft Windows. Do you remember when Microsoft Windows first came out? I had one of the very first copies of that. I was on and went to the Comdex meeting in Las Vegas in 1981 or 82, and actually bought it at the Comdex meeting. We've come so far from the standpoint of both hardware and software. It's been an amazing upward technological spiral that has opened a portal for this virtual reality platform where we are now. Without that, and without that sort of foundational stone building, we would not have been where we are today. It would not even be possible to be even thinking in terms of virtual imagery and the use of that in framing young people's minds and getting people to think in terms of learning in medicine. But I think the future for this is going to be absolutely amazing and extremely exciting; because virtually every part of medicine that we teach can be rendered into a virtual reality platform. Not necessarily with the same ease as some, but the virtual epidural platform for example that we start with, is not a very simple platform when you think about it, because it engenders both the visualization part of the format and it also engenders the force feedback, or feel aspect, which is invisible.

DSM: Why don't you go back and give the background in terms of what had happened to anesthesiology and what you saw an opportunity was with respect to this virtual simulation. Can you also talk about how you embarked on this particular experiment, and then just carry the story on. What was the critical problem that you saw in anesthesiology?

JM: Well the exciting part of the story begins when I was in my residency in Seattle at the University of Washington with Dr. John J. Bonica, who was really the first man of pain, the father of pain in the United States, the whole world, really. He wrote the first textbooks on pain and really is responsible for setting the tempo that we're at today in regard to the human element and the understanding of suffering of people. He was a wonderful technician and he knew how to do an epidural better than practically anyone else in the country. That's partly why I went there, to learn from him. I really wanted to learn, just as Michelangelo perhaps went to wherever he went to learn how to chisel. I wanted to learn how to put needles into people the right way.

I can still remember today my feeling, sitting down with him, knowing he was the taskmaster and knowing he wanted things to be perfect. We sat there, with a patient's back to me, and with this person being a little overweight and me not being able to feel the anatomical points very well and having him say, 'Okay, go ahead.' I was on my own and had great trepidation about how I would do this. So right away he would take my hand and say 'No, not there, this way,' and so you'd move it this way. All the while this gentleman I'm working on who could hear what was going on he finally said to me, 'Is this your first one, young doctor?' And so I said to him, 'Well no it's not exactly my first one.' And he said, 'Well good luck for both of us.' I remember feeling beads of sweat on my forehead because it made me very nervous to think this poor gentleman thinks I don't know what I'm doing. I do really sort of know what I'm doing but I'm learning Dr. Bonica's method. So I remember him taking my hand, shoving it this way, that way, and I would touch a very sensitive part of the bone in the patient, and he would jump a little bit and be very nervous.

So I remembered that experience when I started teaching young people, and I didn't want them to have that. I would approach them differently. I would say to them, "You're very fortunate today. You have a nice young lady sitting behind you, and she is so good with this." And I would be winking at her. "And she's going to go right through this, and do a great job of putting this needle into your back in the right place. It's got to go four and a half inches deep into your back, and it's got to be right near where the aorta is, and other blood vessels in your spine. But we're not going to touch any of those areas. We're just going to place this needle perfectly, within a millimeter or two of where the target zone is." So that would give this person some feeling of confidence.

Then they'd go ahead and I'd gently take their hand and move it this way and that way. I actually carried a bony model with me and I would show what they were doing on the model as they were doing it. I would show them where the needle was going and so that would help.

I've taught perhaps some thousand residents since 1970, from the West coast to the Midwest here about how to do epidurals. Each time as I did that I kept thinking over and over in my mind and retracing how it could be done better. I finally came to the conclusion that it can't really be done much better on a human model, because a human model is so frail.

It's a one-time shot and because you really want to do a good job. You don't want to hurt the patient. If you make a mistake and go past something, I can't say to the resident, "Now bring it back and redo it," because you just don't do that type of thing on people.

When I first started working with Don Stredney, we started talking about different ideas, and he would mention this, and suddenly it started clicking in my mind, what about if we do this. Yes I think we can do this. So the whole thing began to grow and I thought, not only can we build a model, but we can build a model that has never been built before, from the standpoint of repetitions, from the standpoint of forced feedback, from the standpoint of visuals that we have now on computer simulations. The most exciting thing is that we had this wonderful supercomputer that was capable of crosscutting hundreds of MRI sections of backs that we had and then putting together a detailed modeling of that, so you could actually see the needle penetration of different tissue areas. When I became aware of that, everything clicked and I said, "Now we've got the pieces we can put together." So that's really the way it all sort of developed. It took us almost three years to put this together, to get all the MRIs, to get all the supercomputer work done that we needed to do and to put the actual mechanics and the hardware together, to put this model together and make it work. But once we did we were really very pleased with it.

The model you'll see today is the one that is probably two, three, four models down the road from the one that we initially used. We have used this with my residents, my faculty, and we intend to use it in three other medical centers around the country and publish our paper on virtual reality in the use of the epidural this next year. We think it's a very exciting platform, and as I've mentioned, we think it's a platform which will beget many more exciting virtual image techniques in medicine in the future.

