Pioneer Perfusionist Interview: Terry Crane

Mark Kurusz: Today is June 6th, 2024. My name is Mark Kurusz, and we're at the Texas Heart Institute in Houston, Texas, to interview one of the very early perfusionists, Terry Crane. This is being conducted on behalf of AmSECT. There is a history committee, and we've chosen subjects very carefully. And looking at retired perfusionists, for the most part now, Terry has had quite the career from the 1970s until 2022, when you retired, is that right, Terry?

Terry Crane: I retired in January 2020.

Mark Kurusz: 2020, thank you.

Terry Crane: I have given a few lectures for a couple of years after I retired.

Mark Kurusz: Well, we really appreciate you being here, and I'm delighted to be able to interview you. We've been friends for a long, long time. And without further ado, I'd like to ask a little bit about your background and what were the circumstances that led you to become a perfusionist, Terry?

Terry Crane: I was working in a hospital laboratory and diagnostic clinic, while completing my bachelor's degree in industrial education at West Texas State University. I heard about the Texas Heart Institute (THI) School of Perfusion Technology from one of the people who worked in the local blood bank and had graduated in December 1972, which was the year the school started. I applied to the program in early 1973, and I was very fortunate to be accepted.

Mark Kurusz: Sure. And where were you a lab tech? Was that in Amarillo?

Terry Crane: Yes, in Amarillo, Texas, at the Amarillo Diagnostic Clinic and at St. Anthony's Hospital. I worked at the clinic from eight to five during the day and at the hospital from 5:30 in the afternoon until 11:00 at night.

Mark Kurusz: So, you were really doing two jobs?

Terry Crane: Yes, and that's part of the reason I could not come for an interview. I was one of the few, if not the only applicant, who never had an interview.

Mark Kurusz: But did you talk with Charlie Reed over the phone?

Terry Crane: I never spoke to Charlie Reed. I just sent a letter with my application, indicating that I had two jobs working five to seven days a week, and I didn't have time for an interview, but please consider my application. My two friends from the laboratory at St. Anthony's Hospital drove to Houston to speak to Charlie, and all three of us were accepted in a few weeks.

Mark Kurusz: And did you grow up in West Texas?

Terry Crane: I had lived in the south most of my life and lived briefly in California and Colorado. My last two years in high school were spent in Cotton Center, Texas, and there were only 20 people in my high school senior class.

Mark Kurusz: Is that right?

Terry Crane: Yes, Cotton Center was a very small town compared to previous schools I attended, but I learned more in that school than previous schools attended. I also got to participate in sports and agriculture events which I had not done in the past.

Mark Kurusz: When you started in the training program here at the Texas Heart Institute, how many students also started with you? How many were in your class?

Terry Crane: The class sizes at that time were relatively small. We started with 14 students and ended with 12. Students participated in academics and clinical rotations on the same day. They tried to give most of the lectures in the morning, so we could apply those topics to our clinical rotations later that morning or afternoon. We never knew when the lectures would be scheduled due to availability of the speakers. So, lectures could be given at any time of the day or evening, which was significantly different than attending a university.

Mark Kurusz: And when did you start? Was it in January or July?

Terry Crane: I started school in July 1973 and started on staff in January 1974. I worked as a staff clinician for over a year, and Charlie Reed, the program director, and Diane Clark, who was the associate director of academics, asked me to become the associate director of the clinical services. I accepted the job, and it was a good role for me because I had an opportunity to do clinical cases, take care of equipment, supplies, and other things that were necessary for the department. I admit I was surprised that none of the more experienced staff stepped up for the position.

Mark Kurusz: Sure. Backing up a bit, when you started your training, what time of the year was that, and how long was your training?

Terry Crane: The training in the early days for Texas Heart Institute was for six months. Those six months felt like two years, because you would do two or three cases a day based upon the lecture schedule. There was really no time off; in fact, my son was born in October 1973, and I worried about taking time off. My brother-in-law was taking care of my wife in Amarillo while I was in school, and he called me one morning to inform me he was taking my wife to the hospital delivery room. I think I was doing a pediatric case that morning, finished the case, flew to Amarillo that afternoon, and returned to Houston on Sunday. I was extremely fortunate to

have my brother-in-law taking care of my wife and son at this time because I could not spare missing any time from my clinical or academic rotations.

Mark Kurusz: Oh, boy.

Terry Crane: It was a different type of training in those days. Eventually they expanded the program to one year starting in 1977 and offered a bachelor's degree in perfusion technology from 1983 till 1993. Currently the school offers an 18-month post-baccalaureate certificate program.

Mark Kurusz: Do you remember any of the other trainees who you worked with in 1973 that essentially started at the same time you did, Terry?

Terry Crane: Bill Keen, Jim Crawford, and I were working at the hospital laboratory, and graduated from perfusion school together. Bill and I remained at THI after graduation, and a few years later he accepted a job in Florida, where he has since retired. Jim accepted a job in Tennessee after he graduated and has since passed away. Kathy Spiller was another classmate who accepted a perfusion job in Kansas City and is now retired in Galveston. It was interesting that Bill, Kathy, and I worked together in medical manufacturing for a period of our perfusion careers. My other classmates have since retired or passed away.

Mark Kurusz: Sure. And was Charlie the director and Diane Clark the co-director?

Terry Crane: Charlie Reed was the director of the program, and Diane Clark was the associate director of academics.

Mark Kurusz: Okay.

Terry Crane: I recall in 1974 they started writing the book "Cardiopulmonary Perfusion", and we were fortunate as clinical staff because we were able to get copies of each chapter before it was ever published. That certainly helped us because we only had a few books related to perfusion technology. The William Harvey Corporation was one of the medical manufacturers at that time, and they gave copies of the book to students and perfusionists around the country. The book was considered a very good reference because it covered the basics of anatomy, physiology, pharmacology, and perfusion, but I always considered "Heart-Lung Bypass" by Galletti and Brecher as our bible because it was more in depth than what Charlie and Diane covered.

