

MAX E. VALENTINUZZI

An Interview Conducted by

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IEEE History Center

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Interview: Max Valentinuzzi
Interviewer: Frederik Nebeker
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Nebeker: You said that as a youngster you were not attracted to history.

Valentinuzzi: Yes, especially when I was in elementary and secondary school in Argentina.

Like the rest of Latin America and from what I know of schools in the U.S., in Argentina history is taught with an emphasis on the battlefield, on violence, wars, revolutions and things like that. I understand and accept that many events were due to changes that had their roots in war or revolution. No one can deny the influence of the First and Second World Wars, even on science and technology. However, so much emphasis in violent acts led me to hate history.

I came to Emory University, in Atlanta, GA, in 1960. After two years at that university and medical school, as Research Associate, I got the opportunity to move to Houston, Texas, to take a position at Baylor College of Medicine, as Biophysicist. That was a main turning point in my life, because I met Dr. Hebel E. Hoff and Dr. Leslie Alexander Geddes. The former, Dr. Hoff, died about 12 years back (see Valentinuzzi ME, 1987, Hebbel E. Hoff 's obituary, *IEEE/EMB Magazine*, 6(4):55, December). He was Chairman of the Department of Physiology at Baylor College of Medicine, had a Ph.D. in History and he was an M.D., too.

Nebeker: Is that right?

Valentinuzzi: Dr. Geddes is currently semi-retired and is at Purdue University, in Indiana.

Nebeker: Yes, I know him.

Valentinuzzi: They became my mentors. I did my Ph.D. dissertation under the direction of Dr. Hoff, with considerable guidance also from Dr. Geddes. They both really changed my attitude toward history. I took several courses in the history of medicine and physiology, which I enjoyed very much. It was a total turnaround for me.

Nebeker: I know Les Geddes, and he is very special for his interest in history. I'm very pleased. There are not many engineers who have studied history.

Valentinuzzi: Exactly. There is a lot that we can learn from history. It is not just for sheer curiosity. One can see the root or the line of thought that other people followed, and many times ideas can be picked up that are old but conceived at a time when the technology to develop them did not yet exist. In 1870, Adolf Fick in Germany, exactly during the session of July 9 of the Medical Society, presented a communication, just two paragraphs in length, which outlined the idea of what is now referred to as Fick's Principle to obtain cardiac output (*Verhandlungen der physikalische und medizinische Gesellschaft zu Würzburg, 2:XVI, 1870*). Hoff published an English translation in 1948 (*New England Journal of Medicine, 239:26*). Fick could not put it in practice because he didn't have the necessary minimal technology. This principle is today's standard by which other measurements are compared for average cardiac output. When teaching, say, blood flow in the cardiovascular system, Fick's Principle is perhaps one of the first things with which to start. It has a good mathematical derivation and, in fact, it is nothing other than the Continuity Principle found in physics or in hydraulics (Valentinuzzi ME, Geddes LA, Baker LE, Hoff HE, 1968, The node equation and its applications in physiology, *Med & Biol Eng, 6(4):387-397*).

The fact is that I took several courses on the history of medicine and physiology, mostly with Dr. Hoff. There was in the daily environment always the idea of what the history was of each event. I participated in several little projects and collected quite a bit of material. One concept I learned during that period, 1963-72, was the revival of history. It is interesting and amazing, because revival is meant in the sense we can apply what we learn from history to projects we are working on today. It comes to my mind that, based on an old development of the French physiologists Chauveau and Marey, Hebbel commissioned me to try to come out with something equivalent but using an updated technology. Well, after a few months of searching, visits, correspondence, trials and errors, the Projecting Physiograph was produced (Hoff HE, Geddes LA, Valentinuzzi ME, Moore AG, 1968, La sala de demostración de Jean Baptiste Auguste Chauveau y su versión moderna, *La Semana Médica*, 132(27):1033-1042; also in *The Southwestern Veterinarian*, 23(4):313-322). The instrument was even commercialized for a given time by the now extinct E&M Instruments, in Houston. Another revival example takes us to a well-known report on the first measurement ever made of blood pressure, which we used to repeat routinely in the dog. Several aspects, both physiological and instrumental, were well illustrated in this clean cut exercise, as for example, clotting and the damping effect of friction.

Nebeker: Is that right?

Valentinuzzi: Then we did it on a horse, exactly as he had done it in 1728.

Nebeker: Was this at Baylor?

Valentinuzzi: With dogs it was at Baylor, but for horses we used to go to the Vet School of Texas A&M at College Station, every year. By recreating these very early methods one can really see how the idea was developed. We then recorded the blood pressure with modern instrumentation and compared the results, looking for example at the concept of transduction. Hales invented and used a straight open manometer, which was just a tube.

Nebeker: It was just a question of how high the pressure would force that column of blood.

Valentinuzzi: Exactly. It was a technological invention. He invented the first blood pressure transducer, the open manometer. It was a glass tube with a brass loop, directly inserted into the femoral artery (without anesthesia!, for anesthesia did not exist yet). In those days they called it the crural artery. Another concept was the unit of measurement, meters or feet of blood. That was the first unit of measurement. His first problem was that after a little while it became a blood sausage: coagulation obviously showed up. He (Hales) was very lucky. He didn't know it, but the coagulation time in the horse is a little bit longer than in dogs or human beings. Thus, he got more time with the horse.

Nebeker: Was he able to get the measurements?

Valentinuzzi: Yes.

Nebeker: Do horses have higher blood pressure than dogs?

Valentinuzzi: No. Interestingly enough, all mammals have exactly the same blood pressure, the same 120/80 mmHg, plus or minus. Even the giraffe has the same values at its head, because at the heart level blood pressure is in the order of 300 mmHg. Remember, the poor guy has to push the red juice to the brain high up, beyond the

long neck! Another technological concept was measuring maximum and minimum systolic mean pressure. Due to friction and the blood column (inertia), the response time was slow. Actually, it was average pressure what Hales measured. You can read the original version in his classic book, *Haemastatics*, a nice description, indeed. It is probably one of the first scientific papers ever written in English. In those days they still wrote scientific papers in Latin. He described also two oscillations, a slower one, respiration, and a quicker one, which corresponded to the heart beats.

Nebeker: Thus, you did you actually recreate these experiments!

Valentinuzzi: Yes.

Nebeker: Did they work? Were you able to do them?

Valentinuzzi: Oh yes, it was beautiful. As I said before, we did it in the horse at least once every year and we did it many times in the dog. When I went back to Argentina, I did it also many times in the dog.

Nebeker: I imagine that actually to doing the experiment would make you understand the text better.