DSM: Let's talk about how the opportunity to do this came about. You've talked about the philosophical mindset of the solution that you saw. But from a more practical, institutional situation, how did you learn what was going on with supercomputers, and were there any other players that were involved? What was the opportunity that presented itself in allowing you to build this partnership?

JM: Right, that came about in a rather serendipitous meeting with Don Stredney, who happened to be a person who was an artist and who also had a background in anatomy. We just really met for a luncheon one day and talked about our mutual interest to see if there might be something that we could do together. That's really how it happened. Shortly after that, he introduced me to Charlie Bender who was the primary leader and developer of our supercomputer center as it exists today.

Dr. Bender has a great mind for really pushing technology forward, for making it exciting, and getting people excited about the use of it. He made sure that we understood that the entire supercomputer center was ours to explore and to find out what we could use and put together to bring this all to fruition. Around that time, we decided we needed a little more hardware than we actually had, and we were fortunate enough to get a grant to purchase a $75,000 piece of equipment to do much of our development, from the standpoint of programming development early on in the project. So we were very fortunate at that point, too.

But it was really, I think rather a fortunate meeting that Don and I had originally. It was one of those things where the two of us were not really sure which direction we were going to be going from the standpoint of our teaching, and were talking about what we really were wanting to do. We both came with a few similarities, and then we both came with different ideas in regard to what impact this could have on teaching. And I think Don and I both excited each other from the standpoint of talking about what could be possible and what we could do. The more we talked the more excited we got. So it really became a relationship where both of us enjoyed each other and thought this is the direction the research has got to go.

DSM: You say this has gone over a period of three years, so you started back in 1993 or sometime around there?

JM: Approximately early 1993, I think it was the summer of 1993.

DSM: And you built a partnership with him, and how does that develop in terms of a working relationship over the last three years?

JM: It has developed very well. We really have an open relationship. We get together as often as we can, but we have very few structured meetings. It's not a situation where we say, ok every Monday at 8 o'clock we're going to meet, or every Friday at 4pm we're going to meet. We meet when we can and when there's a need, both of us are there. When one asks the other to participate in something, the other who's being asked always gives. There's not been a problem in our working relationship. It's been a very relaxed and a very open type of relationship. It's not been one that has been structured or specified or anything like that.

DSM: As you developed this application, have there been a lot of difficult problems to solve, has it flowed for you pretty easily, or how would you describe going from the time that you sat around and had this interesting idea to now the point that you're ready to get published about this and sharing it with other institutions?

JM: There have been many problems, but one of the most pleasant things about working with Don and Charlie Bender and the other people I've interacted with is, they're always…we can fix this, we can do this, it can be done. The attitude is always there's a solution for every problem, and maybe we don't have it right now but we'll have it tomorrow. That's sort of been all of our attitudes. We can fix anything. I don't care what the problem is, let's think about it and let's try to approach it from this direction. If it's not working, that direction isn't working, we'll go from another direction, and that's what works out.

I remember very early on we were trying to figure out how we were going to get force feedback in regard to placing the needle through skin resistances. We knew that all resistances were different, the skin, the subcutaneous tissue, the muscle and then finally the ligament, which is the end point that you go through. Every one of those had a resistance that would look different if you graphed it. So how would we get that to the fingertips? We thought first we would put a glove on, and the glove actually has sensors in it, and it will push against the skin and that will give it. We finally abandoned that when we came to the realization that the easiest way to do it is to build a vortex, or an open area, where we can put a needle into and have the computer generate the resistances there, identical to the resistances that are measured on a machine. That's exactly what we ended up doing. That was a wonderful step and a point of demarcation or a major solution if you will. So I think all during the development of the ideas behind this, we've gone from can this work, to it will work in almost every instance. That's been part of the enjoyment of developing this whole virtual reality platform for epidurals.

What you're seeing right now on the silicone graphics CRT is really a mock-up of a patient's back, which is drawn really from the standpoint of needle placement in the back. As the needle is moved, you can see penetration of the needle through the skin, subcutaneous tissues. Also, we can see a cross-section in the back of a proximate needle placement. If you look at the red line, you can actually see the red line entering and penetrating the subcutaneous tissues, back, the muscles, the ligament, and finally the epidermal space. A longitudinal section is right above that, a cross-section piece, and then above that you see just a picture of the back to orient the student, or whoever is doing the epidural, to the approximate location anatomically where we are on the body.

So this is an important part of the virtual lumbar epidural platform, but it is only the visual portion of it. Much of the important part of the epidural platform is in the force feedback, or the real feedback if you will, of the fingers and the placement of the hands on the needle and the syringe, as the particular procedure's done.

Now you're seeing the virtual part of the lumbar epidural. This is really the black box, which is in part and parcel the heart of the whole lumbar epidural virtual technique as we developed it here at Ohio State University. It consists really of a syringe placed on the back of the needle, and then a tracking device, such as one would use when placing a needle into the back of a patient. The beauty of this type of arrangement is that the individual doing the procedure can place his hands and get into a position that's comfortable to him, such as he would be in actually doing an epidural on a real live patient. He can then move forward with the guidance of the instructor, starting to feel the resistance of the skin, then right below the skin, the subcutaneous tissue, and right below the subcutaneous tissue the muscle layers, and right below the muscles layers the ligament, which I'm in at this point. Then you can see a release through the ligament right at that point. Then the epidural space is entered, and there is the final release through the epidural space after you penetrate the ligament. So in the mind of the individual who's doing it, the needle is actually penetrating through that tough tissue which is called the ligament flava, and when he gets the release, he or she knows that they're in the right space.