Mark Kurusz: Sure. Now, you mentioned lectures sometimes taking a backseat to the clinical load.

Terry Crane: Yes.

Mark Kurusz: Who lectured the students back then, Terry?

Terry Crane: In those earlier days, the lectures were given by some of the perfusion staff. We also had lectures from Dr. George Reul and Dr. Grady Hallman, two of the THI cardiac surgeons. Dr. Arthur Keats, Chief of Anesthesia, Dr. Kamel Girgis, Dr. Franz Segger, Dr. Alexander Romagnoli, Dr. Phiroze Sabawala also provided lectures from the CV Anesthesia Department. So, our lectures were a mixture between perfusionists and physicians and was based upon their available time to discuss specific topics. I recall the day before my son was born, Dr. Keats was giving us a lecture on general anesthesia used in open-heart surgery, and I was able to use that information the next morning on a clinical case. I still have those notes and they were written on paper towels, because we didn't have easy access to notebook paper or computers like students do today.

Mark Kurusz: Sure.

Terry Crane: I also took notes on medical device instructions for use (IFU) I found in the trash cans.

Mark Kurusz: Well, now, as you look back, there's been a tremendous evolution in perfusion education. How would you characterize your experience in 1973 with what's going on in the program today?

Terry Crane: I'm not exactly sure what's going on in the program today, but I can say from a historical standpoint, it was an extremely difficult program. For example, a typical clinical day for us consisted of assembly of the circuit with a staff perfusionist in the room before the patient arrived, participating in the procedure as directed by the staff perfusionist, cleaning the pump with our staff, and cleaning the stainless-steel instruments for sterilization. We had to be ready to assist the staff perfusionist assemble another circuit when the cleaning mop came out of the room. That left all of us with very little time to take breaks between cases. This type of training was in part due to Charlie's training in the military and he encouraged me when I became the associate director of clinical services to continue that approach. He asked me to push people to their limits and one step beyond. I did that for a couple of years and then decided that was probably not the best way to treat people because we were not in the military.

Mark Kurusz: Sure.

Terry Crane: Those not ready to assemble the circuit could face dismissal from the program. At one point Charlie even emphasized perfusion-related material was the only acceptable item students or staff could read during the day. Again, he really wanted students and staff pushed to their limits, and we did it, but over the years I believe we offered a better approach to teaching. We also extended the length of the program to provide more academic and clinical rotations. At one point we trained students to become physician assistants and later were able

to apply for that certificate. All the staff perfusionists were certified by the American Board of Cardiovascular Perfusion, and a few of us became certified physician assistants. We would assist the surgeons taking vein, opening the chest, retracting, pulling chest tubes, and other tasks as supervised by the physicians. This offered us a wonderful opportunity to see what was being done at the operative table, and we could apply that knowledge to our main purpose of operating the heart-lung machine.

Mark Kurusz: Sure

Terry Crane: I remember Dr. Cooley, Dr. Reul, and Dr. Hallman would schedule their pediatric cases first in the morning, followed by their adult procedures, ended the day doing aneurysms, and we would normally be completed by late afternoon or early evening. Over the next few years, we went from doing 10 to 20 cases a day to approximately 50 a day. When I graduated in 1973, the students and staff participated in a little over 2,000 cases in six operating rooms, and that increased to over 4,000 cases a year by 1977 in eight operating rooms and over 5,000 cases a year by 1980 in nine operating rooms.

Mark Kurusz: That was really a very heavy caseload, even back in the early 1970s.

Terry Crane: Correct, but it became easier to do more cases each day because we stopped using reusable stainless-steel connectors, cannulae, and suctions. We also switched from individual tubing lines to custom tube packs that included precut tubing, plastic connectors, and eventually blood and gas filters were added to the tubing pack. There were also gowns and drapes used to assemble the circuits and to take sterile lines to the operative table. The rooms turned over much faster by using completely disposable circuits.

Mark Kurusz: Sure.

Terry Crane: Those were just a few of the reasons we could do more cases in a day.

Mark Kurusz: Tell us a little bit about what equipment you used, starting with the oxygenator.

Terry Crane: We used all brands and sizes of bubble oxygenators for our cases because we were a teaching institution and wanted students to have diverse skills because we did not know where they would be employed after graduation. I used the Travenol 2LF bag for pediatrics, Travenol 6LF bag for adults, and TMP Venotherm bag as another bubble oxygenator. We eventually switched from bags to hardshell adult and pediatric bubble oxygenators, and those were from Bentley, William Harvey, Shiley, Cobe, and other companies. Later we used the Travenol TMO membrane that required dual pumps but preferred the SciMed membrane because it only required a single pump system. The SciMed also had a wide variety of sizes for pediatrics and adults. Most of the cardiopulmonary device companies have since merged, and vendor selection has dropped from approximately 40 companies to approximately five today.

Oxygenator technology improved over time and so did equipment. Our heart-lung machines were either the Travenol modular pumps, where you would adjust the occlusions with the wrenches, or the deluxe Sarns heart-lung machine that had console or modular pump bases. A few of the console pumps had built-in heat exchangers for the water lines and made our job easier because we could attach the water lines directly from the pump to the oxygenators. We modified a few of the Travenol heater water pumps to provide hot or cold ice water to the oxygenators by strategically moving specific clamps. Dr. Cooley's motto was Modify, Simplify, and Apply. We followed his motto by making the circuits very simple and only had the arterial roller pump with two roller pump suctions. Cardioplegia was delivered by the anesthesiologist from the head of the table, using a blood pressure cuff around a one-liter bag of crystalloid cardioplegia, and the perfusionist did not have to deal with that part of the procedure.

