

**George P. Noon interviewed by Donald A. B. Lindberg, with Steven Phillips and Tom Bowles, January 13, 2010, in Bethesda, Maryland [Video 1]**

Lindberg: Okay, I'm Don Lindberg, Director of the National Library of Medicine. It's my pleasure today to have a conversation with Dr. George Noon, and the topic of our conversation is going to be the late Dr. Michael DeBakey. Dr. DeBakey was Chairman of the Board of Regents of the National Library of Medicine on two occasions and very influential in the establishment of the institution in Bethesda, and a friend of us and the institution, too.

So there is a collection of Dr. DeBakey's materials, his letters and whatnot, and we want to understand better about him and the wonderful history he played in these matters and also in the history and development of cardiovascular surgery in the US. No one knows more about that than Dr. Noon. George, would you tell us a little bit about your -- you have a very long association with Michael DeBakey. When did all that start?

Noon: Well, it's true I do have a long association. It started back actually as a medical student. I came from Arizona to Baylor in 1956, and I, of course, knew about Dr. DeBakey when I got here and then followed him during my years as a medical student and actually worked with him in research. One of the things we did work on was dissecting aneurysms. As a matter of fact I did that for my senior paper on dissecting aneurysms, which he eventually developed.

Lindberg: Yeah, isn't that ironic. So you ended up having to operate on him to cure a problem that you and he had identified many years before.

Noon: Right.

Lindberg: But what a great opportunity for you as a med student to work with a wonderful man like DeBakey. You recognized that at the time, I'm sure?

Noon: We knew that he was more than the average individual for sure, and we all followed him very closely in the development of cardiovascular surgery and, of course, we became a Mecca for cardiovascular surgery in teaching and the performance of operative procedures to take care of these types of patients, and it was really exciting at the time in our careers.

Lindberg: I should think so. In the early days didn't he actually develop one of the blood pumps?

Noon: What he did -- actually, before medical school he developed a roller pump back in the 1930s, 1933 or so, and it wasn't really designed for people. One of his researchers was interested in studying pulsatility, so he developed a pump to show that. And then after that it was realized that it could be used for a transfusion. So he used it for transfusions where they would put a needle in a donor and a needle in the recipient and use the pump by turning it manually and pumping about 500 milliliters of blood and then disconnecting it.

Lindberg: Direct transfusions. We didn't know so much about blood typing then. But now that you mention it, I think I recall Dr. DeBakey in this very studio in an interview talking about that pump, and I think now I can recall him saying that he went to the medical school library, and he

complained to a friend that he didn't seem to find anything on pumps, and the friend said you should be in the engineering school library.

Noon: Right, then he found out that there was a lot written on pumps, back to Archimedes.

Lindberg: Right. Dr. DeBakey -- and, of course, many distinguished surgeons have trained with him and some in the Washington area some of the stories are of a pretty tough task master.

Noon: Well, he certainly was, but you know when you look at his schedule and what he needed to accomplish within a 24-hour-period or the week-period or whatever, he didn't have any real free time. So things that would interfere with his time schedule would be very irritating to him, and he would want to minimize those, so he did it by being a tough task master, and once he was on to you, you made sure it didn't happen again. His schedule went on as programmed.

Lindberg: What's an example of a bad thing that he didn't want to have happen?

Noon: There are lots of examples. One thing, of course, is in the operating room. Everything was supposed to be done in a precise manner, and if it wasn't within that limitation to that precise manner, it would become very irritating to him, not only because of the flow of the operation but it could also jeopardize a patient. That was his main concern about the operating room -- he didn't want to jeopardize his patients' care.

Lindberg: I heard it said many a time, and I could believe it from what I've known of him outside of surgery, that he didn't really want to go home when a patient needed him, and he didn't expect his residents to either.

Noon: As residents what happened is at that period of time we were having three-month rotations, so we'd go from one service to another service. We spent three months with Dr. DeBakey. During that three-month period of time when I was a resident, we never went home. We never left the hospital. We were there 24/7 until we finished our rotation, then we'd move on to the next one.

Lindberg: So there wasn't any danger of your deserting the patient then.

Noon: There was no danger of us deserting a patient because we were there 24/7. The other thing is when he did have a sick patient there's no telling what time of day or night that he would be coming back to the intensive care unit to check on those patients, and so you had to be ready for him at any time during the 24-hour period, because he just might show up. Which was good, too, because we took good care of his patients.

Lindberg: I'm sure that he did. What was the most difficult part of the surgery in those early days? Post-op infections or bleeding? What was the major problem?

Noon: Well, initially when he started doing those operations one of the problems was taking care of the patients after surgery. There really wasn't an intensive care unit, and he established the first one and with that we solved a lot of problems as the surgeries got more and more complex,

but initially there was not an intensive care unit in Methodist Hospital that he was doing these surgeries in.

Lindberg: Amazing. I didn't know that. He's credited and I guess even awarded by the federal government of establishing the first concept of the MASH [unit]. Is that right?

Noon: That's correct. I think that one of the most important periods of time in his life as far as what he was able to accomplish was related to the years the he spent in the military. He actually had an opportunity not to go into the service; Dr. Ochsner wanted him to stay in Tulane, and Dr. DeBakey said, "This is my country and I want to serve my country and I'm going in." So through Dr. Ochsner's connections, he was able to get into the Surgeon Generals Office. That's where they wanted him. He was in Africa and Italy and other places in the service, and was able to make some observations which led to the development of the MASH units.

Lindberg: Pretty amazing. He said a couple of times on tape here that preparing for the plans that he was responsible for making that he headed for the library, and he has lots of tales of what was called Old Red then, where the National Library of Medicine existed down on the Mall. Did he ever mention any of that to you?

Noon: The thing that he mentioned was that the library was -- actually, he said it was a mess.

Lindberg: Yeah, it was a dump, sure.

Noon: Because it was an old building and when it would rain, it would leak, and they'd have to cover up books and things. He said for a national treasure, it was a disgrace, and that's why he wanted to see that something could be done to change that. He wanted to move it out of the armed services into the NIH where he thought it really belonged.

Lindberg: He got that done, I'm happy to say.

Noon: He did. It took some doing, but he did it.

Lindberg: It's interesting to me that he identified the library as a place to go to help figure out what equipment and supplies and whatnot should be put together for shipping overseas to those war posts. To him that was a natural thing.

Noon: Right. If you'd look at things he had published before he was in the service as far as his experience with the library -- he may publish an article that had 200 references. So you can imagine how much time he spent in the library. As a matter of fact, as far as libraries are concerned, he was spending time during his youth when he was growing up his parents sent him to the library to get books to read, so they would get him a different book each week or depending on how fast he would read the book -- one of the things he got from the library was the *Encyclopedia Britannica*, which he was able to bring home, because he couldn't check that out. And he had his brothers and sisters read that encyclopedia until they graduated from high school. So they'd all completed going through the *Encyclopedia Britannica*.

Lindberg: Very amazing man. The library thing is near and dear to our hearts here. As I said he's been very good and faithful to NLM. I've often worried that we don't do as -- didn't in the old days -- as much for surgeons as we do for the internist. I mean not as a deliberate matter, but probably we're more directly influential in choosing drugs and stuff like that than we are in the actual techniques of surgery. And one of the first things that we did that was directly useful for surgeons, I believe, is the *Visible Human Project*. He was very enthusiastic about that. I wonder, did he ever comment to you on that?

Noon: He did, but we really didn't spend much time talking about that. But he said it was amazing what you were able to do with this virtual human, and he was interested in getting it in Houston.

Lindberg: One of the interesting applications we actually presented to him, which is a bronchoscopy, because in that particular application as now with all these fiber optic techniques, the controls of the device can be used to control the display of the computer and the model, of course, is the Visible Human inside the computer. So when he was Chairman of the Board of Regents this last time, we wanted to show him this application, so the president of the company that built the bronchoscopy thing came and demonstrated it, and we were all slightly worried about letting Dr. DeBakey actually have this thing for fear he would consider it maybe as a toy or trivial or something, and he became completely fascinated by it. He said my goodness, it will tell you which is the left and which is the right. It will name the -- he said I never saw anything like that. Of course, he was very familiar with the internals of the lung, but when you turn on the switch, of course for the novice, then it will help identify the things, so he gave it an A-plus. He thought it was a wonderful thing, and we breathed a sigh of relief.