All of these resistances that we've incorporated as we've talked about, are really the important, real feel feedbacks that you get from using this technique. The beauty is you can do it over and over and over again. You can do a hundred of these types of blocks in the virtual medium, and then you can go to the real live patient with the instructor, sit down, and then do it the first time. Hopefully the first time you do it on a learning curve that is really already been honed on the virtual platform, and you can do it the first time perfectly.

DSM: Well Don I wanted to start by telling us a little about your upbringing, and what led you to come to college here at Ohio State.

DS: I was born in Cleveland, Ohio, and then raised mostly in Ashtabula up on the lake. I always had an interest in art and science, and when I went into high school and started to think about going on to college, my father was the one that took me to an art show of a medical illustrator and said, "You really ought to consider this as a possible career." I was really impressed with the work that this individual was doing. So I continued to pursue science courses, and was taking early admissions courses at the Kent State University branch in my hometown in sciences. I also went on art scholarships during the summer, and decided then to enter the medical administration program here at Ohio State in 1975.

DSM: Is that right, when you went into college, you already knew you wanted to go into that direction?

DS: Yes, I applied specifically to Ohio State for the medical administration program here.

DSM: Were there teachers in high school that were formative in your upbringing?

DS: Oh yes, absolutely. One specifically was Nancy Hunt. She was fantastic. She imparted in me that the purpose of a teacher is to make themselves obsolete to a student, and part of that was a real thirst for knowledge, and to learn how to teach yourself, specifically within the arts. So we explored lots of different media, and I think that gives me a strength in terms of my ability to be flexible and adapt a new medium, which was very important in going on to computers.

DSM: What sciences interested you when you were young and in high school?

DS: Biology, specifically. I would not forget my freshman year. We had to make a three-dimensional model of the DNA, and really enjoyed that. Eventually I was accelerated into early admissions programs, and was taking science courses my senior year at the university, mostly in biology and looking at DNA at that level was always very fascinating to me. Then I always liked drawing some of the things that helped me understand the information, so I used those two together to help me understand the representation of these kinds of things.

DSM: Tell us about the medical illustration program. I take it not many schools teach that specifically, so it seems like an unusual type of idea.

DS: Sure. The four years of undergraduate training at Ohio State Medical Administration were really broken into two pre-professional years, and then two professional years. The pre-professional years you took science courses on campus, physiology, anatomy, which was usually done say on cats, and then referred back to the human. There were also lots of art courses. I took sculpture, drawing, painting classes, things like that. During your sophomore year you would then submit a final portfolio for review, and acceptance into the program. The year I was accepted they had six slots for the students, and they accepted four of us into the program. Then once upon entering the professional years, you have very rigorous drawing and painting of different types of medium classes; photography, and going into the OR and shooting and filming. Then we were required to take graduate level classes in the medical sciences, specifically anatomy classes, and histology, and embryology.

DSM: So there was a well-rounded scientific side as illustration side. At the time, and they accepted four of us into the program. Then once upon entering the professional years, you have very rigorous drawing and painting of different types of medium classes; photography, going into the OR and shooting and filming, and then you also had to take, we were required to take graduate level classes in the medical sciences, specifically anatomy classes and histology and embryology.

DSM: So there was a well-rounded scientific side as illustration side. You need to understand the science as well as the art.

DS: One of the things I should mention that was very influential, was we had an Oxberry animation stand in the lab. I always loved Saturday morning cartoons and Disney films and things like that, and was always concerned about how we were teaching the body, which was such an exciting dynamic structure, with static methods: X-rays, disarticulated skeletons and such. I was interested in pursuing traditional animation as a way of imparting information and as a medical illustrator.

At that time, we were required to have an internship, and I received an internship at the Center for Disease Control. Back then the National Medical Audiovisual Center was with them in Atlanta. It now since been consolidated in Bethesda. So I spent a summer down in Atlanta near Emory University, where I got to explore further the use of traditional animation in conveying medical information. That was a lot of work. It wasn't a production facility where you had lots of people to help you out.

The difficulty is, in many cartoon animations, there are simplicities imparted in the course of the characters, which you couldn't always do in a medical simulation. You have to push towards realism, and that made it extremely difficult when you had to provide 24 drawings per second to show something happening. But I pursued that by doing an undergraduate honors program through the medical administration program, and worked on a short film depicting the development of bone in the fetus, and how these things evolved histologically.

DSM: How important was computer training and your artistic training in this medical illustration? Was it mostly done with traditional tools or did you do quite a lot of computer work?

DS: No, actually I can lead off of the medical illustration history because a colleague of mine had received his MFA in painting under Chuck Csuri. And he saw my frustration with the traditional animation technique and the amount of work that it took, and he said, "There's this art professor that's using computers to make imagery. You really ought to talk to him." It just blew me away that you could make pictures synthetically with a computer.