Valentinuzzi: Exactly. You have to do it. With practically every subject you will find that there was always a first time. You can go back and try to repeat it exactly as it was described, and many times you can modify it with the technology available today. This is the revival of history. In other fields, as anthropology, a similar situation can be found. For example, a few months ago they found high in the mountains in northwest Argentina two or three mummies in a state of preservation that is amazing. They can remove pieces from the stomach content and analyze the diet

these people had. Nowadays, with DNA analysis, tissue samples allow even the correlation of races.

Nebeker: I know of some instances of this. I saw some radio wave demonstrations of Heinrich Hertz's experiments. You can recreate the original experiment and use modern instrumentation to better understand it. It has been debated what frequencies Hertz was actually getting. The experiment can be recreated using modern instrumentation.

Valentinuzzi: There is another thing. Let's come a bit closer in time. Dr. Hoff and Dr. Geddes have to be credited for saying this many times in their lectures. In the development of electrophysiology, one of the concerns back in ca 1850 was the shape of the electrical activity (as a time event) of some cells, such as nerve or muscle cells. This started with Luigi Galvani, in 1790-94, when he described the injury potential. It took another 150 years to learn the true origin of the injury potential, when the microelectrode was introduced by Ling and Gerard in 1949. Galvani could not have possibly found out because he didn't have the technology. Now, we know that the action potential, as time proceeds and after it is triggered, goes up to a maximum, comes back and stays at the initial resting level. This lasts, depending on the type of tissue, for example one millisecond. Scientists didn't know this in 1850. In 1868, the German physiologist J. Bernstein came up with an ingenious and delightful idea. He brought up a breakthrough concept now used every day by computing engineers all over the world: the sampling concept (*Archives für die gesamte Physiologie*, 1868, vol. 1, pp 173-207). He used rudimentary technology, like the inductorium (which is a transformer), the slowly

responding galvanometer and the rheotome. The rheotome is a rotating machine that used to be in every electrophysiology laboratory. *Rheo* means “current” and *tomein* “to cut”, thus, literally is a "current slicer". It’s a rotating wheel with moving contacts.

Nebeker: Does that give you samples of a signal?

Valentinuzzi: Exactly. If you can find one of these rheotome machines they used to build, it’s a jewel. I’m sure that if you dig around in the basement or attics of some university you will find one. If you find one, grab it, because that is an historical jewel. There were many marvels. The rheotome, the inductorium and what we now call the galvanometer.

Nebeker: The string galvanometer?

Valentinuzzi: No. Galvanometer. It is a moving needle within a magnetic field induced by an electric current. The first one was actually built by a physicist, C.L. Nobili, back in 1830, and was very sensitive but very slow. Also there was the voltaic pile. In a very ingenious arrangement with the elements I just mentioned (inductorium, rheotome, pile, galvanometer) Bernstein was able to stimulate the sciatic nerve and actually sample the action potential and reconstruct it. It was the Sampling Theorem in operation for the first time, now used every day. Every single minute people are sampling signals. It is the backbone of all digital systems.

Nebeker: Did Bernstein use a rheotome?

Valentinuzzi: Yes, he did. He used the galvanometer, the rheotome, Volta’s pile and the inductorium in a very ingenious configuration.

Nebeker: Do you think that was one of the first instances of sampling of the signal?

Valentinuzzi: To my knowledge, he was the first one. That would be very nice to put in a book.

There are other examples. Hermann von Helmholtz, who was both a physicist and a physiologist (really a genius), using more or less the same technology in another ingenious arrangement, was able to make the first measurements of the velocity of propagation of the action potential. He got something between 28-30 meters per second in the sciatic nerve of a frog. This was in the 1850's (Geddes & Hoff, 1968, Who was the first biomedical engineer?, *Biomedical Engineering*, 3(12):551-558). In 1928, using the same principle but with electronic technology, Erlanger and Gasser were able to measure the same value. It fell within 8% to 10% of the value given by Helmholtz. Erlanger and Gasser built the first electronic oscilloscope and the first biological amplifier. They really were both physiologists and electronics engineers. They got the Nobel Prize for that. That technique was the same philosophically as that applied by Helmholtz. They came up with what is now known as the Erlanger and Gasser Classification of nerves. They stated a law: the velocity of propagation of the action potential is proportional to the diameter (or thickness) of the fiber.

Nebeker: It is very interesting when new technologies like that come out of research.

Valentinuzzi: It is the revival of history by taking certain papers and repeating them as they were done originally.

Nebeker: There have been quite a few scientists, and Einstein was one, who said that it's important to read the original papers of the pioneers. Rather than learning about the great minds through someone else, one can go to the original papers.

Valentinuzzi: Exactly. Philosophically, Einstein was on the other side of the spectrum, because he was a theoretician and never performed a single experiment, but led people to perform dramatic and monumental experiments and measurements to confirm his theory, to this date. All of his experiments were with pencil and paper. Einstein is one of my favorite personages. I think he was the man of the century. *[By the way, I realize now, almost three months later (January 8, 2000), that TIME MAGAZINE appointed Einstein as the Man of the Century. Excellent choice, indeed!]* He was able to perform theoretical experiments. I recall an experiment he performed with pencil and paper. He said: “Let’s imagine a railroad station which is 300,000 kilometers in length with a train that comes into the station at 300,000 kilometers per second with one guard at the beginning of the station and the other one at the other end with a blinking light.” That was his experiment. He started out with that, and that was the beginning of the special relativity theory.

Nebeker: You were born in Buenos Aires in 1932. Would you tell me a little about your family?

Valentinuzzi: I recognize a strong influence from my father. He was a physician and also a physicist by training. When I was eight or nine years old he taught me how to perform real experiments with a frog.

Nebeker: You were an electrophysiologist in your youth.

Valentinuzzi: Yeah ... ha-ha ! I didn’t know exactly what I was doing, but I recall it very well seeing the beating heart. He had a small laboratory in a hospital in Buenos Aires. He was one of the founders of biophysics in Argentina.

Nebeker: What was his name?

Valentinuzzi: His name is like mine, Max Valentinuzzi, without the middle initial "E". In his laboratory he taught me how to operate Pogendorff's galvanometer to measure skin potentials and skin resistance, the so called galvanic skin response. I didn't understand what that was about, but I knew how to operate the instrument.

Nebeker: Where did he work?

Valentinuzzi: First he had a small laboratory in a maternity hospital in Argentina, and thereafter he spent ten years in a research institute in Buenos Aires which had a long name. It was something like Physical Studies Applied into Medicine and Pathology.

Nebeker: That must have been one of the early biophysical institutes.

Valentinuzzi: Yes. Unfortunately he never got enough support. He was not understood at that time, which was ca 1940 through 1944.

Nebeker: That's very early for biophysics.