Mark Kurusz: Sure. And I believe Texas Heart was not at the forefront of using arterial line filtration, were they?

Terry Crane: No, because Charlie did not believe there was adequate data to support their use, and he participated in debates over the intended use of arterial filtration. I recall being confused about his lack of support on the topic because we had completed research on blood transfusion filtration, cardiotomy reservoir blood filtration, and filtration of bagged blood at the end of bypass, and all showed improved patient outcomes.

Mark Kurusz: Okay.

Terry Crane: Charlie may have been slow to accepting the benefits of arterial line filtration, but in the end, he saw enough evidence to support their use.

Mark Kurusz: I believe one of the real proponents of filtration was Dr. Thomas Solis.

Terry Crane: We did our blood filtration studies with Dr. Thomas Solis and Dr. George Reul, and we also had their support when doing our pre-bypass filtration studies. In those early days of bubble oxygenators, we found the devices contained visible particulates in the oxygenators. We would use a liter of crystalloid to rinse out the oxygenator by swirling it around and drain it with those visible particles. We would then add another liter, swirl it around, drain it out, and we kept doing that until it was visibly clear. Sometimes it would take approximately 20 liters of crystalloid to rinse out the oxygenator. We purchased 5-micron Millipore filters, sterilized them, and paced them between the arterial and venous lines to capture the particulates. In our research we would prime the circuit with two liters of crystalloid, recirculated at 2 LPM for five minutes, and then remove the filter to be analyzed and counted using a microscope in my office. It was then we found the particles consisted mostly of nylon tricot used in the oxygenator manufacturing process.

Mark Kurusz: Oh, sure.

Terry Crane: We told the medical manufacturers about this, and they all made significant changes in their manufacturing processes. Later nylon was found to be a complement activator, and the manufacturers found new materials. The only device that did not have a high particle count was the Travenol 2LF for pediatrics and the 6LF for adults, because those are just basically two sheets of polyvinylchloride (PVC) material that are dielectrically heat-sealed together.

Mark Kurusz: Sure.

Terry Crane: The bottom line was the Travenol bubble oxygenators were the cleanest, and all the companies changed their manufacturing processes to reduce particulates in their devices. Our follow up studies indicated a reduction in patients' neurological deficits by using pre-bypass filtration.

Mark Kurusz: Wonderful.

Terry Crane: Yes, it was good for the patients, and it opened the eyes to the perfusion community.

Mark Kurusz: Now, you've mentioned some of the surgeons you worked with. You mentioned Dr. Arthur Keats. Tell us a little bit more about how the perfusion team interacted with the anesthesiologists, and particularly Dr. Keats, because he was a towering figure.

Terry Crane: Dr. Keats was a remarkable man, not just as the Chief of Anesthesiology, but also as a person. We were very fortunate to have him give us lectures, and he helped us in a leadership role because the perfusion department reported to him and his anesthesia group. He believed the anesthesiologist should administer drugs during cardiopulmonary bypass, and this allowed the perfusionist to concentrate on the heart-lung machine parameters. I'm still old-school and believe the same thing. The surgeons and anesthesiologists went to medical school and have their specific responsibilities, and perfusionists are trained to operate the heart-lung machine and those parameters. This does not mean we cannot communicate with each other before, during or after bypass, and I believe that communication between us strengthened the team.

Mark Kurusz: I've often thought that when cardiac surgery is taking place, the surgeon is preoccupied with the operation.

Terry Crane: Sure.

Mark Kurusz: And the anesthesiologist, at least, at least in my experience, was always an ally, and if there was some issue that would come up, you could always...

Terry Crane: Absolutely rely upon the anesthesiologist to take care of the patient based upon their medical training.

Mark Kurusz: …consult with the anesthesiologist and do whatever to make things get back on the track, so to speak.

Terry Crane: Yes, and the other nice thing too, is Dr. Keats would never allow us to operate our pump suctions the moment before protamine was administered. We always turned off our suctions just before protamine was administered, and therefore we never had any problems. I have heard some surgeons and anesthesiologists will require suctions to remain on while a specific portion of protamine has been administered, and this technique has led to occasional clotted circuits.

Mark Kurusz: Sure.

Terry Crane: Which was not good for the patient or perfusionist.

Mark Kurusz: Sure. Tell us about some of the surgeons. Obviously, Dr. Cooley was a profound influence, but who else stands out? You've mentioned two or three names. Tell us a little bit about some of the surgeons you worked with, Terry.

Terry Crane: Dr. Cooley was the most helpful and influential physician in my perfusion education because I was allowed to assist at the operating room table on occasion. The responsibilities of assisting at the operative table and operating the heart-lung machine allowed me to apply many of those techniques to other operative procedures. I recall him showing me different techniques on how to cannulate, cutting lines, and doing so in ways I had never considered. He was also very accommodating and respectful during surgery.

I remember during one case my suctions were not turned up high enough, and the beam of light from his head lamp was shining on my chest. He said, "Terry, I know we are in an energy crisis, but I am losing blood in the operative field. Do you think you could increase the speed of the suctions a little higher so I can see better?" That was the most embarrassing day of my life and we joked about it many times, even after he retired.

Dr. George Reul was also a great adult and pediatric surgeon who influenced my life. I could tell the student what he was doing at the operative field seconds before the event based upon his body stance and sounds from the instruments at the operative table. My prior assisting at the operating table helped because I knew the surgeon's body stance and techniques used for coronary artery bypass and valve procedures. I could tell by their body stance if they were doing a proximal or distal anastomosis, and how far they were in that step based upon the sounds of the needle holder. For example, needle holders make a unique clicking sound, "click 1, click 2, et cetera", and you can hear the needle being snapped from the suture just before it is passed back to the scrub nurse. Their elbow movements told me what they were doing in the

procedure, and that way I could easily anticipate the needs of the surgeon and demands of the patient. Like hearing the aortic cross clamp on and off.