I talked with Chuck Csuri and showed him my portfolio, and Chuck was very interested in my ideas to use the technology to represent the human body, because at that time, people were doing a lot with just working on algorithms to create more realistic synthetic imagery. There were a lot of things that were more readily able to be described mathematically, such as Euclidean solids that are done in cad cam machinery and architecture. So this was an area that Chuck was very happy to see someone try to pursue. So I decided at that point I wanted to continue on in graduate school.

Also, as a undergraduate, I had illustrated a lab manual in anatomy class, and I was asked to teach the class and help around the anatomy lab; which really pushed me even further to work in this area. Working with cadavers is very difficult for many people. I didn't see any of this as a replacement for cadavers, but certainly something to augment that type of research, where it might be difficult for people to be involved with the remains of passed individuals. That's why I entered graduate school, and eventually I begged Chuck Csuri to get me out of the anatomy labs.

Eventually I was put on to a National Science Foundation project that was involved in complex images and synthesis of complex computer modeling. At first it was very frustrating for me. I remember very vividly staying very late at night in the lab. I was very frustrated, and Chuck was in the lab at the time, and he came up to me and said, 'Are you still working in any traditional media at home?' I said, 'No I don't have time. I'm trying to learn this computer system.' He said, 'You really need to, because we need to make the computers bend a little bit more towards what people do. Also you lose a sense of accomplishment after awhile because it takes so damned long to get anything done on the computer, and you need to get back to your traditional media.'

That really planted a seed in my mind, which I think is part of my philosophy today, is that we need to make computers understand more of what we do, and not the other way around. I think that's very important in my interaction with clinicians. They're very busy people. They have lots of work to do. Very few people work much harder than clinicians do, and they don't have time to become a computer scientist to learn how to use a computer. However, the computer can have an incredible impact into their work and help facilitate their work very well.

DSM: What were the first computers you used?

DS: The computing equipment that I started on was an old PDP1145 made by Digital. It was a calligraphic display factor line, and we had a run length encoding system that allowed us to store about eleven seconds of animation, very simple animation.

The damn thing would crash all the time, and I would have to go over and toggle the computer and reboot it and everything. It's amazing now, the amount of power that you have on a desktop computer. It exceeds multiple machines that we had back then.

DSM: Did you work on Macintosh, PCs, things of that sort?

DS: No back then it was mostly mainframes. We were using VAX11780s, Digital VAX11730s as well. Eventually when I went into the production area with Csuri, there was an introduction of early Sun Microsystems, which were desktop workstations. I worked on those for several years and then eventually on Silicon Graphics machines. That's pretty much the transition through.

DSM: You might want to talk a little bit about having gotten your degree in medical illustration. What did you envision as a career, and can you tell us about your first job at Cranston/ Csuri?

DS: During my internship, you learn a lot about where the rubber meets the road. Our internship was between our junior and senior year, and sometimes what internships show us is we don't want to do what we're supposed to be doing with our college degree, and I realized I did not just want to be a traditional medical illustrator. I was very interested in some of the multimedia AV things that were going on, but hearing about Chuck Csuri I really wanted to go on to graduate school.

A lot of medical illustration was textbook illustration, which was something I didn't want to do. I wanted to pursue the dynamic medium, a way to show how the body worked as well. As a graduate student teaching anatomy here at the Ohio State University Medical School, I noticed that there were individuals who were very adept at understanding three-dimensional information. A lot of these were the other medical administration students, who were taking engineering graphics courses where you learn how to do section drawings and perspective and cutaways, things like that. But many of the students were what I call three-dimensionally illiterate. They had a very difficult time understanding what was anterior, and what was posterior, what was lateral, and what was medial. And if they couldn't orient themselves to the structures, it was almost impossible then for them to identify structures.

This really made me want even more to go into an area that would help depict the information in a way that would make it a little more exciting, and would help facilitate those people to understand. I wanted to help them orient quicker to the information, so that the media wasn't a stumbling block. Also I wanted to pursue the idea of dynamically showing or understanding what a joint does as well as demonstrating what a joint does and some other things, and of course with the explosion of biology and, to start elucidating what was happening at the cell membrane.

For instance, we talked about anatomy being difficult for some individuals. Specific pursuits like histology become more difficult because everything is sectioned down to two dimensions; and yet you're still talking about three-dimensional structures. Then when you introduce physiology, you're starting to talk about temporal relationships of those structures. Some people have an ability to understand these abstractions. Some people do not. So I sought out the field as a way to help depict that information in a clearer and more direct way for those people, to help them understand the content.

DSM: So your first career was with Cranston/Csuri. Can you talk a little about that?

DS: Chuck back then decided he wanted to spin off some of the technology and start a production company. He asked me if I was interested in joining the company. At that time I was still finishing my Masters degree. I said I was, but I wanted to stay within the medical domain. And he asked me how I thought that might fly. And I said, "I think we could pursue interaction with the pharmaceutical industry. That they would be perhaps interested in using this information," which in fact we later found out that they were very interested. That was an area that I opened up at Cranston/Csuri, where we were working with a number of pharmaceutical companies. They would often do video press releases when a new drug came out, and what they wanted to do was to elucidate a mechanism of action – how does the drug work? That could be anywhere from the gross level, say its actions on the heart, down to the mechanism of action at the cellular level, if the sodium potassium ATPA's pump is being activated in a certain way, or the calcium channel blocker's working - what is really going on there? We wanted to try to elucidate that phenomenon closer to what science knew about it, so that the physician had a better understanding of it. They had shown that if physicians had a better understanding of the drug, are much more apt to prescribe it, they feel more comfortable with it if they better understand the ramifications of the drug.