Noon: Right. Well, of course, those rituals -- the bronchoscopy, the CT and other modes of imaging now are just unbelievable.

Lindberg: Yeah, it's come a long way, but he also helped us when we made a long-range plan. I came to the Library in 1984 and was very proud of it from pre-knowledge of it but I discovered to my surprise, we really didn't have a long-range plan. They'd done all the right things for 148 years, but there was no plan, so I thought we needed a plan, and he, I believe, chaired the committee.

He was chairman of the board, but I think he also chaired the planning committee in which we made basically a 20-year plan, and so many of the very good developments here have come directly out of that long-range planning, and he was very influential in that. One of the things that he stuck up for was the idea that -- mind you it's '84 or '85 so we were able to deal with text and indexes of books and that sort reasonably well, but we had really virtually no images at all in computers. So he was very keen on the idea that eventually the computers would be able to do images, too, and NLM whenever that becomes possible should get in there and do something that's really important in medicine, because images are very important in medicine. So as it turned out the first opportunity we had, we went to the anatomy, and I think that probably was a practical application and has found many uses in surgery. In your work, do you utilize any of the devices that like project tumors on the outside of the skull to help you know where to operate? You know what I'm talking about.

Noon: In cardiovascular surgery, no.

Lindberg: Not much use there, huh?

Noon: Well, I'm not saying there isn't any use for that. You asked me if I -- no, the answer is no. But with the imaging techniques that are available today as far as the endovascular procedures that are preformed, they're very important. So without those images, it takes away a lot as far as the treatment of these patients.

Lindberg: So you said earlier that surgery is kind of changing. Your kind of surgery.

Noon: Right, I mean it's becoming -- a cardiovascular surgeon that trained in the early days with Dr. DeBakey would be obsolete in the procedures that we're doing now. I mean it's not the procedures themselves or -- the techniques of the operation are all standard, but instead of 100 percent aneurysms being replaced by an operation, we're dealing mainly with endovascular procedures going through the arteries and implanting grafts to do that, and they they've got the balloons and stents, which are taking the place of bypasses and endarterectomies and other things that we did surgically, so there's been a big change. It's an evolution that if you're going to stay current with it, you've got to keep learning, keep working. Take some time off and learn about the imaging.

Lindberg: Well, of course, he lived to see a lot of those changes. What did he think about them?

Noon: He was every enthusiastic about those changes. He didn't feel bad about his things becoming obsolete or --

Lindberg: That's interesting. I'm glad to hear that.

Noon: He looked into the future. He never stopped thinking about the future and what could be developed. Very, very supportive of the changes that were taking place.

Lindberg: I'm glad to hear that. I do recall that he made two decisions that a lot of men and women are afraid to make. Namely, he made the decision to take himself out as chairman of surgery and he made the decision to take himself out as chancellor.

Noon: He didn't take himself out of the role of being an advisor and a confidant during that --

Lindberg: No.

Noon: And he was still very active -- and actually, he couldn't be out of that role because people in the medical center and around the world would come to him for advice and for his trying to answer the questions that they have about health care, about building new hospitals, about new procedures, about whatever. He was always in constant demand from people all over the world, so he didn't -- I mean he couldn't take himself out. He made himself available to everybody that he could.

Lindberg: Marvelously, yes. I've sent a couple of patients to him for surgery and he told me they didn't need surgery.

Noon: Well, that's one of the things that we see not uncommonly. The patients would be sent down to us that their local surgeons were ready to go ahead and operate on, and we'd look at them and just say no, you don't need it. You may need it in the future or what you've got can be treated some other way. But, yeah, there were patients that we saw that were referred for surgery that didn't need it.

Lindberg: Kind of wonderful. I also feel -- maybe you'd comment on this, but to my way of thinking, he sort of paid his dues to medicine. That is to say he was very generous of his time and his instructions, his teaching to the whole profession.

Noon: Well, he was in many different ways. I mean at the local level with the students, the residents, the fellows -- the national level and an international level -- he was amazing and in so many different ways as far as developing of healthcare systems, going to different countries like the Soviet Union and helping them develop healthcare medical systems, etc. It's amazing.

Lindberg: Now we're on the topic of USSR, I wonder if you'd tell us a little bit about the trips in which you accompanied him to these medical missions.

Noon: All right. The first time we went over to do surgery was in 1973, and we operated on Professor Keldysh. He was the president of the Academy of Science at that time, and he had some very bad circulation to the lower extremities and was about to lose his legs, and we did bypasses from the aorta down to the femorals, down to the level of the knees and were able to establish normal circulation in him and save his legs.

Lindberg: Put him out on the road, huh?

Noon: Yeah, and at that time it was still the Soviet Union so there was no publication about that locally, internationally, etc. Nobody ever heard about that. In contrast, when we went over for Yeltsin then it was worldwide news.

Lindberg: Yeah, you were on television all the time.

Noon: Right, all the time.

Lindberg: Tell about Yeltsin, please.

Noon: Well, Yeltsin -- he was invited to come over and examine Yeltsin and determine whether he'd be a candidate for surgery or what was the best way to treat him, and what he found out is he did have coronary disease. He probably had some alcohol-related dysfunction of his heart, and he also had hypothyroidism. He felt that with some treatment that he could get in good enough shape that he could tolerate an operation, so that was recommended and followed through, and

within a period of several months, his condition improved significantly, and at that time we recommended an operation.

We weren't sure how good his ventricle would be with the operation as far as recovery, so we took over some cardiac assist devices. We took a Novacor left ventricle assist device, a Biomedic centripetal pump, an intra-aortic balloon. We were prepared for the worst and hoping for the best, and fortunately the best occurred, and he did very well following his operation.

Lindberg: He sure did. I guess not everybody in Russia liked that, though, huh?

Noon: No, we would have been probably in trouble either way -- if we didn't save him or if we let him die. We were interested in his life and not the politics of the Soviet Union, so that was our goal, to get him over that, which fortunately he did very well. What was interesting is that he -- that's Yeltsin -- would pay attention to Dr. DeBakey and Dr. DeBakey's recommendations before surgery and after surgery, so any time that the local surgeons or cardiologists wanted to get something across to Yeltsin they'd come to Dr. DeBakey and say, Dr. DeBakey, would you please talk to President Yeltsin and tell him that we would like to do that. And if he said okay, it was done. If not, it didn't happen.

Lindberg: So you actually had to kind of get him rested-up before the surgery.

Noon: Right. It took several months.

Lindberg: Pretty interesting. Did you both stay over all that time?

Noon: No, what happened was Dr. DeBakey initially went over by himself and assessed the situation, and then Yeltsin was in a rehab center where he was treated, and then when they felt that things were looking okay and with our conversations back and forth, that's when we went over to help him before the operation. We went over about a week before the surgery and stayed a week after the surgery, to make sure everything was coming along okay.

Lindberg: Well, you sure did a good thing.

Noon: Yeah.

Lindberg: Even if his political opponents didn't like his recovering health. Well, another spectacular person was the Shah of Iran, were you part of the procedure as well?

Noon: No, I wasn't really part of that procedure. He went to Panama and examined the Shah for the first time then the Shah went over to Egypt and then Dr. DeBakey went to Egypt, and that's where he did his splenectomy, the operation on him, and that was performed in Egypt, but I wasn't part of that procedure.

Lindberg: How did you get out of it?

Noon: Lucky, I guess. No, Gerald Lawrie one of the other surgeons that was in our department went with him on that.

Lindberg: Well, as we both remember, the hallway into his office is lined with photos of Dr. DeBakey and essentially every famous person you can almost name, but one struck me was the Duke of Windsor. Were you part of that surgery?

Noon: I wasn't part of the surgery. I was there when the surgery was performed and, of course, he was very proud to be asked to do the operation and especially pleased when things turned out very well.

Lindberg: Yeah, they did. I wonder -- it didn't sound like dealing with the duchess was a special joy.

Noon: No, it was trying to say the least, but he managed it very well and everything worked out fine.

Lindberg: Amazing man. His life involved the surgery itself and the medical procedures and MASHs and whatnot, but also a lot of public policy issues. Do you -- of course, you were too relatively young to have been involved when he was on the Hoover Commission and that sort of stuff, but his active involvement in politics extended his whole life, so you must have seen at least some of that.