Valentinuzzi: Yes. After the 1955 revolution in Argentina, when Juan D. Perón was ousted, he was jobless. He had practiced medicine as a gynecologist and obstetrician for twenty-five years but always had wanted to be a full time researcher, so he quit his medical practice and went to the States. By then he was already fifty years old. He had been in touch with Nicholas Rashevsky since 1938 or 1939. I think I am the only one in Argentina who still subscribes to the *Bulletin of Mathematical Biophysics* and the only one with the whole collection of that journal. It was founded by Rashevsky, who was head of the Committee of Mathematical Biology at University of Chicago. My father went to Chicago in 1957 and spent several years with him. Thereafter, he retired and got the American citizenship, however, finally returned to Argentina and died in 1986. I had the opportunity to visit with

him many times when he was in Chicago, meeting Rashevsky and his group. I still have a few pictures. Rashevsky was an impressive personality.

Nebeker: What do you remember of Rashevsky's personality?

Valentinuzzi: Physically he was very impressive, tall with a beard. He was Russian and never lost his heavy accent, but he spoke perfect English, always searching for the specific word to use. Sometimes he used words for which people did not know the meaning, but there was never a doubt it was the correct word. He founded the discipline now known as Mathematical Biology. The Society of Mathematical Biology is another outgrowth of his activities. However, there has been a change in philosophy since then. In the beginning and for over twenty years it was very theoretical. One of the criticisms many people made against Rashevsky's school was that there was too much emphasis on the theoretical aspects. However, I have taken those volumes many times and found things that could be used and are still valid as background material.

Nebeker: Did your father work with Rashevsky in Chicago?

Valentinuzzi: Yes, for several years.

Nebeker: What sort of work did your father do there?

Valentinuzzi: He was one of the pioneers in the field of magnetobiology, which is very much on the move now.

Nebeker: Would you explain that field for the layman? What in particular was your father looking at and what are the uses?

Valentinuzzi: Magnetobiology can be looked at from two very different points of view. Pure magnetobiology, in essence, refers to electrical and magnetic fields originated in

biological activity. The other point of view is the effect on biological tissues of external magnetic or electric fields. But the latter is a different story. If you have a nerve with the action potential moving from here to there, it is equivalent to an electric current moving in that direction. There is an electric and a magnetic field associated with it. From that stems the concept of magnetocardiography and magnetoencephalography. Years later, laboratories began working with this concept. A laboratory was built by David Cohen in Chicago before he moved on to MIT. I think that for many years it was the only laboratory in the U.S. to detect magnetic field changes from the heart and from the brain.

Nebeker: Is that technique used today?

Valentinuzzi: Yes, but to my knowledge probably only in Finland. I do not know if the MIT lab is still on. If you take a look at various proceedings of the IEEE/EMBS Annual Conference maybe you will find some papers on the subject. The technology is rather difficult because the fields are very minute. From what I recall from long ago, they needed parametric amplifiers due to the noise from fluorescent light, electric lines, elevators and so on which would affect it. The room used for detection had to be very well shielded. The magnetocardiogram can be found in many papers.

Nebeker: What specifically was your father looking at in that area?

Valentinuzzi: He was trying to explain the generation of the magnetic field from the biological cell. In 1957 or '58 he published a little book that originated from a course he offered before in the City of Montevideo, Uruguay. It was later translated into English in California. Thereafter, my father worked on the semicircular canals

and organs of orientation (Valentinuzzi M., 1980, *The Organs of Equilibrium and Orientation as a Control System*, Harwood Academic Publishers, New York, 194 pp). He was on a U.S. aeronautic grant. That was at the beginning of the space flights. They are subjected to strong anti-gravitational fields that cause them to lose orientation.

Nebeker: Your father studied the human side.

Valentinuzzi: He developed a theory.

Nebeker: That's an example where physics is extremely important.

Valentinuzzi: Yes, physics and mathematics.

Nebeker: I remember a picture of three loops at right angles and how they respond to acceleration.

Valentinuzzi: Exactly. The semicircular canals. Rashevsky had a problem with the University of Chicago and he was forced to retire when he reached sixty-five, moving thereafter to Michigan State, where he died in 1972 of a massive myocardial infarct. Then, the Committee of Mathematical Biology disappeared and my father had to move out, as the rest did. First, he went to the Billings Hospital where he worked with Dr. César Fernandez. They had a well-equipped laboratory with a rotating table to put cats and pigeons. They performed beautiful semicircular canal analyses. These canals have sensors to detect linear, angular and Coriolis acceleration, the latter being a very unique acceleration (named after a French engineer), which can elicit a tremendous dizziness, even fainting. Cats and pigeons adapt very well and rapidly to the stimulation of these physiological sensors.

Nebeker: You must be one of the earliest second generation biophysicists.

Valentinuzzi: Perhaps, but I do not really know.

Nebeker: What was your education like in Buenos Aires?

Valentinuzzi: I recognize also a strong influence from my father in that respect. However, my early experience with formal education was not a happy one. My father, a democrat by conviction, knew several languages, and was an admirer of the German culture ... Goethe, Beethoven, Mozart, Nietzsche ...

Nebeker: Helmholtz?

Valentinuzzi: Yes, also Helmholtz, and German science by and large. He insisted that I go to a German school, and I did. There was a strong German presence in Buenos Aires, with eight or ten German schools.

Nebeker: Is that right?

Valentinuzzi: There was even an association called the *Argentinien Deutsche Schulverein*, which means the Argentine German Association.

Nebeker: Were you unusual in being a non-German pupil?

Valentinuzzi: I belonged to a minority group within the school. Most of the students in those schools were of German origin, but perhaps 30 percent were not.

Nebeker: Did those schools have good reputations?

Valentinuzzi: Their reputation for quality education was very good. I started school very early in life, when I was four years old. "Kindergarten", -literally childrengarden-, is a German term, but even in the United States this word is used. I attended it for two years.

Nebeker: Did you learn German in kindergarten?

Valentinuzzi: Yes. I spoke it with relative fluency at a very young age. When I was four years old it was 1936. Hitler was moving into power in Germany. I actually attended two German schools in Buenos Aires, first at the Germania Schule (one year), thereafter at the Humboldt Schule (three years), and finally I was transferred back to the Germania, to finish elementary education in 1944. I well remember the portraits of Hitler in every classroom.

Nebeker: Is that right?

Valentinuzzi: I would say the discipline at these schools was definitely Nazi and I couldn't stand that. We were punished with slaps on the face, spankings and sometimes made to put out our fingers to be hit with a ruler on the fingertips.

Nebeker: How long did you go to these two schools?