DSM: So you were able to provide that type of illustration. Were you able to do some of the animation you wanted to do as well?

DS: Yes, that's what we did at Cranston/Csuri. We basically would sit down with the client and storyboard out what was happening. That was very exciting for me to interact with the scientist at these pharmaceuticals, and to be at the level where I would say, "What about this structure?" And they would say, "Well, yes I think it's the way you're depicting it, but we don't want to say that. Our competitors are still out on it." That was very exciting, to be at that edge with them, to try to depict some of these phenomenon, and it worked very well. But eventually the company was growing and I was getting pulled off onto some of the other jobs, working for a spot on NBC or some other thing, and I really wanted to stay in this area. So I accepted a faculty position at Ohio State, and wanted to get back into the research. And at that time also, some of the early work with CT scanners was really coming into fruition, and magnetic resonance was coming online much more-so, and I started to see some of the acquisitions of some of the actual patient information, where before what we were doing was generating the data directly into the computer through various methods.

DSM: So you came back Ohio and went into the industrial design department?

DS: Yes, yes. More importantly I was with Chuck, who was running an interdisciplinary graduate center called the Advanced Computing Center for the Arts and Design and I worked with them.

DSM: When you went back as a faculty member, what degree of freedom did you have to develop your ideas, and what research focused your work?

DS: Being in the College of the Arts, I think there was a little bit of a stretch because I did not want to abandon my background. I wanted to continue to work with clinicians and physicians - some of them that I knew were here at the university. Also I'm more interested in education of an individual as a human, as opposed to say a specific area. We have a propensity to want to create specialists, and I think there needs to be a stronger interdisciplinary approach to education. For instance, one of the things that I did as a faculty member was to develop a curriculum for a class that I taught for two years on visual perception in the Arts and Design. That specifically looked at, as a very interdisciplinary class, the mechanisms of vision – everything from the anatomy of the eye to brain, what was happening at the visual cortex level and so on. I did it that way so that students could understand that they have visual systems, that that's exactly what they're manipulating when they create visual information; also to show how they're manipulated by the system themselves.

And one of the things we looked at was how various artists were affected by the visual system in many different ways. For instance, how artists like Serra exploited the visual system, and then artists like Monet who actually suffered cataracts and how it affected their aesthetic. We looked speculation of how perhaps deteriorating vision influenced Rembrandt's work over a period of time, and I think it was important for them to look at integrating this information together.

The other courses I taught were at the graduate level about how to do computer graphics. Most of it was done with data modeling - how to model information directly in the computer using data generation tools, where you did everything with a computer - to how you might make three dimensional models and sculpt those, and digitize those and put those into the computer. I taught the kinds of things you would have to take into consideration if you were going to bend those models and animate say a character or something like that. Then we also spent a quarter on motion choreography, where we looked at motion and acceleration, deceleration, Newtonian motion, things like that. The third one was more on surface attributes with modeling of surface reflections, lighting cues, how to set up lighting in a scene and so forth, textures you might impart, surface qualities where you give a sense of textural quality to the surface.

DSM: So you had a wide range of things you did in that position. I have to ask you this question, my wife is a visual artist and thinks that most people think of knowledge as only being textual knowledge, and don't get a sense of visual knowledge at all. It seems like you may have some thoughts along that line.

DS: Not only textual but multi-modal, I mean haptic, proprio-ception. In fact I think probably some of the best work done on that is Howard Gardner at Harvard, who looks at that people have various specialties in terms of the way we learn. I think we all do, the problem is that we're channeled in our education to go into a particular area. I do have a very strong concern for our educational system today that is predominantly based on text. I think we're losing a lot of expertise out there. What we need to do is, in a very similar way to what I mentioned earlier about the computer, we have to have a very clear understanding of what is becoming available through the cognitive neurosciences now of how humans learn – how we investigate our environment - and we need to adapt our educational system to take that into account. One of the things kids do is incidental learning, they learn incidentally when it comes to language. And we need to understand some of those mechanisms at the visual, at the haptic, at the sematosensory level, and incorporate those in education. Not to say that there aren't teachers that are out doing that, but it seems like we have a propensity to really allow for textual information to dominate.

Reading seems to be the essential way to get information. Of course the first thing that happens whenever you talk about this is people think that you're talking about supplanting those kinds of things, and we're not. We're talking about augmenting those kinds of things. I think later on I'll talk about some of the implications of what we're doing in medicine, as the Ohio supercomputer center looks at some of the things that it's doing in the state of Ohio in terms of education, and where we see this going in the future.

DSM: So you came to the Ohio supercomputer center in 1993?

DS: Yes, that's correct.

DSM: What was the opportunity that was offered to you?

DS: Pretty much a blank slate. I was told to keep going, develop this research further. They wanted me to expand relationships with the clinicians that I was working with here at Ohio State University. That was kind of frightening and exciting at the same time, and it really was to try to create a vision for an area of research that we wanted to be involved with. It was somewhat comparable to some of the things that we're doing.