Noon: We got to see some of it. Actually, as residents and working with him, you'd see Dr. DeBakey the surgeon, Dr. DeBakey the educator and the teacher, and then Dr. DeBakey the politician, the one who's going to testify to Congress. We knew that was going on, but we really didn't see that part of him. So there aren't many people that really got to see the whole Dr. DeBakey the different things that he did and was involved in, and it's just amazing, and what he was able to accomplish during his lifetime would be something that would maybe take four or five people normally to do.

Lindberg: I think that's about it. Yeah, exactly right. One part -- in looking over -- I guess I should say for the record that the things of his life that we have now as a part of the holdings of the library were contributed by his widow, Katrin, from their home, his office in their home and their library in their home and attics and so forth -- so we're trying to appraise those. I mean we want to make a Profile in Science of Dr. DeBakey, but only if it can be done in an excellent fashion. I very much appreciate your coming here to help us make that evaluation of those things, but one area that I had hoped to learn more about is the artificial heart, because he wanted this virtually all his life.

Noon: Right.

Lindberg: That project [artificial heart] got dropped by NIH and the rest of the government funders.

Noon: He was, of course, instrumental in developing the funding for the program in the 1950s and into the 1960s, and then in the '70s and '80s then it just got, like you say, dropped. I guess it was a matter of they didn't feel the progress was enough to justify the money that was going into it at that time. When Dr. DeBakey first started working on it, they felt that they would probably have a heart that would be available within a period of five years. Well, that didn't really happen. It took much longer than everyone anticipated, and after that stopped as far as the funding in our laboratory -- there were laboratories that got shut down because there was no further funding -- we then later went to NASA to develop a pump with them, which we are now using clinically in supporting patients.

Lindberg: Yeah, I mean it all worked ultimately.

Noon: Right.

Lindberg: But it's a tougher job than anybody thought. Well, even this go-to-the-moon thing took ten years didn't it?

Noon: It took ten years, yeah, but they got up there, and they're back and we started this in the '50s and we're 2010 right now, so--

Lindberg: --and counting. But the little pump, this ventricular assist device -- he was involved in many pumps -- but the ultimate one he's shown me many times is just about the size of a thumb, and you could have it in a little case in his pocket. You were largely responsible for that project were you not?

Noon: Well, I was. We had been working on basically pulsatile pumps the whole time that we were in the laboratory. The pulsatile pumps became clinically used but they were such large and cumbersome [devices] we wanted to develop something that would be smaller and easier to implant, you could put it in smaller patients and be less noticeable to the patient once it was in, and also would be very reliable.

So in thinking about that, we thought maybe the best place to look at something like that would be to go to NASA, because all the requirements that we would have for durability, energy requirements, etc. would be similar to what they would want in their space program. And we knew of a pump Dr. Rich Wampler had developed, which was an axial flow pump which was put in percutaneously through the femoral artery, would support patients with a two or three-liter blood flow turning around about 25,000 revolutions a minute.

Because you would think an axial flow pump would completely tear up the blood cells, and he demonstrated that this could be performed without having significant damage, and so that's where we started from as far as the axial flow. And the engineers from NASA that we went to talk to -- there were three of them initially -- we got an appointment to see them through one of our heart transplant patients who was an engineer at NASA and we called him up, and then he put us in contact and we met with these individuals, and they were interested in working on it, and they started out on their own time, and we expanded from there.

Lindberg: And the funding was difficult, huh?

Noon: Well, the funding was difficult. At first there was no funding, and then they were able to get some funding from NASA and the DeBakey Medical Foundation gave some money toward the funding of that, and then subsequently a company was developed which then went out and sought funding, and we received funding to go ahead with the project, to go from the laboratory to the animals, to the clinics and taking care of patients.

Lindberg: Yeah, we looked yesterday at some photographs of cows. Would you say how that was used? That was interesting.

Noon: Well, the way the cows -- first of all when we were developing the pump, we wanted to make sure the pump met the requirements as far as the pumping, the pressures, etc. And then from that we wanted to make sure that there was no blood trauma or significant blood trauma, so we went to a blood loop, where we tested it in a blood loop, and the first time we put it in the blood loop every blood cell was destroyed within a minute so we had to go back to the drawing board, and it took some time to do that. Once we had it in the mock circulatory with blood so there was minimal trauma, then we went to the animals, and we chose the cow. The first cows we put it in, we put a saddle on the back of the animal, and we put cannulas into the heart, into the descending aorta and then connected the pump which would be on the outside and we'd leave the pump in for 24 hours and then 48 hours and then a week, and we'd take it out and look at it. So one cow may be used for evaluation of 10 or 15 pumps.

Lindberg: How interesting.

Noon: We went through about 50-some iterations, and once we were satisfied, we were ready to do internal implants, that's when we put it on the inside of cows, and they were running around with these devices on the inside with their controller and batteries on the outside. Once we showed that that was working out well, then clinically -- implants -- we went to Europe, and we started in Berlin and then went to Vienna and then spread from there. We initially went to NASA in 1988, and we did our first implants in 1998.

Lindberg: Ten years.

Noon: And of course one of the things that was a question as far as the pump was concerned -- there was no question it could pump and do the things we thought were necessary to maintain circulation. The question is what happens with the pulseless or nearly pulseless situations, is the body going to tolerate it? Or what are the organs going to do? Are they going to be able to exercise normally, etc., and we were able to show for the first time that for long-term support this was perfectly viable and worked just as well as the pulsatile pump.

Lindberg: Yeah, the world had never had a human being without systemic -- without systole and diastole.

**Donald Lindberg Interviews George Noon/Video 2**

Lindberg: Well, we were discussing the animal trials, experiments I suppose you'd say of the axial pump ventricular assist device, and we saw pictures last night of some of those things, this saddle thing that you put on the cow. I didn't ask you at that time: did it have to be a Texas Longhorn?

Noon: No. We wanted a long-lasting pump, but we weren't considering the Texas Longhorn.

Lindberg: So any old cow will do.

Noon: Actually, we did them in calves because a grown cow is so big, and when we were doing it for the implants where we were actually putting them in the cow, we were leaving them from 60 to 90 days, so during that time the cow would grow a lot, but it would still be an acceptable size for the pump.

Lindberg: But unlike the 4-H farm boys, you didn't try to lift the calf every day, though, did you?

Noon: No, we didn't.

Lindberg: You actually were getting these experimental devices, these ventricle assist devices, implanted and successfully in patients in Europe before you got permission in the US. Is that right?

Noon: That's true. We went to Europe in 1998, and it was about 2002 when we did our first implant in a human in the United States. It took some time going through the hurdles of the FDA to complete all the requirements to get approval to do that.

Lindberg: Why was it so long?

Noon: It's a long tedious process, and there's a lot of information that they want, and to develop that, and I guess it's more than we needed in Europe. It just took some time.

Lindberg: So have a lot of these pumps gone in now?

Noon: Yeah. In fact, what's interesting, too, is at this point that the old pulsatile pumps have virtually been eliminated. It's very rare that a pulsatile pump will be implanted at this time. All the newer pumps that are being developed are all continuous flow pumps, and one of the trials that we had as far as improving pumps for destination therapy was with an old pulsatile pump called the HeartMate I and it worked well as what we called a bridge to transplant, and then when it went to destination therapy or this rematch trial -- found out that the HeartMate after a year and a half or so would require a replacement because it developed mechanical problems.

So one of the things that's happened now, except for patients that need destination therapy and can only be approved by putting a HeartMate in, it's not placed in or any other pulsatile pump is placed in at this time. But now we have patients who have been supported by the HeartMate I

pulsatile pump, which had been converted because that pump broke down, to the HeartMate II, which is an axial flow pump like our pump.

There isn't a single patient that would say they'd rather go back to the pulsatile pumps. They're all very pleased with the continuous flow pump, and for a variety of reasons. One, it's much smaller, and so with body movement they can't tell that it's there. It doesn't make any noise. With the pulsatile pumps, you could sit on the ward where these patients were in the hospital, and you could close your eyes, and they'd walk a patient down the hallway, and you'd say, okay, this is a Novacor, you know this is a HeartMate. This is a Thoratec, and you'd walk by with one of our pumps on, the patient just walked by and you'd say I don't hear anything.