To me, perfusion is not just a science—it is also a fine art. I was once told an artist can see and show to others what ordinary eyes cannot see. A simple example of anticipating the needs of the surgeon is operating the suctions at a speed to remove the blood from the operative site without making noise or collapsing the tubing. We know less blood is removed by suctions when the tubing is collapsed, and the speed should be reduced to remove more blood per unit of time. That was one of the nice things we could do in the earlier days of perfusion, but over the years many surgeons and perfusionists have overlooked the basics of suction control. The perfusionist should anticipate the needs of the surgeon and the demands of the patient. And by staying ahead like that, you can do a remarkable job.

Mark Kurusz: Sure.

Terry Crane: Dr. Grady Hallman was another excellent adult and pediatric surgeon, and I learned a lot about cardiac surgery because he was an outstanding teacher. I recall he taught residents how to fill the aortic cannula appropriately by having the perfusionist pump fluid to the end of the arterial line, not over it, and he would meticulously attach the arterial line to the arterial cannula without spilling any blood in the operative site. I enjoyed listening to him teach the residents about various steps of the procedure, and I could visualize what was being done at the operative table. I also enjoyed his discussions of classical music playing in the background. I rode a motorcycle to work every day because I do not like driving cars, and I started listening to classical music. I did not know what the instruments were or what the music meant but liked the sound. I remember a few people would stop me in the parking garage or at a gas station and say, “Why are you listening to that?”

I’d say, “Because I like it.”

So, Grady Hallman had an impact on my perfusion career, as well as my interest in classical music, but I still like the American Indian flute and country music.

Mark Kurusz: Sure.

Terry Crane: I would like to add, Dr. Reul also impacted my life as a perfusionist by his steady and calm ways he practiced medicine. He also involved me in blood filtration studies, and eventually autotransfusion. We purchased a cell saver in the mid-1970s, but we never collected enough blood to process from Dr. Cooley’s cases because he didn’t lose that much blood. We kept the device for about a year and had to place it in storage because of lack of use. Eventually, cell savers became more popular with other physicians, and we ordered units from different manufacturers because we wanted to expose students to multiple devices.

Mark Kurusz: Wonderful.

Terry Crane: We had immediate success, and I was able to collect data from all those procedures to show how much blood was processed, transfused, and including savings to the hospital.

Mark Kurusz: Sure. Before we leave, regarding some of your background, what sort of certificate or diploma was awarded to the graduates of the perfusion training program here? Was it from St. Luke's or Texas Heart?

Terry Crane: Our perfusion certificate was from the Texas Heart Institute, which is a research and educational foundation, but THI also provided clinical support to Texas Children's Hospital and St. Luke's Episcopal Hospital at that time. Eventually Texas Children's built a new facility and St. Luke's was acquired by the Catholic Health Initiative. The THI Perfusion Department was eventually transferred to St. Luke's many years later, but the school remained under THI. Students continue to do their clinical rotations at St. Luke's/Catholic Health and at other clinical affiliates around the country.

Mark Kurusz: Sure. Tell us a little bit more, too, about your training as a physician's assistant. Was that a similar certificate from THI?

Terry Crane: It was similar in that we were trained by the physicians, applied to the national physician assistant (PA) program, and were awarded a PA license. I did not renew mine when I went to work for medical manufacturing, and today I would have to attend a master's program to receive credentials as a physician assistant. Thinking back on it now, it would be considered basic on-the-job training, similar to how perfusion and other allied health jobs began, but eventually those allied health groups required formal academic and clinical training before receiving their credentials. We would scrub in to carry the lines to the operating table and assist at the operative table until it was time to run the pump, but sometimes we remained at the operative table to assist when needed. That experience gave me a significant advantage over other perfusionists, because I could see and hear the sounds various instruments being used, including the sutures, and that would tell me what they were doing at the table, and I could apply that knowledge behind the pump.

Mark Kurusz: So, you got a wonderful perspective from that experience.

Terry Crane: Yes. I gained a whole new respect for the physicians by assisting them at the table and seeing the stress they face, and that is different than the stress we face as perfusionists. I could apply surgical knowledge behind the pump by anticipating their needs before being asked to perform a task or by being told what to do by the surgeon. Another thing I learned, while at the operating table, was you can hear all the tiny whispers and conversations that are going on in the room. Most people do not know that when sitting or standing behind the heart-lung machine and should be very careful what they are saying.

Mark Kurusz: Sure. I'd like to shift gears now a bit, Terry, and ask you about some of your career highlights. In your opinion, what were some of the most notable perfusion practice changes or innovations that occurred during your practice as a perfusionist? You've already mentioned pre-bypass filtration.

Terry Crane: Sure, I will never forget going from an arterial roller pump to a centrifugal pump. Dr. Harold Kletschka, Ed Rafferty, an engineer, and Allan Robinson, a perfusionist, had come to the Texas Heart Institute in 1975 to show us the new BioPump, and I was amazed by the technology. It was incredible because everybody used arterial roller pumps up until that time. We ran it in the lab for a few days, and then used it on the first open-heart procedure on August 14, 1975, which was the day before my birthday. The other interesting thing was we were scheduled to do an adult case that morning, but it was changed to a 10-year-old Jehovah's Witness patient. We were discussing if it would be practical to use for a pediatric patient, and everyone agreed it would be acceptable due to the wide range of flow possibilities. The pump did not come with a hand-crank as a backup and Charlie had us extend the arterial line from the bubble oxygenator to a pre-occluded roller head, remove the tubing from the roller pump head, and extend it to the BioPump going to the patient. This became a great backup system in the event the BioPump failed, which it did not. The BioPump made the most significant advancement in pump technology, and I also know, from conversations from many perfusionists, it made a significant difference in future patient outcomes by preventing air from being accidentally pumped from the bubble oxygenator arterial reservoir to the patient or venous reservoir to a membrane.