The supercomputer centers charters to help promote high performance computing in the state of Ohio. A big component of that is to help scientists visualize what they're doing, which is some very esoteric science - everything from quantum chemistry, and the visualization of energy, and molecular interaction, to how black holes emerge and so on and so forth. But there wasn't many things going on with medicine, and what this area also allowed us to pursue was computer interaction.

So visualization is one way to look at information but it's only passive. We like causality. We like to be able to make a change to our environment, to press on things, to poke at things, and then to see a reaction occur. That's very difficult in computational science because some of the things they're computing are horrendous, and that's why they use supercomputers to do so. We're really coming to an era where modeling is getting much more sophisticated, and these things are going to be as they are now, much more achievable. And the sophistication level of modeling, very complex things in the future, is going to get better and better and better. I do want to make this comment: I think that there are really two models of this. One I think would be Ray Bradbury's model, which he really showed in his short story from The Illustrated Man and the Belt, which was the precursor to the holodeck, which was machine-driven. You're going to step into a room, turn a knob and reality is going to be created around you. That's a tough one to do.

The other side of that gets back to neuroscience. And that is Gibson's Model, like a neuromancer. That is the idea that we're going to know more about how we perceive information, how we think about information, how we manipulate symbols cognitively, that the two are really going to help us come upon some pretty phenomenal simulations. One quote that I would like to use is by Ganapathy at ATT Labs, who said that, 'Reality is a myth. All that matters is perception.' We have brains out there that are pursuing information, and the idea is to communicate that information which they arrive at; and to communicate it in such a way that it transfers to other individuals.

So what we have to look at is what are the interfaces that the brain uses? We have evolved over millions of years at incredibly sophisticated interfaces, with phenomenal bandwidth for absorbing information. In fact this is why the National Science Foundation in 1987 convened the panel on scientific visualization. The idea that just visualizing information opened up a bandwidth for ways to understand subtleties of various types of information that scientists were pursuing. However visualization is only one way. In fact there are other modalities: auditory, proprio-receptive and so on and so forth. In fact through neuroscience we also know that there are multi-modal kinds of things that are happening within our brains, and that it's not the sum of the parts, it's multiplicative. These are the things that engage us, this type of interaction with what we conceive as reality.

Now we know reality is really a construct. So if we can build on the kinds of cues that can move us in this direction, I think we have a very powerful tool here to help transmit information. However I think one of the issues is of virtual reality, which is a term that I absolutely abhor. I always say I don't know how to define reality. I have a hard time with reality, let alone virtual reality. But I think that's a tough issue and a lot of people talk about the issues of immersion reality. I think there are various levels of that. If you sit through a film and you're simulated by 24 frames per second, and a stereo channel through your auditory communication channels, people come out of the film in tears, laughing uproariously, and they've been immersed. So it's really how you engage the individual in. And I think filmmakers have perhaps a more intuitive understanding of how these things are manipulated. Griffith knew that at the turn of the century - the idea of parallel editing, which he said he stole from Dickinson - the brain interprets information as it bounces from salience to salience. If we can put the information in that kind of way, I think we can engage people, and often that engagement is half the job of helping to transfer the information.

DSM: So you've had at the supercomputer center really an opportunity to move to this area of biomedical visualization and how you compute it, and then develop some of the theoretical ideas that you just talked about.

DS: I'm interested in the medical area of course because of my background, and my fascination and honor for the profession. It also presents very difficult problems to the technology. We feel if we can simulate these kinds of things, we can help spin these things off to other areas. For instance, we can create a digital bullfrog that we can disseminate to all the schools in the state of Ohio, which levels the playing field for the amount of information that schools can actually obtain. Some schools may not be able to get those kinds of lab things. So the more rich environments that we can create for transformative information, whether it's at a scientific level or K-12, the better off we'll be. I think part of it is to allow students to start interacting with this information, so that we can gain a better understanding of how they'll interact with this.

I think the proscenium lecture has had its day, quite frankly. If you can read a book, you can get that information fairly straightforwardly. Then to walk into a lecture and have the same information presented to you verbally, it's kind of painstaking for a lot of people. I think most of the kind of education that we do in terms of learning, we learn on a single basis. It's done by ourselves in many cases. What we want is we want that coach to be there over our shoulder eventually. I think that that technology is getting to the point where it's going to free up the teacher to be more of a coach as opposed to a conduit of information.

DSM: Let's invite John back in. One of the things we're interested in is the partnership you had in developing your new application. So I thought I would start with John. You talked earlier about a time when you first met and began talking about working together. Maybe you could talk a little bit together now about what that first meeting was like, and how you guys began to shape an idea for a new innovation.

JM: I don't know if Don remembers, because it was a long time ago, but you had asked me the question where I had recalled that one of my earliest meetings was at a lunch some time ago. We met to talk about the possibilities of our collaborating on something, but that something wasn't really defined. I had a few ideas on this or that, that had to do with a placement of epidurals and the use of a continuous pump to relieve their pain. Don, having his background in anatomy and also as an artist, started coming up with other ideas. We started talking about "what ifs" and "what possibilities" – do you remember?