Lindberg: That's wonderful.

Noon: So the patients couldn't hear it and we couldn't hear it. We can actually hear the pump with a stethoscope but not -- standing by the patients you cannot hear the pumps, so that was nice for a lot of patients.

Lindberg: Of course, you were back in the old days, too, when the valves were very noisy.

Noon: The valves were very noisy.

Lindberg: I mean one could hear those across the room.

Noon: Right. Well, the first Hufnagel valves that were put in -- one of the main causes of death long term was suicide because they couldn't stand the noise of the valve.

Lindberg: Amazing. But back to the ventricular assist -- the axial flow pump -- have you thought about how evolution worked? I mean how did it create human beings all with so far as we -- I guess, we assume all during our lifetimes we had systole and diastole and here it turns out we really don't need any of that stuff. Just a constant flow of blood is sufficient. How could that be?

Noon: Well, maybe it's -- you think about it, but then you say how could we -- the engineer -- a continuous flow pump for the body that you're born with, that you could live with, and I don't think we could do that. Some of the smaller invertebrates, there's ways of circulations going on but nothing in mammals, for example, reptiles, etc. that can really take the place of the heart in a pulsatile fashion or a non-pulsatile fashion.

Lindberg: But how did Mother Nature equip us to tolerate this whole new thing -- heart function without the pulsatile heart function?

Noon: Actually, when you look at the --

Lindberg: Can you test any difference in the brain function, attitudes, emotions, or reflexes?

Noon: First of all in considering how important is it to have continuous flow or pulsatile flow when you look at the pressures within the arterial tree, in the arteries you've got pulsatile

pressure. Then as you get down into the vein or capillaries it's non-pulsatile, and then doesn't become pulsatile until it gets back in the lung and you have a pulmonary artery that's pulsatile, so there's only two small areas in the whole circulation circuit that are pulsatile. So then the question is how important is the pulsatility in these two areas? Because other places where you're having change of nutrition, etc. it's virtually non-pulsatile. We've actually looked at the circulation in the brain--

Lindberg: That's where you worry, sure.

Noon: --and it's non-pulsatile basically in the brain. When you have a pulsatility of the heart, by the time it gets up there and it's going through the capillaries of the brain, etc., it's not pulsatile so -- with a transcranial Doppler you can look at the flow through the brain with our pump or in just a normal individual, and you really can't tell much difference.

Lindberg: I see. All right, so I over-interpreted it. We really didn't need an evolutionary change.

Noon: So the other thing is we have done studies in patients who have had these devices in, and one of the things that we put devices in for is what we call "bridge to transplant." So [if] a patient who is on a transplant list is so sick that they're not going to really survive until they can get a transplant, they have a device implanted. What we would do -- we would take samples of the heart at the time we did the implant and take samples of the heart at the time we did the transplant and compare them with devices that were pulsatile and devices that were non-pulsatile and really couldn't identify any significant difference in what we were finding. In fact, all the tests that we've done up to this point there isn't anything that really would make a significant impact on an individual because they have continuous flow. One of the things, of course, in continuous flow pumps, is the individuals taking care of the patients have to learn a few things. For example, since there's no pulse, when they try and feel a pulse or they try and do a regular blood pressure, they can't get it. They have to have Dopplers to get that. When the patient first goes to the intensive care unit after surgery they're used to seeing a nice pulsatile, and then they just see a wave going across there, and then they're checking their lines to make sure there's no problems, and realize this is what you'd expect to see in a patient with a continuous flow pump. There are pulse oximeters we put on their fingers where the pulse can tell you what the oxygen saturation is -- they don't necessarily work with a continuous flow pump, so we had to make some modifications.

Lindberg: How big a device is a Doppler, sufficient to get a blood pressure? How do you get a blood pressure?

Noon: Oh, with a Doppler? What we do -- well, we put the Doppler over the artery in the arm if you're going to get it in the arm and you can hear the blood going through with a Doppler, and then you inflate the cuff, and then you let the cuff down and you get a Doppler pressure. And see that's another thing as a cardiologist or radiologist or surgery who's trying to access the artery to put in a catheter or monitoring line can't feel a pulse, so what we so is we use a Doppler for that to identify the artery, and then we can put the needles into the arteries where with the pulsatile one, you can feel the pulse and go for the pulse.

Lindberg: Pretty amazing.

Noon: Yeah.

Lindberg: Now there are a couple of pieces of legislation that Dr. DeBakey was important in and concerned about. One that I experienced directly was Regional Medical Programs. That was a result of his chairing the Heart-Cancer-Stroke Commission, I guess it was, that reported to Lyndon Johnson. In those days he was recommending centers of excellence, particularly thinking of surgery as well as other things but particularly in surgery. That program lasted about ten years and then to my regret Congress cancelled it during the Nixon administration. Did he ever comment about that? Was he satisfied with RMP?

Noon: To tell you the truth, I really didn't have any significant conversations with him about that, so I can't really say.

Lindberg: He wrote papers up until the last year of his life on public policy issues, one of which had to do with healthcare reform. I was given by Katrin [DeBakey] a manuscript copy in which he had written out in hand, virtually the entire article as it was ultimately published. It was interesting to me that he didn't utilize assistance, at least in those kinds of articles, to prepare anything.

Noon: It's amazing what he did on his own. Of course, in a lot of things that he did he had his sisters which were a great help to him, Selma and Lois, Dr. Lois.

Lindberg: Dr. Lois DeBakey has long experience with the National Library of Medicine as well, and I first met her here, and we love her dearly. Some of the things that are in this collection that we have of his papers include notebooks that he kept really as a child and letters from him to his father, which are really lovely letters. So he was in the habit of writing, but he couldn't do much writing I suspect when he was doing surgery a large number of hours per day. He did it, of course, early in the morning, late at night, and then he did it with the help of associates and people like myself and his sisters. But in travel, he wrote, also.

Noon: Right.

Lindberg: Because he published a little journal that he kept in going to China investigating acupuncture and so forth. I think that's in the public domain, if I'm not mistaken.

Noon: Right.

Lindberg: In the case of these policy papers, as I said, I was really impressed that he wrote out by hand the whole business. Of course, I wouldn't have been surprised if he had used a laptop and word processor, but he didn't. He did it all by hand. I've seen similar pretty lengthy correspondence when he was working with [Rene] Leriche and there it was not only perfectly written, but it was perfectly written in perfect French.

Noon: So when he was with Leriche -- He learned before he went over there to speak French, and then after Leriche, he went to Heidelberg where in Germany, he became fluent in German. So during that two-year period of time that he was overseas, one year in Strasbourg and the other in Heidelberg, he learned or was able to communicate well in both German and French.

Lindberg: Pretty amazing. Did he continue that skill? Did he ever have an occasion to use it in Houston?

Noon: Well, I heard him speak more French than German. Of course, he eventually married Katrin who is German, but most of their conversations that I ever heard were all in English.

Lindberg: But patients -- I mean, he didn't really use it in his practice. Well, Spanish is spoken in Houston to some extent.

Noon: There were a significant -- not a significant -- I mean there were patients that came over that spoke French that he would speak French with. So that was one foreign language that I heard him speak.

Lindberg: So he kept the skill.

Noon: He kept the skill. He didn't really speak a lot of Spanish, and he didn't speak much German. So he would rely on English or translators for those, but in French he would do pretty good.

Lindberg: I've asked him questions about Arab countries, and he knew Arabic apparently or some.

Noon: I don't know how much he knew. When he was 12 years old, his family took a year off and went to Europe and Lebanon and Arab countries, and he said that during that period of time, he was able to speak or learned quite a bit of Arabic and also the script but he didn't really keep up with that, so in later years, he really didn't write or speak much Arabic.

Lindberg: I suppose there would be less occasion, but he apparently had a real skill with languages.

Noon: He had a real skill with a lot of things. Like his parents said -- they could have taught him Arabic when they were growing up. He told me that they said "You're in the United States and we're speaking English," and so they didn't really carry on conversations in Arabic.

Lindberg: I think in that generation people sort of turned their backs on the Old Country and were as American as possible, so that's understandable. The experience in the war, you spoke of the MASH units and so on, he also created a twin registry in the armed services that is called MFUA -- m-f-u-a -- I've forgotten now exactly what that stands for [Medical Follow-up Agency] but it was a registry of twins who had served in US Army, and he was just impressed by the relatively decent medical records that were available and the potential for future studies, and I wondered if that had come up in your conversations?