Mark Kurusz: Really?

Terry Crane: Absolutely. Especially when there was a loss of operating level during cardiopulmonary bypass or blowing off lines and how the BioPump prevented these events. It also had other advantages for left heart bypass and ECMO. The BioPump became the basic design for all centrifugal pumps that are on the market today. Also, technology regarding transition from bubblers to membranes made significant differences including reduced priming volumes with smaller circuits have all contributed to improved patient outcomes. Blood filtration and advancements in autotransfusion has certainly improved. I cannot overlook how roller pump technologies have also changed over the years, from using wrenches to using deluxe occluders, and especially safety devices, such as level sensors, air detectors, pressure monitoring, temperature measurements, inline sensors, etc. and how they helped us see physiological trends during bypass. We were able to take corrective action sooner and improve patient outcomes.

Mark Kurusz: Sure.

Terry Crane: Those items that have been helpful and beneficial in the past several years include data acquisition systems, which have provided us with documentation that we can compare techniques and technology that lead to better patient outcomes.

Mark Kurusz: Sure.

Terry Crane: And computerized reporting is legible.

Mark Kurusz: Sure. So, with the volume of cases here in Houston I collected an interesting statistic, when I was in Galveston in the late seventies, that one-seventh of all open-heart procedures in the United States were performed in Harris County. That was due to a large part, obviously, with Texas Heart and Methodist Hospital and some of the outlying hospitals. Here's a follow up question to the technological advances. Because Texas Heart was doing so many cases, did you frequently see industry representatives, not salespeople, but engineers, coming to observe, to pick your brain?

Terry Crane: Oh, absolutely. In fact, we created a program at the perfusion school to help educate those individuals. We provided basic science classes, reviewed various devices used in the market, and then allowed them to observe different procedures using various devices in surgery. We were able to condense one year of perfusion training into two weeks so the engineers, sales, or others could visualize the features and benefits of different devices. This became very easy because we were a teaching group and used almost all the perfusion devices in the market at that time. Eventually we only had access to the observation domes, but this still allowed us to discuss features and benefits of the various devices. This educational exchange helped develop better devices for the future. Today those individuals are not allowed to observe the same way they did in the 1970s, but every effort is made to assist the manufacturers in their company focus groups when designing new devices.

I worked for medical manufacturing for a few years and was fortunate the perfusion department allowed me to bring people from different departments in the company to observe open-heart surgery from the observation domes. Patients were draped and not identified, and this allowed the engineers, salespeople, quality control, regulatory affairs, and other departments to see how the devices were used in cardiac surgery. People left the observation domes with a greater pride in knowing what they did had an impact on patient outcomes. Many times, there would be high school or university students touring the domes on the same day, and I would include them in my lectures. Regrettable today such visitations are not allowed, even with unidentified draped patients, and alternative methods are used to educate people interested in the development of medical devices or individuals seeking medical careers.

Mark Kurusz: Well, you touched on this early on in this interview, and that is you obviously mentored and taught a lot of students over the course of your career. Can you give us a guesstimate of how many you think you've mentored, Terry?

Terry Crane: I assisted in the training of approximately 1,000 Texas Heart perfusion students, and it was rewarding, but I admit some of the students did not graduate. Most of the graduates remained in perfusion for a very long time. Some became perfusion program directors, others became chief perfusionists, and some became leaders in our professional organizations, such as

the American Society of Extra-Corporeal Technology, the American Academy of Cardiovascular Perfusion, the American Board of Cardiovascular Perfusion, and other groups. It is rewarding to see many of my graduates have published and presented research papers or case reports at various meetings around the world, and even a few have assisted in book chapter revisions. I am extremely proud and happy to have participated in a small way of those individuals' perfusion education.

Mark Kurusz: Sure, and have you maintained contact with some of those students over the years?

Terry Crane: Yes.

Mark Kurusz: Okay.

Terry Crane: I try to keep up with many of the graduates, and I say I keep up with them, but some do not know that have followed them on social media or discussed their careers with others. It's like when attending a perfusion conference, and I would listen to all the presentations and posters. Most of my friends knew I liked sitting by myself, while taking copious notes, and sometimes, years later I would ask the person about their presentation. Many seemed to be surprised I remembered small things about them, but I explained we all learn from one another. I would also point out I still had a copy of their resume because I never knew when I may need to hire someone. I helped a few students from other perfusion programs find jobs and did not tell them who I was at that time, but years later some of them found out where I worked and thanked me for the assistance.

Mark Kurusz: Sure.

Terry Crane: So, I do try to keep up with THI graduates from afar by following social media and speaking to various people around the county, but not upfront or close.

Mark Kurusz: Well, you shared an interesting anecdote when we were putting together the recent tribute for David Palanzo, and that is, Dr. Cooley apparently was very interested in the notes you took at the meetings. Is that right?

Terry Crane: Absolutely. Oh, yes, in fact, when I would come back from the Academy conferences, Dr. Cooley knew I took notes and made sketches, and he always wanted to review my notes from the conference, and I said, "I'm sorry, I can't do that, but I'll give you a clean conference bulletin because my notes and drawings are too messy to read."

I told Dr. Cooley he was the most eloquent person I knew, and I would be embarrassed by my scribbles, spelling, and other things I wrote in those bulletins, but I would give him a clean copy to review.

He said, “That’s okay, I’ll take the clean copy.”, and we would discuss a few of the topics in more detail.

For many years after that first encounter, I always provided him with a clean copy from the AACP and AmSECT meetings because he was very interested in what our perfusion organizations were doing to help improve techniques, technology, and patient outcomes. Eventually the organizations stopped printing the conference bulletins in favor of click-on aps, and we would discuss topics of interest when I returned from the conference.