DS: Yes, actually we were thrown together by my boss, Charlie Bender. He brought Jack, and some of his other faculty and residents out to the supercomputer center. Charlie brought me in and asked me if I would do a presentation on my work. At that time I was working on some Cray research, where we were doing three-dimensional visualization of a human brain. And I think something must have clicked with Don. Afterwards he said to me, "I wish I would have known you three years ago." I wished the same, because he's been very forgiving in terms of some of the things that the technology can't do. He understands that. And for some doctors that's too difficult. To get this technology to evolve, we need to find people like John that will be involved in helping shape it. It's not always going to work the first time, but there were a few things that we showed him he said, 'Gee, if you could do that, what about this?' And I pushed him and said if we want to go after funding, we want to get something that's really difficult to do, "What are the tough issues?" I think it was at that luncheon that when we got back together, he said, "I think you need to look at the epidural. Here's the scenario. It's really tough for the residents to do." So I came in and videotaped one day while John was teaching. Then I also had the pleasure of John doing the epidurals for my last two children that were born. It is kind of a frightening thing when you think of it, there's a cognitive pain watching the epidurals. When you realize what they're doing with the needle, and where they're placing it, and the delicacy, and finesse that they have to use to do this. It's amazing. So it was a challenge to try to pursue this project, and it still is difficult. There are some things that are very difficult to try to mimic in a simulation. But we've come some way.

DSM: You two bring different skills. Now how do you mix the skills that you bring to this project?

JM: As I said to you this morning, one of the more pleasant aspects of this whole thing has been the enjoyment I've had from working with people at the supercomputer center, which to me is the highest technology level we have on campus. I look upon it as a privilege to work with a group of people who are at the technological level that they are, and you know my dedication to technology already. In addition to that, as an extra bonus, all these people that we work with are grand people. They're really fantastic. They have incredible minds. They're very intuitive. From the education standpoint, nothing is fixed in cement. Nothing is concrete. We look at ideas as possibilities, and how can we change those to make it better. Someone might turn around backwards and say, "What if we did this instead of that?" And that's the enjoyment of working with this group, it's really a very thrilling group to work with. It's a group that's dynamic. It's a group that instills excitement and thoughtful processes.

DS: Also, I would say that we have a very good rapport. We're close friends. I've traveled pretty extensively now with John, and that's really important, because part of what I expect from him and I do get is, "This is useless. Don't pursue this." And that's very important because we don't have his expertise. We need to know what are the most direct routes in some of these areas. If you work all day and you're up all night, and then you show it to him, and it may deflate your ego a little bit, but he'll say, "That isn't really critical to the problem." It's actually healthy to have that kind of interaction, because it allows us to focus in on the problem much more directly. In addition, we are really relying on his teaching experience, which is vast, and knowing what the residents are expecting on these kinds of things, the kinds of pitfalls that they're going through. The first time that I witnessed an epidural with John, he immediately afterwards took his resident into a debriefing room and went over some of the highlights. He's also what I see as the epitome of education as the coach for these people; hitting the high points, showing them the kind of things that they really need to take into consideration when doing this technique. So that's why I feel the epidural simulation might really be helpful for residents to gain that proficiency level, and get their own confidence level raised before they actually go to interact with people.

DSM: Let's talk a little bit about the technology that you specifically use in the supercomputers that are behind this. What's the machine that really makes this all possible in the background?

DS: Well I think there are several components. One, we do a lot of algorithm development on the supercomputers. However, you know our goal is to have something that we can place in several of the residents' lounge. Residents can come in on demand, as they put in long hours, and come into the lounge and call up information and practice it, practice it repeatedly. But once the algorithms are developed on some of the bigger machines, then we move down to work stations that are on the desktop, and that's important because computing needs to be disseminated out. In addition to that, it's the interface that helps provide the haptic feedback to the user. That is essential because feel is such a strong component of this, although I don't want to downplay the incredible ability of these people to visualize this anatomy within their heads. That's really paramount. Some of these techniques are very difficult, and the reason they're not more commonly used in other hospitals is because you do not have the expertise there. These experts are able to visualize, able to put together a mental model and quickly adapt that model to the specific variants at which they're introduced to in that specific case. That's what we're trying to simulate in the virtual world as well, the idea of what would happen if I make a mistake, or what happens if I expect the patient to be shaped like this, and there's a slight anomaly in their anatomy? Can they work around that, can they become adaptive to that type of situation, which they must?

DSM: You were both teachers, you on the computing side, you on the medical side. I get the sense that a lot of the motivation behind your partnership is not only working together but having the students that you both teach work together and work on similar problems, is that correct? How do you see the teaching side of the partnership?

JM: My teaching aside, from the clinical standpoint up until the point when Don and I put together the idea for the virtual epidural, was basically really one on one in the field at the bedside of the patient. It was really typical of me to say, "Watch me, now you do it while I watch you." That it is still very important to do, and I'm not sure that it will ever be outmoded, and I prefer that it wouldn't be. But when we were talking about the ideas behind this, most of the business we went about is trying to move or shift, the learning curve, from this very steep learning curve, to this type of curve. So by the time the person got to the point of working with the human interface, that individual would feel some relaxation and confidence, and also have the built-in sensibility and feedback that they knew when something was right and when it was wrong. That's what we really went about. That's very important, from my standpoint that's a huge demarcation from past methods of learning.