Noon: To tell you the truth, we never discussed that. I mean there was a registry for vascular injuries that we discussed, but as far as the twin registry and that we never really discussed that, and actually I don't think that I've really seen that written up in things that I have regarding Dr. DeBakey and that period of time, and I don't know why that is.

Lindberg: So for this permanent collection, I think I'd better be sure that I dig up some of this documentation, because I recall vividly a celebration of its having existed for 50 years and, of course, it was amazing that the man who founded it was there 50 years later to chair the meeting. In the interim it had been run by the National Academy of Science. He didn't run it, he just started it. So I think I'd better dig around and get some more information about that one. We are taken up with news about the health care bills. Did he have a view about that that he expressed to you?

Noon: We didn't spend a lot of time on that [health care reform]. It would have taken so long to discuss that, I don't think -- really we didn't talk much about that. He had his views. One of the things that he felt is that the VA hospitals, which he was instrumental in developing, too, for taking care of veterans coming back or armed services individuals or injured -- in fact the VA hospital is one of the reasons he stayed in Houston because he went to Houston in 1948. There wasn't an adult teaching hospital, and he tried to make some arrangements with some of the other hospitals and was not able to get a satisfactory arrangement. He was actually ready to go back to New Orleans to Tulane, and there was a naval hospital in Houston, which they were able to get converted to a VA hospital, which is now the Michael E. DeBakey VA Hospital. And he got it converted to the VA hospital and staffed it and then that kept him in Houston.

Lindberg: That's interesting. I didn't know that part of it. I have gone to that VA hospital named after him, of course, but --

Noon: So the other thing I was going to say about the VA -- he's very proud of the Michael E. DeBakey Hospital because when you look at the statistics of the care that they give their patients, their results, etc., they're one of the best in the country, and he said that they're providing that care for these veterans for half the cost it would be in private sector. So he said on more than one occasion, we need to pay attention to what's going on at the VA hospitals. In fact, when he got his Congressional Gold Medal, he mentioned that in his little talk.

Lindberg: He did, I remember vividly. It was one of the few things that made the president's face go red.

Noon: Yeah. It made the VA go -- because we visited the VA headquarters after that. They were very pleased with what he had done. He felt strongly about it. He mentioned on many occasions-

Lindberg: He was justly proud of the VA and VA care. That's interesting. He did tell me I think in an interview here once that when he went to Houston that he actually was the only board certified surgeon in town.

Noon: That's right. There was no residency program and there were no board-certified surgeons in town or at the medical school, so he developed the residency program. He developed the system where people could become board certified.

Lindberg: There must have been a little town-gown feeling.

Noon: There was. There was as big town-gown feeling, and that's why he at one point was ready to leave and go back to New Orleans. Another thing that came up with Ben Taub, who there's a hospital named [for], the city/county hospital -- Ben Taub Hospital -- he was able to make some changes in the Jefferson Davis Hospital system at that time, which helped Dr. DeBakey get some teaching services over there.

Lindberg: So there was a person named Ben Taub then.

Noon: There was.

Lindberg: What was he like? What did he do?

Noon: He was a real estate-- he was a businessman. He wasn't really into oil as far as I know, but he was a businessman and very wealthy and very interested in healthcare and was on the board of the city/county hospital at that time, Jefferson Davis, and then he was able to make the changes after Dr. DeBakey met with him. It helped Dr. DeBakey make a decision to stay in addition to the VA hospital. So the Jefferson Davis later became the Ben Taub General Hospital.

Lindberg: I see. I didn't know that, either. That's interesting. I have seen an aerial photograph of essentially the campus of the Texas Medical Center in the days you're speaking of, the early days. Most of what's there now was cow pasture.

Noon: That's correct. In fact, one of the things Dr. DeBakey used to mention every now and then is that when he first went there -- like you say there's a lot of forest, trees, around there without buildings just there are a few buildings in there, and one of them was the Cullen Baylor College of Medicine building or University College of Medicine at that time. One time he said he heard a bang and went out to investigate it and found out there was a hunter out there hunting deer in the Texas Medical Center, so that's what it was like back in those days. It was really just a couple buildings and a lot of woods around it.

Lindberg: He takes credit or pleads guilty, maybe either way, to making the decision to invite the University of Texas to participate with Baylor in that development. Is that sort of an epic?

Noon: I'm not sure what he was doing with the University of Texas. One thing that they did along the way -- when he became president of Baylor -- I think it was in '68 or '69, something like that they stopped being Baylor University College of Medicine. It was Baylor College of Medicine, and with that change and not being affiliated with the Waco Baylor, they were able to get state funds to help support Baylor, and I don't know if that's what you were talking about.

Lindberg: No, I was really -- that's an interesting story, too, because I've heard it said that that was pretty much an oral, personal agreement with Michael DeBakey as opposed to sort of a statutory commitment. I guess, you'll find out about that.

Noon: Yeah, things are changing these days. We'll find out.

Lindberg: No, I was just thinking of the development of the Texas Medical Center as an entity different from Baylor College of Medicine, and a decision somewhere along the line to entice and encourage the University of Texas to be a part of that Texas Medical Center, which I think they initially were not.

Noon: They were not. The University of Texas component to the medical center was M.D. Anderson.

Lindberg: Right.

Noon: And it was a part of Texas from the very beginning, but they were the only ones until the medical school came in University of Texas Medical School [indiscernible] Houston. But what his role is in developing that move or development of a medical center in Houston, I don't know.

Lindberg: I wonder what am I missing? I'm not asking all the questions I ought to ask. What have I failed to ask you that would help us to understand Dr. DeBakey better?

Noon: I think that one of his main goals was education, and what he has done for education is remarkable, not only at the medical school level, at the national level. And he would start actually with high school students, and they developed the Michael E. DeBakey High School for --

Lindberg: I did forget that.

Noon: Yeah, and so he was very proud of that school, and the students have done very well nationally in exam scores that they have. I remember one time that you came to Houston, and we had some talks about Dr. DeBakey, and it was after his surgery, and they had, I guess, six or eight hundred high school students in the auditorium, and when they heard that Dr. DeBakey was coming in, they went wild. It was like a rock star walking in. They were yelling and screaming, and when he got in there they were hugging and kissing and wanted his signature.

Lindberg: He tolerated it all very well.

Noon: He did very well. But in addition to doing very well, he enjoyed it. I mean he loved every minute of it, because that's something that he was very proud of.

Lindberg: I think rightly so. There is an affiliation between National Library of Medicine and one of the high schools in town here and I've asked him about it. I guessed I expressed some impatience that we hadn't made more progress and asked him, "How did you make so much progress with that school in Houston?" He reminded me that it took 25 years.

Noon: It took 25 years, and he was dedicated to that. It wasn't something that was there and he never went there. He went there on a regular basis and visited one-on-one with the students over there and the faculty, so it was a continuing obligation that he was committed to and fulfilled.

Lindberg: Didn't he also talk to Baylor faculty into teaching more or less free over at the high school?

Noon: Right, yes, he did.

Lindberg: Yeah, so that would be a big important thing.

Noon: Right.

Lindberg: That's something we haven't been able to do. I think he has a right to be proud of that. Now will that all continue I suppose in his absence?

Noon: It will continue, and Houston is proud of it.

Lindberg: He did tell me, though, that it needs a new physical building.

Noon: They do want a new building, and I don't know if they have at this point the finances to construct a new building, but that's one thing that he was working on, to try and develop the funds to build a new building.

Lindberg: And Baylor was prepared to give land for the building.

Noon: Right. Whether they do that in the McNair campus but -- he didn't have the -- the funding is not completed to go ahead with that at this time.

Lindberg: We have a few building needs here, too, that are not completed.

Noon: Of course, right now as far as the Texas Medical Center -- there's not much room for new structures in there. It's pretty well all that forest has been converted to concrete and iron buildings.

Lindberg: It's pretty amazing. Is that the biggest medical center in the world?

Noon: The biggest in the world.

Lindberg: I mean, it really is a city.

Noon: Then you figure the number of people that are employed there on a 24/7 basis -- there's a lot of activity that goes on there.