Valentinuzzi: All of elementary school from 1936 to 1944, from age four to twelve. Those were the war years (1939-1945). I told my father many times that I was very unhappy and begged him to allow me go to another school, but my father refused. I have two little stories. I was very rebellious and not a well-behaved student, because I reacted to the harsh treatment. I remember well a teacher I had in first or second grade (at Humboldt's), a woman named Margeritte Heisecker. She was tall, and must have been in her late twenties. I am short now (5' 6" or 166 cm), but at age six or seven I was really a tiny guy. One day, I did something rebellious, talking through the aisles without permission. She slapped me twice on my face very hard in front of the class. I got very angry, grabbed her skirt, kicked her, and then ran out of the classroom. I wanted to get out of the school, and they couldn't catch me. They called my father at the hospital because they couldn't control me. I

remember saying, “You are not going to spank me. The only one who can spank me is my father. You cannot treat me like this.” It was big mess in the school. As the years went by, many new teachers arrived. I now realize they were Nazi refugees. Not long ago, there was an article in an Argentine newspaper about how many came to our country, some of them highly important. They were fleeing in 1943-44 as the end of the war approached, and spoke practically no Spanish. I started to develop antibodies against them, and instead of learning more I began forgetting the German language. It was a defense mechanism. I had an even more serious event with another teacher in 1944, when I was twelve, this time at the Germania Schule. I was a little bigger, but still small, however, since the German schools had good gymnastics and several sport activities, I was well trained and strong. It was the last year of elementary school and I was ready to go into the secondary school. I had a teacher named Herr Kasis. I hated him because he looked exactly like Hitler and easily mistreated us.

Nebeker: Is that right?

Valentinuzzi: He had the little mustache with his hair combed exactly like Hitler’s. I admit I misbehaved, always doing exactly the opposite of what I was told. In response to my misbehavior, in front of the class, I got one slap and then another slap from Herr Kasis. This time I fought back, strongly punching and kicking him. I hurt him and he hurt me, but he won because he was bigger. I got all red because he hit me many times, and I did exactly the same to him. He pushed me out of the room. Oh, my golly, it was a mess! The principal of the school was a tall woman, Frau Winzer. When my father arrived I told him in front of her the kinds of things Herr

Kasis did and that I wasn't going to allow it anymore. "All of them are Nazis", I yelled, "they think that I am a Jew and I won't let them treat me like that." At that time I didn't even know anything about the atrocities of the Holocaust, but it came out of me as a gut unconscious spurt. There was no Jewish student in that school. Let me underline that during all my life I have enjoyed the friendship of many Jewish people and that I still maintain strings with a Jewish family, German refugees in Argentina back in 1942, who lived in our house in Buenos Aires and who, many years later, went to Israel. I have visited with them and one their daughters spent some time with us in Tucumán not long ago.

My father told the principal that he would go to the Ministry of Education and have the school shut down and, by golly, they tried to cooperate with my father. It was the end of my academic year, and a compromise was arranged in view of the fact that I was ready to go to secondary school. When I left that school I said to myself, "I am going to forget German," and I did. I later regretted that very much, because of the opportunities I missed all through my life to read and speak German and communicate with German people. Later, I realized that language and politics have nothing to do with each other. It is crazy nonsense to attach a political image to a language.

Nebeker: You grew up at a very sensitive time.

Valentinuzzi: Definitely. I know some German now, understand a little and can read a little, but I do not speak it with any fluency at all. I really mumble it.

Nebeker: Did you have any contact with the German community in Argentina after this schooling?

Valentinuzzi: No. The last year the German schools were open in Argentina was 1945. After the war all of the German schools were closed except for the two which were not and had never been Nazi schools. Those two schools, the Pestalozzi and the Cangallo School, remained and are still open. Those were the only German schools that accepted Jewish students, and they never belonged to the Deutsche Schulverein.

Nebeker: That's interesting.

Valentinuzzi: Thirty-five years after I got out, I got a phone call from a former classmate from that school. My mother had taken the call, and she told me that the lady who called invited me to a dinner she was organizing. I didn't go, because my memories really were not good. Many years later my father told me that he recognized he made a mistake in forcing me to go to those schools.

Nebeker: Was your experience in those schools traumatic for you emotionally?

Valentinuzzi: Yes, definitely, it was very traumatic for me. I felt really very bad. In 1945, I started secondary school at an excellent college in Argentina called *Colegio Nacional de Buenos Aires*, which belongs to the University of Buenos Aires. The atmosphere there was completely different. It was an incredibly freeing experience. It was like finally breathing oxygen, breathing pure air without any kind of fear. This is when I began to study with real enthusiasm.

Nebeker: The German poet Rainer Maria Rilke was forced to go to military school as a child. It was a traumatic experience for him, and he too was released from that. Maybe it's a little bit similar.

Valentinuzzi: Exactly. However, after leaving that elementary school my father forced me to take more German lessons from a former teacher of mine from that school for two

years, because my German was fading. It was a failure. I finally told him I would not take it anymore. I said, “Daddy, I’ve had it.” We had a really big argument about it. By then I was fifteen years old and I said, “No and no. You are not going to force me anymore.” That was the end of it. The funny thing is that twenty years later I again began to study German on my own.

Nebeker: Did you get a good education in the German schools?

Valentinuzzi: Yes, it was good. By and large their teachers were good in all subjects, - geography, history, math, Spanish, even basics in the Argentine Constitution and the laws. The Spanish language has many rules which were well taught setting the framework for having good orthography, mostly without misspellings. When I write, even in the leftover of German I still have, it is practically without mistakes. I think that it is due to the good background I got in language in that elementary school. In fifth or sixth grade, for example, in history, we used to study in detail the Egyptian culture, European history, American history and Argentine history.

Nebeker: What was your secondary schooling like?

Valentinuzzi: It was excellent. That is something I do not at all regret. My father said, “You have to go to the best school possible,” and he chose that school. It was free, because it belonged to the university, but there was a difficult entrance examination. I studied for three solid months for that examination. Then, I took the exam, passed it and was accepted. That was in December 1944. It was a six-year school. We had six years of Latin, we had French, and the option of English or German. You can imagine which one I chose. I took only three years of

English there, and that is the only formal and systematic English education I ever had. I learned the rest by myself when I came to the United States. However, I took that course with a great drive and my background in German probably helped. There are some similarities. My secondary schooling included a lot of history and improved on the education in it I had received in elementary school. We also had a lot of courses in literature, chemistry, math, physics, biology. Our last year in English we had Shakespeare. I read *Hamlet*, English poetry and so on.

Nebeker: Did everyone receive the same education at this school?

Valentinuzzi: In those days, yes, and I think it is the same thing right now. The only difference is that that college accepts now women, which looks quite right to me. The degree it offers is Bachelor, but it is not analogous to a Bachelor's degree in the U.S. The Bachelor degree given in Argentina in those years was something academically higher than a high school diploma in the United States.

Nebeker: Was it something like the *lycée* in France or the gymnasium in Germany?