Think about it, people used to learn how to do this using a syringe filled with saline and an orange, for example. It'd penetrate the skin of the orange, and they would say to themselves, now the orange peel is the ligament flava and when you puncture through this, you'll feel the release, and that is the epidural space. That is really not much of a reasonable model. So, that's why this is such a powerful model, because up until that time, it was really not conceived that we would have this type of thing.

When we were talking about it, all these things made sense of course because this is how pilots learn to fly. Most pilots learn to fly now on structured aircraft by working on simulators for hours and hours and hours. Of course, they save millions of dollars not injuring good planes, and not risking lives, and these pilots learning all these mistakes before they go in. So the simulation experience is really a viable one for teaching, that's for sure.

DS: The philosophy is to raise their proficiency level and their confidence before say, a pilot would get into a real plane and do these kinds of things. The other point that I might make about your question about the importance of my interaction with John is the exposure to the residents in the department of anesthesiology. Medicine is extremely complex. It's a no structure domain, and how individuals learn the information varies from faculty to faculty, and resident to resident.

Part of the simulator must adapt to that wide range of approaches that various individuals may have, and that's part of learning on demand. One individual may go through at one particular pace and maybe off in different areas than say another individual doing the same kind of thing. And that's really important. We need to have systems that allow for that kind of free exploration, to learn what it's like to make a mistake. And if you learn from the mistake, then it's not a mistake. You know my favorite quote is, I think it was Edison who said 'the best inventor is the guy with the most junk in his garage.' I think they have to experience the variants. They have to experience some of the mistakes so that they get a better understanding of what it is they're doing, and this helps them build that mental representation of anatomy. Then of course, as John mentioned, it has to be right, it has to feel very close, if not exactly on, as close as we can get with the technology so that it does maximize the transfer to the real world situation, which is the bottom line for the simulator.

DSM: One of the things I did want to throw at you, a kind of curve ball, our theme this year for the awards program is Patterns of Life and Pathways of Innovation, and I wonder if that theme resonates with the kind of partnership that you have put together in some way that strikes you.

JM: Well from my standpoint, Patterns of Life and Pathways of Innovation could be really very much what I spoke to this morning about my patterns of life. You asked how my link to technology was made and how I used it in my patterns of life, and I think I pretty much explained that I've always been in awe of technology since I built my first stereo set and saw it actually bring beautiful music to my ears; an opera that I could hear. That really set the pace for me to realize that technology could do things that could really help. Then throughout the years as I went through my residency, and through the various teachers I saw them using over and over again, typical stylized types of teaching. What I would often say to myself is, "I wonder, if that voice would be recorded, what the curve would look like, what the waveform would look like?" I would think this as I would be going to sleep listening to someone droning in a monotone. Then I would listen to a dynamic speaker, who had energy and excited the entire crowd, who was jumping around the front of the room like a frog from lily pad to lily pad, and I would say to myself, "I wonder what this one would look like? I put those two together how dramatic they would be."

So I began to realize that it's not just technology, it's really people and technology together. I really think that's what this whole key is about. That's why I think it's such an exciting theme, because it really does establish then the second half of that whole thing. The patterns of life that can lead into the second part, really are exciting, and something that can be used in an individual to turn his teaching around, to turn how people learn around. Sometimes it only takes on individual or two in an institution or place to make the difference and to really make a change.

I think Don is a very deep and a real thoughtful type of teacher. He loves technology. He works on the consummate machine now, probably the most powerful, if not it is the most powerful workstation that we have today. And he creates everyday on it, really. So it is like creating a piece of art in his work. That's how I would characterize what he does but he should speak for himself, right?

DS: One of the patterns is the interdisciplinary work, and I think it's real important that specialties come together and look at where the two of them can go with a particular idea. I think that's the excitement of the work that we're doing, is the problems that I get from the clinicians in terms of what they'd like to do, looking at what they're capable of doing with what they currently have, and where they might be able to go with new technologies and that.

That's very rewarding - the ability to hopefully make a difference in some of their work, to help facilitate learning a difficult problem, to sit back and have people try out the simulator and have somewhat of a hot experience on it. That's the reward.

DSM: Is there anything else we should mention before we wrap this thing up?

JM: Well I know we've had this model in various places around the country and one of the best ones was right here at OSU several months ago. We had the unit over on the medical school plaza, and we had various students coming in. These were students at only the first and second year level now, mind you. They had never touched a patient before now. Some of them had seen, or maybe done a spinal because of their father, or someone else was a maybe a physician and/or they've been an institution where they were allowed to do this. But it was exciting to see the younger people who were very computer oriented, tune in and turn on to this type of learning. I have a video of some of them. It was really interesting to watch their facial expressions as they would get the release, and feel the sensation of plowing through the epidural space, the ligament, and knowing that was the endpoint. One of them turned real quickly and said, 'That's it! That's exactly it! That's exactly what it feels like.' Remember that? It was very exciting. That's positive feedback, and we hope that's what will happen when we do get prototypes to the point that they can bring people this real feel sensation.

DSM: Any other closing remarks?

DS: No, I think that pretty much sums it up.

DSM: Thank you both so much for a wonderful Oral History!