Lindberg: Did he express to you any regrets?

Noon: One of the things that he was disappointed with -- when he first came to the medical center and after a few years he was affiliated with the Methodist Hospital, and that was his primary teaching hospital and that's where he did a lot of the firsts in surgical treatment of aneurysms and vascular disease and heart -- and after 50 years or so when that affiliation was broken, he was very disappointed. His goal was to try and keep them together and if not get them back together. So that's one of the things that we're presently still pursuing to fulfill his wishes, and I think that the hospital and the medical school who have named things after him -- like the hospital has Methodist Hospital DeBakey Cardiovascular Center the Michael E. DeBakey Department of Surgery at Baylor College of Medicine and on and on. They're all proud of what they have developed with his help. But now they need to get back together and fulfill his wishes that it would continue as a joint effort.

Lindberg: That would be a wonderful memorial to him. I know he was bitterly disappointed with that, too. Well, maybe you can help that happen.

Noon: Well, we're working on it.

Lindberg: Good for you. What else have I forgotten to ask you? I guess I forgot to ask you if you want lunch.

Noon: Well, one of the things in developing cardiovascular surgery -- initially there were no grafts to replace arteries or to bypass arteries, and the aneurysms -- when he first did aneurysms this was done by using a homograft, where they would take an aorta from a cadaver and prepare it and put it in a patient, and that worked well, but after a period of time these homografts became diseased, and they became aneurysmal and have to be replaced, and so in looking for a solution for that he developed a Dacron graft which there's other places in the country that were working on developing artificial arteries to use for this purpose, and he went to Foley's, which was a store in Houston, to get some material and was looking for nylon, and he went in to get the nylon so that he could do some work trying to develop a graft, and when he got down there and asked them for the nylon, they said that they were out of it, but they had this material called Dacron so he said, okay, let's try that. So he started working with it on his sewing machine at home and developed some grafts, and the Dacron proved to be the long-term solution to the problem that they were faced with.

Lindberg: Yeah, fate was kind. It's a wonderful story.

Noon: Yeah, fate was very kind.

Lindberg: We're still looking for that sewing machine. Is that still around?

Noon: I'll tell you what, Bill Butler thinks it's in his attic.

Lindberg: In his attic?

Noon: No, not Bill Butler's, in Dr. DeBakey's attic.

Lindberg: Oh, back up to that attic. I've been there.

Noon: Yeah, that's the last place that he -- because he asked me the other day if you had seen it. Because the last time he knew about it was up in the attic and what they've done is they purchased a similar machine so that they've got one, but it's not the original one that he used.

Lindberg: Well, back up to the attic. I'm going to look.

Noon: Yeah, back to the attic. It's in some corner in the attic covered up with something.

Lindberg: It's a big attic, but we'll find it.

Noon: Yeah, so I think that for the long term that was a significant development that he had with the Dacron graft taking the place of the homograft.

Lindberg: But it must have -- I mean the sharp contrast between that experiment which was done in a day or two. I mean a weekend maybe, and the FDA holding him up for four or five years before they can put in a much more commercial and reliable and professionalized pump -- I mean did every -- did it cause him to be bitter or complain? I never saw him bitter but --

Noon: As far as the development of the graft, after he did show that they could be constructed -- they did animal experiments, so they felt confident it would be okay to put in humans. At that time there was no IRB, Institutional Review Board, and in fact he said, "I am the IRB." And he had to use his own conscience and judgment and knowledge in going ahead and doing some type of experimental procedure in patients so the time it took from when he first sewed that graft until it was implanted was -- I don't know -- probably was less than a year. I'm not sure how long it was.

Lindberg: I see.

Noon: It wasn't the next day.

Lindberg: I see. I pictured it being a week and a miracle.

Noon: But now in a similar situation it may be 10 years or 15 years to go through the --

Lindberg: Right, I see.

Noon: -- FDA approval and not only that, the timing is the cost. For example, to develop a heart like we have or a ventricular assist device you can go from when you first start to implanting patients may take like \$60,000,000 or more. And at that time there was a lot of that; \$60,000,000 expenditures was not necessary, because you could just go right on to your implants so it was a matter of time and money both.

Lindberg: What animals did he use?

Noon: We mainly used the calves.

Lindberg: Oh, yeah, you wanted something big.

Noon: Well, the calf -- we used 70- to 80-kilogram calves, which is a similar size as a person or an adult. The other animal that we used occasionally was sheep.

Lindberg: But in the open heart work, generally, that's dogs, huh?

Noon: Yeah.

Lindberg: Okay, I think I have to thank you, and we'll return and do another session perhaps.

Noon: Okay.

Lindberg: Thanks very much.

Noon: Thank you.

### **Donald Lindberg Interviews George Noon/Video 3**

Lindberg: Dr. DeBakey established -- the Soviet Union -- you did -- you were good enough to tell us about trips that you made over there, but wasn't there a permanent kind of collaboration? How did all that go?

Noon: There was a permanent collaboration. It actually started about a year after we operated on Professor Keldysh, the chairman of the Academy of Science, and that was a joint program between the United States and the Soviet Union. The agreement for that was signed by Kissinger and Gorbachev on one end and on then the other was signed by Dr. DeBakey and Dr. -- now I can't think of his name. Shumakov, it was Dr. Shumakov, and so what it consisted of -- they had their laboratories over in the Soviet Union we had our laboratories here in the United States, and we would make exchange visits and compliment each other. And part of the work that we did, we did implants of total artificial hearts in the Soviet Union. We put an artificial heart from the United States in one animal and an artificial heart from the Soviets into the other animal and carried on some experiments. So we were surprised. About three years later, they were having a celebration of the 60<sup>th</sup> anniversary of the Soviet Union and as part of the scientific achievements, they had a picture of myself and Shumakov holding our hearts up right beneath the astronauts and cosmonauts and the accomplishments that we both did were part of their reporting that they did on scientific achievements for that time.

Lindberg: That's very nice. That was a really big deal.

Noon: Right.

Lindberg: How long did the work continue jointly?

Noon: It lasted for about four or five years. One thing as far as the Soviets and actually after the Soviet Union came down when we were over there with President Yeltsin, we had a dinner that was at the home of the Secretary of Health, and in his basement, he had a pool table, and the Russian surgeons that were at the dinner, they would disappear and they'd either go play pool or they'd go outside and smoke. But anyway, Dr. DeBakey followed them down to the pool room and was standing around just looking at them, and out of just kindness they said Dr. DeBakey would you like to play pool with us, so he said okay. So when it came to be Dr. DeBakey's turn, he completely cleared the table. As they say in Texas, "He kicked their ass." And they didn't know that he was a very good pool player which he learned to play pool when he was growing up, so we had the Soviet-American pool championship, which was won by DeBakey, an American.

Lindberg: That's a good story. I'm not surprised that he was good at that. He was good at every other thing he encountered. Was he a shooter?

Noon: Guns?

Lindberg: Yeah.

Noon: When he was young he did. In fact, they used to go duck hunting, take a 22 and shoot them in the head. Later on he gave up hunting because he didn't have time, and he also said later on that he just didn't have the heart to kill a larger animal like a deer. But when he was growing up, he did go hunting ducks and geese and rabbits and that type of thing and he was a good shot. He also was a good musician when he was growing up, and he also oftentimes compared surgeons to musicians because of the skills that go into doing the operation and the dedication it takes and the exactness it takes to do a good job.

Lindberg: So he was soloist, not a member of the orchestra, huh?

Noon: He was both, I would say. No, actually, he wanted to play in the symphony when he was in college, and he went to try out, and he was playing the saxophone at that time and they said they didn't have any need for saxophone players, but they could use a clarinet player, so he went out, bought himself a clarinet, worked on it for six weeks, and came back and tried out, and got a seat in the band.

Lindberg: I can easily imagine that happening. Surgery is something of a team sport, isn't it?

Noon: Yeah, it is a team sport. Without the whole team functioning properly, you're not going to end up with good results consistently. It [surgery] is just like any other group of people working together to common cause. If you don't do it in teamwork, you're going to have problems.

Lindberg: So is the surgeon a conductor or is he a soloist?

Noon: He'd better be a conductor.