Valentinuzzi: Yes, exactly. The secondary schools are usually five years in Argentina, but in that school it is six years. I was nineteen when I graduated from it, but I didn't regret it at all because I received such a good education. We could go directly into the University of Buenos Aires without an entrance examination.

Nebeker: You studied telecommunications at the university.

Valentinuzzi: Yes.

Nebeker: How did you decide on that field?

Valentinuzzi: That's another story. When I was in secondary school we had two years of chemistry. We had inorganic the first year and organic chemistry after that, and I

really liked it. We practiced in the laboratory every week and I almost became convinced that I liked to proceed further on with chemistry. In my last year (1950), there in the middle of the year, we got an invitation from a Professor of Mathematics at the University of Buenos Aires named Dr. Jean-Charles Vignaux, an Argentine of French origin. He was a little man, shorter than I am now, and an excellent mathematician. This was in 1950. Two years earlier he had founded the Institute of Radio Technique at the University of Buenos Aires with money granted from the Naval Ministry in Argentina. He brought in many professors, many from Germany (ain't it paradoxical?). About ten of us from my secondary school went to visit the new Institute, which was a small house in Buenos Aires. We spent six or seven hours there, and it was wonderful. I saw an oscilloscope, radio frequency analyzers, audio generators, vacuum tubes and things like that for the very first time. We knew about the transistor, which had been invented in 1948 or '49.

Nebeker: Transistors were not very practical in the first years.

Valentinuzzi: Right. After that visit several of us said, "That's it. We have to study that thing, whatever it is." Several of us in that group went into Radio Technique, starting our first year at the University of Buenos Aires in 1951. Then, the name was changed to Telecommunications Engineering. Many years ago the name changed again, and now at the University of Buenos Aires they call it Electronics. My undergraduate degree is Telecommunications Engineer. Unlike the States, where "engineer" is a more general word, it is a degree in Argentina. A mistake many Argentine engineers make when they come to the United States is saying, "I'm an

engineer,” and they are instructed to fix the elevator and be the technical boy that does this and that.

Nebeker: In Germany they have the engineer diploma.

Valentinuzzi: Correct. Same in France. I received my undergraduate degree in the middle of ‘56.

Nebeker: Did you intend to go into radio engineering?

Valentinuzzi: In fact I did go into radio engineering for a while. One year before finishing my degree I began working as a technician for a radio communications company called *Transradio International*, a subsidiary of USA RCA Communications in Argentina. I got a lot of good experience there. I worked there for five years, from 1955 until 1960.

Nebeker: Were you working on transmitters and receivers?

Valentinuzzi: I did all kinds of things in telecommunications. The experience I got there was superb. I will never forget or regret those years. I did all kinds of things, including transmission, reception and multiplexing. We were in close contact with RCA Communications in New York, and it was a booming period in Argentina. After Perón was ousted in 1955, there was a boom that lasted nine to ten years for the universities, industry, and everything in Argentina in general.

From 1957 to 1959 that company got a good amount of money and installed a lot of new equipment, including equipment for the so-called teleprinting over radio (TOR). It was all electronic equipment. They got Hassler equipments, which was electromechanical. First, they got the RCA multiplexing system, which was also electromechanical. It was what used to be called time division multiplexing

(MUX). It took a piece of signal 20 milliseconds long and split it into two or four. Out of the 20 milliseconds, it got two and even eight channels by subdividing it. Thereafter, as mentioned before, they bought Hassler equipments (from Switzerland), which were also electromechanical but with some electronics, and that was even better. They also got the Siemens type, which was electronic and had transistors, and Phillips equipments, with vacuum tubes. I also got good experience as the assistant to Christian Van Dahlen, an engineer from Holland who came to Argentina with the equipment and stayed three or four months with us in Buenos Aires. By then, I was twenty-five or twenty-six years old. NOTE: all sounds too informal and colloquial.

Nebeker: Was this multiplexing equipment?

Valentinuzzi: Yes. The Philips equipment had electronic multiplexing. I learned a lot by working with Van Dahlen. He was a superb amazing guy. We used to play piano together, and I had the chance to practice my English with him, as a must. He had developed the TOR system with another man named Van Duuren.. The two had come to this equipment in an underground operation during the war years, concealing it from the Germans. Immediately after the war they launched off the idea.

Nebeker: They made it a commercial product.

Valentinuzzi: I think so, although I am not familiar with the details. This equipment enabled Argentina to communicate point-to-point all over the world with the so-called automatic error detection. It had a system that detected an error, sent a signal back to the transmitter and requested that the signal be resent. This is what they call

automatic request (Valentinuzzi ME, 1958, Sistemas modernos de radiotelegrafía con teleimpresores, *Revista Telegráfica Electrónica*, pt I, Sept, pp 517-19; pt II, Oct, pp 605-7). It had a memory and was really a very simple technology. Those years were very beautiful. I enjoyed them, and worked 12 to 14 hours a day.

Nebeker: Why didn't you make a career of being a radio engineer?

Valentinuzzi: I had continuous contact with my father after he went to the United States. In 1957, when he went to Chicago, I stayed in Argentina. He went first by himself, and then a little later my mother, brother and sister, who are much younger than I, joined him over there. I became interested in information theory. Remember the papers by Shannon and Weaver in the little book called "The Theory of Communications"? I believe it was published in 1949.

Nebeker: Yes.

Valentinuzzi: I became interested in the communication capacity of a channel and started to read those papers. I applied for a fellowship from the National Research Council in Argentina, which had recently been created by Dr. Bernard Houssay. Perón had ousted him from the University of Buenos Aires, and one or two years later he won the Nobel Prize (1949, I believe). When I applied for that Fellowship, funnily enough, I applied to go to Germany! You can see that German keeps following me! By that time I had realized that German is a language and has nothing to do with political ideas. I had studied German again, especially in anticipation of going to Germany. I published with my father a paper calculating the communication capacity of a telegraphic channel in a local journal (Valentinuzzi M, Valentinuzzi ME, 1959, Fórmula de Shannon y aplicaciones para el ingeniero,

Revista Telegráfica Electrónica, Sept, 48(563):478-483). It was a little thing, but an early honest attempt. I was accepted by Doctor Engineer Küpfmüller, in Germany, to study the capacity of communication channels. Even though the project was acceptable, I did not get to go because the fellowship was not approved.

I then started to think about communication possibilities in biological systems and started to study some physiology, just on my own. My father came back to Argentina for a little while, and we did some studies together, too. Then in 1960, I got an opportunity to come to Emory University in Atlanta, so I came here.

Nebeker: Did you go to Emory University to study biophysics?