Mark Kurusz: Sure. Well, you’ve been an AmSECT member, according to your resume, since 1974...

Terry Crane: Yes, I graduated in 1973 and think I joined in 1974.

Mark Kurusz: …until you retired. That’s quite a long period to be an AmSECT member. And then when licensure came in in Texas, it was required that perfusionists had to become licensed in the state of Texas. That was from 1995 until you retired, as well.

Terry Crane: Yes, my Texas State Licensure number and ABCP certificate number were very low in the sequence provided.

Mark Kurusz: Do any cases stand out in your mind that you want to share with us, either good or bad, Terry?

Terry Crane: Oh, sure.

Mark Kurusz: I mean, obviously, every perfusionist remembers some of the bad cases.

Terry Crane: Yes, sure.

Mark Kurusz: Are there any good or bad cases that stand out in your memory?

Terry Crane: One that just comes to mind in the mid-1970s was a basilar artery aneurysm repair, and the neurosurgeon wanted to use deep hypothermia and circulatory arrest.

Mark Kurusz: Okay.

Terry Crane: I was the clinician on the case and had a student assisting me, but I had never worked in a neurosurgical case. I became extremely lightheaded when they used specific instruments in the procedure and thought I would pass out but overcame the lightheadedness.

Mark Kurusz: Oh, no.

Terry Crane: I never had a problem with the noise of a chest saw or dealing with the stress of deep hypothermia and circulatory arrest, but the sound of the saw used on the skull got to me on that case. I had another basilar artery aneurysm repair a couple of weeks later and did ok on that case, but that first case was eye-awakening.

Mark Kurusz: You're talking about the saw they used?

Terry Crane: Yes.

Mark Kurusz: As they cut through...

Terry Crane: Yes.

Mark Kurusz: …the cranium.

Terry Crane: Yes, and I just had never heard that sound before—a sternal saw versus that saw was totally different and exposing the skull versus the chest had an impact on me.

Mark Kurusz: Okay.

Terry Crane: So, that was a memorable one, and there were many adults and pediatrics procedures we did with Dr. Cooley and others, but that one neuro case stands out and using the first BioPump for open-heart surgery really stands out.

Mark Kurusz: Were you present for any of the artificial heart or LVADs that were put in here?

Terry Crane: Yes, as a matter of fact, when I first started in the 1973, Dr. John Norman oversaw the research lab working on ventricular assist devices, total artificial hearts, and intra-aortic balloon pumps. Back in those days circulatory support devices were tested and implemented by the people in the cardiovascular research lab, and they provided IABP and VAD support. I remember discussions in those days included how soon the devices would be more readily available, and here it is 50 years later with significantly improved circulatory assist devices. It has been a remarkable journey working with Dr. "Bud" Frazier and seeing the impact on changes that improved functional designs, materials, flow dynamics, smaller sizes, and other contributions that have extended the lives of so many patients in my perfusion career.

Mark Kurusz: Sure. Could you tell us a little bit about teamwork and how important that is, and be specific, maybe with some examples…

Terry Crane: Sure.

Mark Kurusz: …of how teamwork worked in your setting.

Terry Crane: When I became the head of the perfusion department and program director for the school, I told the students and staff to remember the first part of the word TEAMWORK means, “Together Everyone Accomplishes More”, because I wanted them to work together on various assignments. Staff would have specific assignments related to equipment, supplies, lectures, et cetera, and I also wanted students to participate in a few of the perfusion-related tasks, such as assisting in writing procedures because it would help the students after graduation. For example, asking a staff person to write a procedure may end with “open the package and assemble the circuit”, but a student needed to have more details. That is one reason I had staff and students participate in writing procedures. This included photographs and videos to assist in training future staff and students. Basically, we needed more details than open a package and assemble a circuit. Eventually I changed the terminology from procedures to guidelines.

Mark Kurusz: Sure.

Terry Crane: Even the use of aseptic technique was included in the procedures, and I believed all of this would lead to improved teamwork in surgery. I would also tell students that “communication is the key to their success”, and you need to use “challenge and response” while working with others in surgery. For example, if a surgeon says something to you, you need to respond back accordingly because it can be very easy to misinterpret what they said, just like, “Sump on or Sump off”, or even going on cardiopulmonary bypass. There’s a big difference between “Ready to go on” versus “Radio on”, or “Protamine versus Prolene.”

Mark Kurusz: Good point.

Terry Crane: Challenge and response communication is extremely helpful as seen when giving heparin before the beginning of the bypass and confirming the heparin has been administered before turning on the suctions or initiating bypass. I think it is very important to use challenge and response as part of teamwork. The other part I tried to emphasize to the staff is that it’s extremely important that we work, not fraternize, with the students because they are going to be an extension of you when they leave our program. The student/graduate may be assigned to a cardiac procedure for a member of your family or a friend in another city or another state during their clinical rotations or place of new employment. You want to know that you’ve done your best job to create the best student/graduate because they are an extension of you and the program you represent.

Mark Kurusz: You mentioned before we sat down for this interview that you’ve got some artifacts at your home. Would you be willing to share some of those or photographs of what you’ve collected over your career?

Terry Crane: I’d be glad to. I have a few hundred boxes that I’d have to go through because I’ve collected various items over 50 years, and those unlabeled boxes cover about 2,000 square feet of storage. I have examined about 100 boxes this past year and found some of the old stainless-

steel connectors, suctions, and cannulae used in my earlier days of perfusion. I also found some old flat and convoluted discs and many of the bag and hardshell bubble oxygenators. My collection also includes various membranes and their reservoirs, blood filters, and a variety of heart-lung pumps. I kept all my perfusion books, THI journals, AmSECT journals, and AACP journals. So, I'd be glad to share pictures of a few of those items with you.