Lindberg: Okay, I'm glad to know that we've got that all straightened out. There was one other topic that we didn't discuss earlier that Dr. Phillips reminded me of, and that's the DeBakey High School. How did that get going? Why did he do that to begin with?

Noon: Actually, I think it had a lot to do with minorities he wanted to get a better education for. So the High School for Health Sciences was developed, and after a period of time as they got better enrollment and established, then they called it the Michael E. DeBakey High School for Health Sciences. He was very proud of that high school, and it was very good as far as the students that were there achieving academically, and they could compete and were in the top of the high school around the United States. They were very competitive in their exams and results of their studies.

Lindberg: That's a thing to be proud of. Okay, we're going to change interviewers and the opportunity for a real expert in surgery to be part of our team in an interview beside you is a rarity it would be foolish not to take advantage of, so you guys can talk about the distal anastomoses and all those kind of things that interest you.

Noon: Okay.

#### **Steve Phillips Interviews George Noon/Video 4**

Phillips: I'm Steve Phillips. I'm Associate Director at the National Library of Medicine, and I'm privileged to sit here with Dr. George Noon and ask some surgical questions. George, your experience at the Texas Medical Center from my view as a cardiac surgeon is quite unique and certainly more extensive than perhaps what I trained under and what I did. Dr. DeBakey would never demand anything of someone else that he wouldn't do himself. I think we know that. This was his goal, to achieve excellence.

In achieving excellence he surrounded himself with excellent people. You had the chance to interact with, not only train under and learn from but also interact and teach with Dr. Stanley Crawford, Dr. Cooley, Dr. Morris, and of course Dr. DeBakey. What was your recollection of those days and the variety of things you were able to learn and absorb?

Noon: As you say, the experience we were able to obtain from that was just remarkable, and we were in a stage where cardiovascular surgery was being developed, so there were new things happening every day. He had the doctors that you mentioned, Crawford and Morris, etc., who first started working with him and then would branch off on their own so that they were running their own services, and Dr. DeBakey supported that. Of course, when they left it gave me the opportunity to come over when I finished my residency to spend full-time and become an associate of Dr. DeBakey. During that period of time we saw, of course, the evolution in the treatment of cardiovascular disease. We saw instruments being developed that made and facilitated doing the operative procedures that we were doing. We had a higher volume of operations than any other center in the United States at that time, so we were exposed to a volume which was very beneficial to us in our training and in our surgical procedures.

Phillips: And because of Dr. DeBakey's international reputation, you saw international patients and the pathology that really did not exist in the United States.

Noon: That's true, after he got established and it was circulated around what they were doing with cardiovascular disease especially aneurysms at that time and then later on occlusive disease -- patients actually came from around the United States and around the world. We had more patients from outside Houston that we had coming from Houston doctors. But they were there along with trainees that were coming from all around the world to learn about the surgery that we were doing in Houston.

Phillips: As you said, he trained so many people from around the world that when they went home though they were trained to do certain procedures, they didn't have the facilities to do those procedures, and they subsequently either referred the patients back to him in Houston or even accompanied them back.

Noon: Right, that's correct. That's one of the problems that they had in training individuals that were going back to countries or wherever they came from that didn't have the facilities to do those type of procedures, so in a way it was a wasted training for them because they weren't able to practice what they learned, and they'd have to come back with their patients for us to fix them up since they weren't able to do it at home. But as the years went by that disappeared and centers all around the world became more and more proficient in treating cardiovascular disease, and we saw less patients coming from abroad because they were being treated abroad, and they were being treated well.

Phillips: I think that system certainly motivated many physicians from around the world to improve their own situations, which perhaps they would never have done if they hadn't met Dr. DeBakey and trained in Houston.

Noon: Right. You know it's amazing what was considered training in Houston because he became a household name really, and physicians would come and they'd spend a day and watch Dr. DeBakey operate for a couple of hours, and they'd go back home and they'd fix a diploma up, and say that they had passed through Houston and they were Dr. DeBakey-trained even though they never really were.

Phillips: They were star struck.

Noon: Well, they wanted to impress the people around where they were working to get some cases to work on.

Phillips: Let me ask you about Dr. Stanley Crawford, who many people in our specialty knew of Stanley's excellent work in vascular surgery, but many others do now know and I know that you spent time and interacted with Dr. Crawford -- in fact you used his technology, some of his techniques, to operate on Dr. DeBakey. You did Dr. DeBakey's major surgery, and that is not something that a number of cardiac surgeons would not be capable of doing. Would you describe that to us?

Noon: First of all, Stanley Crawford became an expert in thoraco [abdominal?] and thoracic aneurysms and was world renowned for that. The procedure that we did on Dr. DeBakey was, of course, developed by Dr. DeBakey and Crawford and associates. I mean it wasn't just Crawford himself. In fact, I think Dr. DeBakey would take claim for doing the first ascending aortic aneurysm which was what he had.

Phillips: He classified them.

Noon: Right. In the 1960s the dissecting aneurysms -- which had what we call a Type II dissecting aneurysm -- he describes the aneurysm, the pathology, and labeled them as Type I, Type II, and Type III DeBakey aneurysms, and he had a Type II aneurysm, which developed when he was about 96 years old.

Phillips: You then performed the procedure to repair that on Dr. DeBakey.

Noon: Right, I performed the procedure where we removed the aneurysm and suspended his aortic valve and fortunately he did well. Took time to recover, but he recovered and got back to normal activities.

Phillips: Many healthcare systems around the world related to the economics of the situation would probably not even consider studying someone to determine that they had a Type II dissection, let alone operate.

Noon: Right.

Phillips: And that's a real tribute to our system that will allow someone like Dr. DeBakey, who is still very productive, to become healthy again.

Noon: As far as his operation was concerned, he postponed it as long as he could. He wasn't really looking forward to an operation.

Phillips: I can understand that.

Noon: But when it came time we decided to operate on him and got permission from his family, there was some concern from the ethics committee at the hospital that we shouldn't be operating on him because of what you mentioned, because of his age, etc. In fact, they called a special meeting, and it wasn't until his family came in and said, look, enough of this meeting. If we're going to save Dr. DeBakey we need to go ahead and do the operation, and they gave us permission to really proceed at that time, which we of course went ahead and did.

Phillips: And, of course, one of the contributions of Dr. DeBakey and you and your team were continuing to make was the development of the left ventricular assist device, and I happened to be fortunate enough to be present in the operating room when you inserted the first device into a woman, I believe --

Noon: Right.

Phillips: -- in the United States. And I asked Dr. DeBakey who was going to scrub, and he said Dr. Noon is going to put it in with a medical student, which is a tribute to the design of the device, so that it's easily implanted with probably just a short learning curve. Would you, perhaps, give us a little insight into that day?

Noon: It is a relatively easy operation where you emplace an in-flow cannula into the apex of the left ventricle and bring a graft around it and sew it to the aorta so that part of it is relatively easy, it just --

Phillips: For most people, thinking about putting something into the apex of the heart -- and we might say it's simple -- someone may challenge that, but actually it is technically fairly easy.

Noon: Technically fairly easy, right.

Phillips: The other end of the device connects --

Noon: To the aorta, so that you're taking blood from the left ventricle, pumping it through the pump back into the aorta, and then you're relieving the work of the left ventricle to the left side of the heart.

Phillips: So the ventricle that is weak will be assisted by an extra little pump.

Noon: Right, and that's why they call it a LVAD, left ventricular assist device.

Phillips: What are your thoughts about the status and the development of this whole family of devices? I just might mention or start off the conversation that my view is that technically we've reached the point where these devices are efficient and small enough to be implanted in large numbers of people, comparable to the way the pacemaker was in the late '50s and '60s. There were so many people, half a million people going into heart failure every year that walk around with 10 and 20 medications that are burdened by this and still do not feel quite well. But in your experience with all these people and patients, they seem to recover nicely and function fairly normally.

Noon: They do, and we started putting devices in in the 1980s to begin with. And have made considerable progress in the devices that we're putting in as far as their size, etc., and also what we call the adverse events that occur with the devices, such as bleeding, infection, etc. We're at a point today where those adverse events are minimized and now the cardiologists who were reluctant to send patients to have these devices in are sending the patients in at a much earlier stage so that they're not in kidney failure, liver failure, lung problems, etc., which made the results a little bit miserable in that really sick population of patients. But now the things are much better as far as these adverse events. They're coming in much earlier. The other thing is we initially were putting devices in as a bridge to transplants, that's what they were approved to [do], so those would be patients that were on a transplant list that wouldn't survive without the support of the device, and so the device is put in and would be left in until they were transplanted and, of course, take it out.