Valentinuzzi: Yes. I went as Research Associate to the Anatomy Department at Emory. There was a man there from Argentina who was working on some biophysics problems. That turned out to be a really bad period for me. He was a fake, a really crazy unreliable guy who had no academic degree at all. Essentially, I wasted two years of my time, though I continued to study on my own. I did some electron microscopy at Emory and studied a lot of statistics and electrophysiology. When I left Argentina and had advanced very much in my five years at the telecommunications company there. I had started as a technician and, at twenty-eight, I was in charge of a full laboratory. Everyone told me I was crazy to leave the company. I even got a bonus every three or four months as an incentive. A few years later that company collapsed when point-to-point communications went down because of the new satellite technology.

Interestingly enough, when in 1957 the Sputnik was placed in orbit by the Russians, we caught its signal with one of the very sensitive receivers we had. I still keep a tape with it. The funny thing is that for doing that and for calling the press (without authorization) with other technical personnel of the company (we were so excited), I almost was kicked off from the company and had to present formal apologies to one of the managers!

Nebeker: The first communication satellites were in the early '60s.

Valentinuzzi: Yes. This happened when the satellites began to be used globally, a little bit later. That company had not wanted to sign the agreement forming an international company joining the satellites.

Nebeker: INTELSAT may be the organization to which you are referring.

Valentinuzzi: Yes, it was probably INTELSAT. The company collapsed and disappeared after that, so I hadn't made a bad move after all. Later on I heard of people who got caught in the middle of that, and it was a mess.

Nebeker: Was it your intention to get a Master's or Ph.D. at Emory?

Valentinuzzi: Not at that time. After only a short time there, I became very frustrated and began to think about going back to Argentina. I went to Emory in September of 1960 and it was only three or four months before I realized it was a flop. Then my first daughter was born. I felt like a failure while the situation only got worse and worse.

Early in 1962, I received a little brochure about a symposium that was going to be held in Houston on information theory applied to neurophysiology. I thought, "Information theory is what I like. This is for me," and sent in my name. I didn't

present anything, because I didn't have anything to present. I had a baby a few months old and we drove all the way from Atlanta to Houston to attend the three-day symposium. It was there that I met Dr. Hoff and Dr. Geddes. That turned out to be a major turning point in my life. On a Friday night, I went to a cocktail party in the Doctors' Club at the Texas Medical Center. I told Dr. Hoff that I was an electronics engineer at Emory University in Atlanta and explained my unhappy situation to him. He was always very kind and happy (when he was not mad, which was not often, indeed). He said, "Why don't you postpone your leaving by another day and come to my lab tomorrow morning?" and I agreed to do that. He said, "Come at 9 o'clock tomorrow morning to the lab. I'm going to show you something and I'll introduce you to Dr. Geddes." When I went there, there was another person visiting the laboratory at the same time as me, Dr. Mary Brazier, a top neurophysiologist. I think she has died since, but I am not sure. There was Dr. Hoff, Dr. Brazier and myself.

Nebeker: I've heard of her.

Valentinuzzi: When I first visited the laboratory I had no idea that I would be spending many years there. After that Dr. Hoff said, "When you get back to Atlanta, send me your curriculum vita and I might have something for you." Five minutes after getting back to Atlanta I sat down to write out my curriculum vita and sent it to him. A few days later I got a letter saying, "We have a spot for you here. We have a contract with NASA and there are some respiratory physiology subjects on which we would like you to work." One month later, in March or April of 1962, I went to Houston. I was within that contract with NASA, and they were

developing the first impedance pneumograph, which was used in the first suborbital flight with John Glenn.

I did some measurements, and everything was classified so I couldn't publish anything. I worked with Lee E. Baker, who was working towards his Ph.D. in Physiology, and in fact that was his Ph.D. dissertation. We became excellent friends. Dr. Geddes was in charge of that project. Then I started my Ph.D. There was a period in which I went back to Argentina. It was really a mistake because I had already started my Ph.D. Going back to Argentina disrupted that. I got another offer from Dr. Geddes, returned to the United States and stayed with him for several years until I got my Ph.D. I could have gotten my Ph.D. at least two years earlier if I had not left the first time.

Nebeker: What was your Ph.D. topic?

Valentinuzzi: Cardiovascular physiology. My mentor was Dr. Hoff. My years at Baylor were superb.

Nebeker: How long did you work on that NASA project?

Valentinuzzi: One year. I then got an NIH Fellowship to proceed with the Ph.D. After finishing it I got a special fellowship from NIH, and I was appointed Assistant Professor of Physiology. Dr. Geddes should have been the next chairman, but for reasons I do not know or understand, Baylor didn't want him. He left Baylor in 1973 or '74. His contributions were first class.

Nebeker: Was that when he went to Purdue?

Valentinuzzi: Yes. I had the chance of being a student of Roger Guillemin too, who won the Nobel Prize in 1977. I visited with him a few years ago, in 1993. We had dinner

together in San Diego. He is a wonderful man. I had seen him before in 1976, when I was visiting Baylor for a short period. The department was coming down and essentially all the group had disappeared because Dr. Geddes had left and Dr. Hoff was nearing retirement. The department, as I had known it, had collapsed. It had become a fully different place. It is amazing how laboratories develop, evolve and vanish. Obviously, people make a lab alive. First, people, thereafter, equipment, and finally, buildings.

Nebeker: It's often strong personalities that make the difference.

Valentinuzzi: Yes, exactly. After that I realized it was not my place anymore. Unfortunately, the situation in Argentina at the time was bad. Back to the story with Roger Guillemin. As I said, it was 1976 when just by coincidence he and I run into each other at Baylor. I knew of his papers, and a few classmates of mine had been graduate students of his, including Wily Vale and Max Amos. I wrote him a letter saying, "You know something, Roger? I think you are heading for a Nobel Prize." He got it the next year.

Nebeker: Would you tell me a little more about your Ph.D. work?

Valentinuzzi: I registered as a graduate student in the Baylor program and I started to take the different courses. I took all of the physiology courses and gained an excellent background in physiology at Baylor.

Nebeker: Did Baylor have an established Ph.D. program in Physiology?

Valentinuzzi: Yes. They had a Biomedical Engineering Program with a Ph.D. in Physiology. I took a major in physiology and a minor in biophysics. The program was based strongly on experimental aspects, and we did a lot of laboratory exercises. I will

never regret that, because physiology is intrinsically an experimental science. This is very important point in light of the new tendencies toward replacing experiments with computer models and things like that. I am not against the computer models and they are a complement, but please do not forget that in the end we want to understand our body. We want to understand the animal. We want to understand the cell.

Nebeker: Right.

Valentinuzzi: This is something on which Dr. Hoff and Dr. Geddes constantly insisted.

Nebeker: Do you feel that there is the danger or occurrence these days of getting too far from the biological system by doing too much theoretical and computer modeling work?