Mark Kurusz: I've asked you in the past for product information. You always had all the instructions for use.

Terry Crane: Yes, I collected most of them from all the cardiopulmonary companies. They were very helpful for lectures, and now I'm trying to decide whether to keep them or throw them away.

Mark Kurusz: Before we get to the final section, I wanted you to expand a bit on when you left perfusion and went to work for industry. You didn't leave perfusion, did you? Because you maintained your cases.

Terry Crane: I kept my certification and license while working for manufacturing because I believed in being up to date on current techniques and technology, and I thought I would be respected more by the perfusion community for keeping my certification and license.

Mark Kurusz: But tell us, what prompted you to move over to the manufacturer side?

Terry Crane: Charlie Reed "encouraged me" to do so, and I applied for a job as a technical specialist for Texas Medical Products. They knew I had completed a variety of engineering classes, and TMP asked me to design and develop disposable medical devices for cardiac surgery. They also knew I had designed and manufactured numerous medical devices in my apartment before the Food and Drug Administration rulings of 1976 and had the expertise they needed. I worked in technical support, engineering, and eventually became vice president and general manager for the company. All those positions allowed me to develop and improve devices used in cardiac surgery. For example, disposable suctions versus stainless steel suctions, and being able to dispose of them after surgery. A simple tubing organizer to help organize and prevent reversed lines at the table.

Mark Kurusz: Sure.

Terry Crane: I modified the TMP Air Aspirator Needle, and it could remove more air from multiple locations than any other device on the market. I revised connectors to not have parting lines on the last barb, which could lead to air being pulled into the circuit.

Mark Kurusz: Yes.

Terry Crane: Cannula prices in those days were approximately $20 each, and I designed cannulae for less than $5 each. I was visiting THI one day and Dr. Cooley asked me if I could make a single atrial cannula, and I said, "Yes." I cut off the end of a venous line, tapered the end, and cut some holes into it, and he said that would work. He asked about cannula for a smaller patient. So, I cut off the end of an arterial line, tapered the end, cut holes in it, and he again said that would work. Those cannulae became 52 French and the 43 French single atrial cannula and were used for many years at a significant cost reduction to the hospital.

Mark Kurusz: Really?

Terry Crane: Again, the cost to the hospital was five or ten dollars each versus the sophisticated two-stage, wire reinforced ones that were probably 30 or 40 dollars each.

Mark Kurusz: Sure.

Terry Crane: I did something similar for aortic cannulae and had tubing extruded to have long 3/8" ID sections and tapered to 24 French or other sizes. The tips were polished using radio frequency and had low pressure drops. They were also cheaper than other devices on the market. It was great a great feeling to design and develop devices that people wanted, needed, and were not overpriced.

Mark Kurusz: Very good. Well, for the last section, which we've titled perspectives, philosophies, and reflections, what do you think are some of the personal attributes that contribute the most to a person potentially becoming a perfusionist? Because you obviously interviewed many prospective students.

Terry Crane: Oh yes, thousands. We would interview 50 to 300 people for each class and accept eight or ten, and that was twice a year.

Mark Kurusz: And what were you looking for when you interviewed them?

Terry Crane: For myself, I was looking for several things. Number one was work ethic. I prefer hiring people that have a strong work ethic, and it means not just being at work at seven o'clock in the morning because that's what time you start, but instead being there 30 minutes to an hour before. I believe that you should be in the operating room before the patient and remain in the room until the patient leaves. When you're talking to these applicants, you are also looking for diversity in their jobs. So, you're looking for that work ethic and diversity. As an example, I recall one time I was interviewing two applicants and they were from the same city, same college, and both were laboratory technologists. I asked some key questions about chemistry, hematology, and bacteriology, and other laboratory tests because that was my background. One of the applicants only specialized in chemistry. The other applicant was a generalist, like I used to be, and answered questions related to the various topics. Basically, he

had to know a little bit about everything, and I think he referred to it as a jack of all trades and master of none.

Mark Kurusz: Right.

Terry Crane: I accepted what I considered was the generalist, and the other young man, a specialist, was asked to reapply, but never did. I think diversity is extremely important because it's people who have various skills and aptitudes. There are certain people you recognize as having mechanical aptitude, whether it be working on a car, building furniture, remodeling, plumber work, being an electrician, or other jobs. You can also see certain people have excellent verbal skills needed in surgery. There were many attributes applicants had that made it easier for us to accept them as students, and this included a diversity of work and educational backgrounds. We had police officers and military personnel apply, and they were great students because they were disciplined and had strong work ethics. We had a few people who worked on farms or were professional ball players and wanted to change from their current jobs or careers to become a perfusionist. They wanted to make a difference for their families. Each group of applicants, as nurses, respiratory therapy, etc. all had specific talents to become a perfusionist.

I'll never forget one interview—the young lady was talking about working on her family farm, and toward the end of the interview, I asked her to show me her hands, and so she showed me her hands with palms up. I said, "Thank you very much, and we will notify you of our decision next week.", and she left the interview.

The other people on the interview committee asked me, "What was that all about?"

I said, "If you ask most girls to show you their hands, they're going to do so with the palms down, but when she showed her hands with the palms up, you could see the calluses in her hand, and it showed she was not afraid of work. That was the reason I selected her.

Mark Kurusz: Sure.

Terry Crane: A similar situation was a single mother. I recall she said she did didn't have any work experience.

And I said, "We're going to stop the interview right here. The reason I'm doing this is because I'm going to explain something to you as being a single mother. You have a job that's 24 hours a day, seven days a week. You help lead, guide, and direct your children. You help take care of them. You help take care of others, so, do not tell me you don't have any work experience. You have plenty of work experience." I voted to accept that applicant.