Phillips: Actually, what you are saying these adverse events, which raises red flags sometimes to the regulatory folks or even the general population, would not have had the opportunity to occur, because most of these people would have died.

Noon: That's correct.

Phillips: So we're at the point now where I think the quality of life -- and I hope you can confirm that -- for these folks are excellent.

Noon: It is impressive the way these patients get around. Initially, these patients would stay in the hospital until they were transplanted. And then we have another group of patients that are called destination therapy, where the device is placed in and is left until they die or they recover and the device is removed. But patients don't stay in the hospital very long anymore. They're going out to their homes. Many patients are going back to work. In fact, some patients are feeling so well, they don't even want to consider having a transplant anymore they just say they'll stick with their device, and the longest one of these devices has been in an individual is seven and a half years, and that patient didn't die from his pump going bad. It was because of other complications related to nosebleeds that he had and then developing renal failure. But in examining the pump seven and a half years later, the pump looked pristine, so we're expecting that there's not going to be any problem with duration of these pumps, whereas -- and this is an axial flow pump compared to the pulsatile pumps, which did have a limited lifespan, depending on which pump you put in, anywhere from a year and a half to maybe at the most five years they'd last and then have to be replaced.

Phillips: Surgeons are generally creative people. We all try to modify operations, improve operations. Could you possibly tell us about your experience with doing this and creating some different technologies and techniques that have been helpful?

Noon: As far as one of the different things that we did differently in some patients is that normally we would go through what we call [indiscernible] to implant the device, and we see many patients who have had previous operations like coronary artery bypasses or other procedures following which they develop a lot of scar tissue around the heart, and sometimes it's difficult to get everything freed up and exposed to do the operation, so we developed a different technique where we go through the side through the ribs, in between the ribs, we call a thoracotomy, and implant the device into the apex of the left ventricle and into the descending thoracic aorta so that we would stay away from the heart and the bypasses or whatever had been done previously through the sternotomy incision.

Phillips: That's perfect. Well, Dr. Noon, thank you for your insight and spending some time with us and supporting the effort to create the Profiles in Science for Dr. Michael DeBakey.

Noon: Well, thank you. It's nice to be here.

**Tom Bowles Interviews George Noon/Video 5**

Bowles: I'm Dr. Tom Bowles, a surgical consultant to Dr. Lindberg at the National Library of Medicine, discussing with Dr. George Noon a project on the history of cardiac surgery in this country. Dr. Noon and I were colleagues many years ago in Houston finishing our training with Dr. DeBakey, and at that time I think we both experienced a very exciting training period with an extraordinary surgeon. Subsequent to that Dr. Noon became the right-hand-man of Dr. DeBakey and the development of many of his surgical innovations, and particularly the one I wanted to ask Dr. Noon about today has to do with the left ventricular device, and Dr. Noon was a critical player in its development. George, I wanted to ask you about your role in helping to select the materials for that particular critical piece of clinical equipment, and your use both in the lab and then subsequently clinically in its development.

Noon: Let me just give you a little history. We started working on a total artificial device and assist devices back in the 1950s and '60s, and actually the first successful left ventricular assist device for temporary use -- it went out to a period of ten days -- was done in 1967 on a patient who was unable to be weaned from cardiopulmonary bypass after having had a double valve replacement. So we went back that far, but in the development of these we sort of hit a wall in that we were unable to make significant improvements in the durability, the size, the materials that we were using in developing these pumps, and we -- a period of time from the '70s until the '80s -- where not really much activity was going on.

[Noon:] In the mid-1980s, we started implanting pulsatile devices which are large devices such as the Novacor, the HeartMate II-- I mean the HeartMate I--and the Thoratec pump, which will pump on the outside of the body. Anyway, these were sort of large and cumbersome, and we decided we wanted to make a smaller pump. The only way we could make a smaller pump would be to go to a different kind of flow rather than pulsatile flow. So we called one of the engineers from NASA who we'd done a heart transplant on and asked him to put us in contact with those engineers out there who might be interested in developing the pump. So they did, and there were three engineers we met with, and they had worked with axial flow pumping fuel in the [space] shuttle. So that's how we ended up working with a smaller size pump.

[Noon:] One of the things, of course, in these pumps is the trauma to the blood and hemolysis, and it took a period of time -- in fact, from the time we first started on the pump in 1988 until 1998, when we did our first implant, it took almost ten years to get it to the point that we were ready to put it in human beings. Things were a little bit slow because the financing was not so great. But anyway, one of the main factors that was able to help us in diminishing the amount of trauma to the blood was computers where we do CFD and computerized fluid dynamics, and we were able to visualize the flow through the pump, and so we could decrease areas where there were vortexes and stasis, which were contributing to the hemolysis.

[Noon:] After a period of time, we were able to minimize this and proceed on with our clinical implants. As far as the device when we first started out, we were using Lexan just to mill the device and then we went over to titanium. We used titanium. At one time because we were having some problem with blood clot, we tried a heparin coating called Carmeda, which ended up being a disaster, and it didn't really work, so we stopped and so at the present time, we're not using any coating on the titanium at all. Subsequent to our first initial clinical experience where we did about 444 pumps, we were still having some problem with blood clots on some of the

areas of the pump. We went back to the CFD and flow visualization and have developed another version of the pump, which looked similar, but at the present time our experiments both in the mock loop and in animals have shown no evidence of clot formation. We're getting ready to start a second round of implants in patients.

Bowles: That's remarkable. That's really some achievement. One other consideration -- I know the concern -- your whole group -- was the external power source and the need to penetrate the body to something external and controlling infection in that circumstance. Was that something that caused any significant problems in the beginning or how did you choose to deal with that?

Noon: One of the, of course, major complications of these devices is infection, and one of the areas where this infection develops is in the driveline that comes out from the body. In the pulsatile pumps, because they also had to have air going back and forth were very large and stiff, and so there was a high incidence of infection, but when we went to the smaller continuous flow pumps, there was a much smaller driveline, and so the infection rate just went way down. So the infection rate is very low at the present time.

Bowles: That's wonderful.

Noon: We had always anticipated or what we would like to do is develop a device where there is no driveline coming through the skin. There's no tethering, and so we'd have what we called a TET system where the power would be transmitted through the skin to a controller and also keep a battery charged, which is on the inside. Presently, the devices that have had that [TET] are not being implanted, but when they were implanted, they had about a half hour of battery life when the battery was on the inside, which is not very long, and otherwise they had to be connected up to this outside power source, which was transmitted through the skin called a TET.

Bowles: That's remarkable, so helpful and so clinically relevant now, becoming more so as these get implanted more and more for at least temporary relief of a serious cardiac condition. Let me ask you one last question maybe a little bit more personal with regard to working with this extraordinary Dr. DeBakey and his energy levels even in his 80s and early 90s. You were a relatively young guy when you were working with this guy. Was it tough to keep up with this dynamo?

Noon: Yeah, he was always tough to keep up with, and even younger and when he was older, he had a lot of energy, more energy than most people. I know like when we were on service together, I was there as a resident spending three months in the hospital without ever leaving the hospital, and he would show up all hours of the night, coming to check on patients that were sick and he'd look just as fresh as ever and be back the next morning. And, of course, he'd go on trips where he'd give lectures, and he'd come back at two o'clock or three o'clock in the morning, and he'd be there at six o'clock in the morning ready to roll. His energy was --

Bowles: Well, fantastic. I know he had frequent trips to Washington consulting with President Johnson. I remember one of our colleagues at that time -- I can't remember his name -- got on the plane -- and he was always worried about flying and he thought I wonder if anything is going

to happen to this plane, and then Dr. DeBakey got on the plane, and he heaved a sigh of relief, and he said, well, if Michael DeBakey is on this plane, surely nothing could happen to him.

Noon: Nothing is going to happen.

Bowles: Yeah, that's right.

Noon: That's true.

Bowles: Okay, well, listen is that enough? Will that do it? Okay. We don't want to keep George here all afternoon, but does that work? Okay.

Bowles: That was great, George.

Noon: Thank you.