Valentinuzzi: I have the impression that in the U.S. in the last ten to fifteen years there has been a tendency toward moving away from the experimental aspects of physiology. When I was an instructor and assistant professor of medical physiology, the courses we offered used to have full experimental exercises of at least four to five hours every week. There was an animal, usually a dog, and many times we used other animals. We swept through all of physiology. Those were medical students. We also had specialty sessions for cardiovascular physiology, electrophysiology, gastrointestinal (GI) physiology, neurophysiology and so on. We even practiced a little bit in the hospital. Of course, the medical students had a lot work at the hospitals. Everything was based on the experiments. It was very important to "wet our hands".

I learned a lot about surgery and had a tendency of performing it myself. I designed surgical procedures to access this or that organ and got a commendation for designing a simple technique for accessing the phrenic nerve without opening the thorax. This kind of experience is extremely important for both physicians and physiologists. If you take a look at the curriculum of medical schools today, you will find that the number of exercises in the laboratory has decreased tremendously. What's more, in many schools they never even touch an animal. This is even true in anatomy, where now instead of animals they are using the digital man. The digital man is very nice, but it's not the same thing as working with the actual living tissue. By the same token, dead tissue is not the same as live tissue. In that respect, I think we are on the verge of something that may turn dangerous. The influence of the anti-vivisectionist organizations has been very negative in that respect.

Nebeker: Do you think those groups have had a strong influence on the educational programs?

Valentinuzzi: Yes, definitely. I am not against the defense of animals. I love animals. Dr. Hoff always said, "If you want to work with an animal, the first thing you must do is respect and love the animal." It sounds paradoxical because you are going to kill it, but you must respect and love that animal. This is what I also teach my students. I helped Dr. Hoff many times when he would perform demonstrations. He always said, "Remember never to make an incision longer than needed. Keep it as small as possible. Don't be a dirty physiologist and try to control the bleeding." Every year I spend at least two or three hours before we go into an

animal laboratory explaining to students this approach and the philosophy behind using the experimental animal.

Nebeker: You got very good training in experimental physiology. What did you study in regard to the cardiovascular system specifically?

Valentinuzzi: In the beginning I wanted to go into mathematical modeling, because I have a good background in math. When I was appointed assistant professor, I made a proposal for a course which was accepted, and for two years I taught a course called Systems Physiology I and Systems Physiology II. It was a mathematically based physiology course. I wanted to develop a dissertation in this area and I had something in mind. Then, one day Dr. Hoff called me and said, "Tomorrow I'm going to give a lecture on the discovery of the circulation. Harvey did some experiments on the snake." I didn't know that. He brought Harvey's translation by A. Willius and Thomas E. Keys, *De Motu Cordis* [On the Movement of the Heart], which originally was written in Latin.

Nebeker: Yes.

Valentinuzzi: Dr. Hoff said, "He used a snake. You can help me with a demonstration on a snake." I thought, "Wow!" He said, "Get in touch with the people in the vivarium and try to get an anaconda." I did, and we got an anaconda.

Nebeker: How big was it?

Valentinuzzi: It was a baby one.

Nebeker: Ten feet long?

Valentinuzzi: It was an anaconda imported from Brazil and was easily ten feet long. It cost thirty dollars. I had never before seen an anaconda except in pictures. We used

that anaconda for a demonstration and that was a hard animal to use. We had to somehow anesthetize it. I kept thinking, “What will we do?”

Nebeker: Aren't anacondas dangerous?

Valentinuzzi: They are not too dangerous. Some may get very aggressive and then you've got to be careful because of their bite.

Nebeker: Do they have venom?

Valentinuzzi: No, but their bite can be bad. They are usually relatively friendly. I've seen an anaconda when it gets mad and you want to stay away in that situation.

Nebeker: Did you succeed in this demonstration?

Valentinuzzi: When it came to anesthetizing the snake, it was quite a challenge. Dr. Hoff said, “We are going to pith this snake.” To pith an animal is to destroy the central nervous system by inserting a needle below the atlas, first forward to destroy the brain and , thereafter, backward to destroy the spinal cord. When this is done to a frog the pithing needle is not too long. I said, “Dr. Hoff, I think the needle is a little too short for a snake.” He said, “We'll have to get a longer one. Go to the shop and get some.” We did, and somehow we pithed the snake, at least somewhat. I say somewhat because it wasn't completely pithed.

Nebeker: Were you able to detect the heart?

Valentinuzzi: Oh yes, of course. You can even perceive it through the skin. We opened up the heart. My dissertation was on the cardiovascular physiology of the snake heart.

Nebeker: Is that right?

Valentinuzzi: I used thirty-five anacondas and boa constrictors for my Ph.D. dissertation.

Nebeker: Did your work explain exactly what was going on in these systems?

Valentinuzzi: I think it helped a better understanding. I developed a mathematical model to describe some electrocardiographic findings, found some heart blocks that are easier to detect and study in the reptilian heart, and also developed several methods to anesthetize the snake. Later on, I continued with the idea of applying a model precisely as described in a paper I found in the *Bulletin of Mathematical Biology*, by Sidney Roston, that was written in the early '60s. It was a nice mathematical model and I decided to test it experimentally. I developed a number of experiments and ran two experimental series. By then I became acquainted with a graduate student from England, Trevor Powell. He stayed for almost two years, did the project together and published (Valentinuzzi ME, Powell T, Hoff HE, Geddes LA, 1972, Control parameters of the blood pressure regulatory system (Part I): heart rate sensitivity, *Med & Biol Eng*, 10:584-595; Valentinuzzi ME, Powell T, Hoff HE, Geddes LA, Posey JA, 1972, Control parameters of the blood pressure regulatory system (Part II): open-loop gain, reference pressure and basal heart rate, *Med & Biol Eng*, 10:596-608. We got the Nightingale Award for it in 1973.

Nebeker: Did you find that the model could be made to work?

Valentinuzzi: Oh, yes. In fact we added some other contributions and definitions, for example, the definition of sensitivity to changes in the heart rate and blood pressure. Due to that paper, I was invited to contribute a chapter in a book published in England that same year by the Institution of Electrical Engineers (IEE). They published a series of books, about nine or ten, before being discontinued. These were monographs on medical engineering. The editor was Dennis Hill, who is now

retired. He used to travel between London and Houston quite a lot, and we published together a number of times. One chapter of one of those monographs was published in 1975, and it was based on that series of experiments.

Nebeker: You completed your Ph.D. in 1969 and were Assistant Professor at Baylor?

Valentinuzzi: Yes.

Nebeker: Where did you go from there?

Valentinuzzi: I first went back to Argentina in 1972 to stay just a few months. Several unrelated things happened that influenced my decision to go back to Argentina. Dr. Geddes was not happy at Baylor and was about to leave. I could probably have gone with him, but did not pursue that, and Dr. Hoff was possibly going to retire soon.