So, the interview process is a very difficult. I would like to say we were 100% correct in the selection process, and it's not true, but we have gotten very close by reviewing the whole

person. This means consideration is given to the college or university attended, types of classes taken, major and minor, GPA, and work experiences. There is also a big difference between listening to what the applicant says versus hearing someone respond by using a quote from the book "Interview 101," I want to know the person and not some interview book they read.

Mark Kurusz: Sure.

Terry Crane: I could also understand applicants who were nervous in the interview because it reminded me when I was an oral examiner for the American Board of Cardiovascular Perfusion, and I also get nervous when speaking to a group of people.

Mark Kurusz: Well, this is sort of a two-part question. First of all, what does it mean to you, now that you're retired, to have been a perfusionist? And please expand on that by telling us a little bit about what were some of the personal satisfactions and the rewards during your career as a perfusionist.

Terry Crane: Oh, wow, there were many things.

Mark Kurusz: What did you enjoy the most?

Terry Crane: The most I enjoyed in those earlier days of my career was teaching students, and I'm sure some of the students from my earlier career wouldn't agree because I did push them to their limits and one step beyond, but I really did enjoy teaching. Charlie reminded me every year, "Terry you no longer have control over the student's lives, education, experiences, or anything else after they graduate, and must push them to their limits and one step beyond. Remember they will no longer have you or our team to answer their questions or protect their patients in difficult situations. The best they can do is learn from the experience of others and have good guidebooks, preferably perfusion related."

I understood what he was saying and felt comfortable that most of these people did well in perfusion school and extremely well in their perfusion careers. I also knew that some of my family members may require open-heart surgery anywhere in the country, and I wanted the best care for those individuals. During my career as a perfusionist I had a few of my family members and friends that required open-heart surgery, and the perfusionist assigned to the case was THI graduate, but a few were done by graduates from other programs. I am very pleased to report all did their best to take care of my family members and friends. There will be more of my family and friends requiring cardiac surgery in the future, and it is wonderful to know graduates from all the perfusion programs have been doing their best to improve patient outcomes.

Mark Kurusz: Sure. Now, you've mentioned Charlie Reed many times over the last several minutes. Tell us a little bit about Ray McInnis, because didn't he succeed Charlie as the program director?

Terry Crane: Yes, as a matter of fact, Raymond McInnis came back to the program at a perfect time before Charlie retired, and they wanted to change the post-baccalaureate certificate program to a bachelor's in perfusion under the University of Texas Health Science Center. Raymond had a master's degree in education and did an outstanding job in reorganizing the school into the bachelor's degree. He did a great job as a leader by improving the academics and clinical training, and everything worked well, but eventually the program changed back to a post-baccalaureate certificate program ten years later. I was only working part-time for the department when Raymond retired, and I asked if I could apply for his job. I was really surprised he was supportive because I was not too kind to Raymond when he was a student in school. I recall having him come in one evening, after he had gone home, and complete a task, which I do not remember at this time, but he was not a happy person.

Mark Kurusz: Okay.

Terry Crane: We did the white glove treatment on all our heart-lung equipment, rechecked the paperwork at the end of the day, and maybe someone on staff found something out of order.

Mark Kurusz: Sure.

Terry Crane: Regrettably, I have heard staff and students in some programs are not held to the same level as they were in the 1970s by both participating in set-up, completion of the procedure together, and neither person leaving the OR until the patient is transferred.

Mark Kurusz: Okay.

Terry Crane: So yes, Raymond was and is a great and remarkable man, and I learned a lot from him.

Mark Kurusz: Well, in our closing few minutes here, this is your last opportunity to say anything to the younger generation who might be viewing or reading this interview. Terry, do you have any closing thoughts or anything that we did not cover that you'd like to share with the group?

Terry Crane: I think the most important thing I would leave them with is to maintain their work ethic before coming to school and maintain a stronger work ethic after graduation. One of the most important things I hope I got across to students was to open a patient's chart—well, a computer now—and find something in the chart you can relate to. It could be a first, middle or last name, birth date, even a city, state or country, but something you can relate to. You should treat every patient as if they were your mother, father, brother, sister, son, daughter, or close friend. I recall a couple of times when the student said, "Terry, I can't find anything to relate to for this patient."

And I said, “Well, I’ll tell you what we’re going to do today, this patient is from another country, and we are going to treat him as the uncle of one of our graduates from that same country.” I was very pleased to see how the student reacted and ended with a great outcome.

I had another student who could not find anything in the chart to relate to, and I said, “Well, the name is very similar to my niece from another state, and we’re going to treat this patient as if they were a member of her family.”

A day later, my sister called me to ask if I could find this patient who had surgery in Houston, and due to HIPPA regulations I couldn’t tell her it was my assigned case. I said, “I’m sorry, but there are a lot of hospitals in Houston that do open-heart surgery, and I can’t call all of them to check where the patient is located, but you could ask the patient’s mother which hospital the family member was admitted. The mother is welcome to call me if the patient is in our hospital and can invite me to visit, but I cannot go into patient records because of HIPPA laws.”

I later found the patient was a very close friend to my family in another state, and that was a unique situation. So, you feel good that you’ve treated patients like members of your family or friends. We may not be able to tell students specific private information we may know, but at least we tried to teach them to treat patients as members of the family or close friends.

Mark Kurusz: Sure.

Terry Crane: Sometimes, with patient permission, we can share personal information with students later.

Mark Kurusz: Well, Terry, this has been a wonderful hour. We really want to thank you for spending the time today to do this interview for AmSECT. We’ve been friends for a long time, and it’s just been a great afternoon with you. Thank you so much.

Terry Crane: Thank you very much and I appreciate this opportunity. Thanks again.

Transcription by Vanan Online Services, Inc.
Edited by Mark Kurusz