Events developed which indicated that there was no future for our group at Baylor University. One or two years after Dr. Geddes left, Dr. Hoff retired, and there was a period of nothing happening. I say nothing because there was only a temporary chairman who was just in charge of administrative things, and it took over two years to find a new chairman.

I believe that the chairman they finally found, Dr. Bush, is still the chairman today. Dr. Bush changed the orientation of the department completely. In fact, he fired the entire staff to start anew. I was a visiting professor, which was just more symbolic than real, but all of the visiting professors were sent notes saying their positions were discontinued. Even the name of the department was changed. I think it is now the Department of Physiology and Molecular Biophysics or Molecular Biology, as is the tendency in many places nowadays. The focus in that department turned to molecular biology and moved away from organ physiology.

The practice of using experimental animals has nearly vanished. That was one reason I decided to go back to Argentina. Another influence was the push and pull from the family.

Nebeker: Did you personally prefer working in the United States or Argentina?

Valentinuzzi: That's a difficult question to answer. I am 67 now and just facing retirement.

Looking back, I do not regret my choices. I don't think it's a good idea to regret one's own life. I have been rather successful in Argentina in spite of many, many difficulties. When I returned to Argentina the country was in a very dark period. Some of the obstacles were really huge.

Nebeker: Did that adversely affect you or people you knew personally?

Valentinuzzi: Yes, it affected us. We lost many people and many opportunities. For several years I was torn with the question of whether to stay or leave. I feel fine in the States. In the States I feel at home, have many friends, and there are no real problems. The years I spent in the U.S. were very productive. I produced a high concentration of papers during my years in the States. I recognize how much I received there and maintain strong contacts with the U.S. On the other hand, I felt I needed to do something for my country. So much needs to be done. Ten days ago we celebrated the twenty-fifth anniversary of our laboratory. I review everything for the laboratory, and it has been productive.

Nebeker: Did you establish that laboratory?

Valentinuzzi: Yes.

Nebeker: Would you tell me how that came about?

Valentinuzzi: There was some activity in bioengineering in Argentina before, but it was a very small seed. Now we have a relatively solid laboratory with the first biomedical engineering Master's degree and Ph.D. programs in Argentina. There are not many projects and we have produced only five Ph.D.s, but we started that program only a few years ago. One graduate, Dr. Julio C. Spinelli, is now a high level manager at Guidant CPI, in St. Paul, MN, where he has been working for ten years. He happens to be also my son-in-law, but that is just sheer coincidence. He was on a fellowship for nine years in my lab and met my daughter during that time. He was the first person in Argentina to obtain a Ph.D. in Biomedical Engineering. There are other students that can be considered graduates from our laboratory. Some of them are now in Spain, some in the States and some in Argentina. We founded the Argentine Society of Bioengineering, which will be twenty years old next month, and has organized twelve national congresses. It has a small journal that is now five years old in which papers are published in the field of biomedical engineering.

Nebeker: Are there other institutes today in biomedical engineering in Argentina?

Valentinuzzi: Yes. There is an undergraduate school of bioengineering in the northeast part of the country, in the Province of Entre Ríos, city of Paraná. We contributed to the organization of that program over 12 years ago. When I say "we" I mean other people from our lab offering courses as well as myself. In Buenos Aires, there is the Favaloro Foundation. You have probably heard of Dr. Rene Favaloro. He developed the coronary bypass at the Cleveland Clinic, in Ohio, over twenty-five years ago. We collaborated with them for several years and they now have a

private university, with a medical school. The exchange with them has really been significant. They also have an undergraduate program with a master's degree in biomedical engineering.

There is another university in the Province of San Juan, which is on the western side of Argentina, south of Tucumán. They too have an undergraduate program in bioengineering, and we contributed to the organization of that program also.

Paradoxically, we do not yet have an undergraduate program in our own university. Unfortunately, my university does not give us enough support to do that. Sometimes you can get better recognition on the other side of the fence than you can in your own yard.

Nebeker: Would you tell me how you came to establish that Institute?

Valentinuzzi: When I went to Argentina, there was a very small laboratory created by two men, a physician (who is now deceased) and an engineer, Fernando Martínez Corvalán and Luis F. Rocha, respectively. The engineer was a classmate of mine many years ago at the university [in Buenos Aires]. They created that laboratory within the Institute of Electrical Engineering. It was called the Laboratory of Bioelectronics. Bioelectronics is a term that is coming into disuse.

Nebeker: Like medical electronics.

Valentinuzzi: Correct. It would be a very nice idea to write a history with a chapter devoted to the development of terminologies, such as medical electronics, bioelectronics, electromedicine, cybernetics, biocybernetics, bioengineering, and perhaps some others. Paradoxically, the two largest international organizations do not use any of those terms. The International Federation for Medical and Biological Engineering

(IFMBE) doesn't use the terms bioelectronics or bioengineering and the IEEE/Engineering in Medicine and Biology Society also seems to stay away from those words.

Nebeker: How was it that you returned to Argentina?

Valentinuzzi: The first cause was the lack of a future at Baylor, and the second was the influence of my family. My eldest daughter had finished elementary school in Houston and was ready to go into high school, in 1973. I was not happy with the education that could be found in the high schools in Houston. We searched, and she would have had to attend the high school designated for the area in which we were living, which was in the southwest side of the city, and I didn't like what I learned about that school. For one thing, that school had a drug problem. My daughter was also unhappy with that choice. She was twelve years old and told me she did not want to go to that school because of stories she heard about it from the parents of her friends and so on. We registered her in a Catholic school. We were happier with the quality of education offered at that school, but still there were drawbacks. For one thing, I do not much care for the religious side of education in catholic schools. Every day they were obliged to go to mass and pray at 7 o'clock. I had, -still have-, my reservations about that. I don't know your personal beliefs.

Nebeker: I am not a religious person.

Valentinuzzi: Five years of going to mass every single day seemed to me to be a bit too much. It was not just mass, but the other rituals as well. It was also rather expensive. I was offered a contract at the university where I am now, so we decided to go back to

Argentina. Unfortunately, the years we almost immediately faced from 1974 on were very difficult. Argentina was apparently waiting for me to come back in order to say, “Now we are going to blow everything up.” It was one thing after another. There was violence, terrorism from the Right, terrorism from the Left, killings and bombings. Those years were hard, traumatic.

Nebeker: Were you living in Buenos Aires?

Valentinuzzi: No. I had decided that if I went back to Argentina I would not go to a big city. I prefer smaller towns. I had been in Tucumán years before for just a few days, but it seemed to be a very nice place.

Nebeker: That’s not a big city?

Valentinuzzi: Well, the City of Tucumán has a population of half a million. The province is very small (about 24.000 sq km). The entire Province of Tucumán has a population of slightly over one million. It is a beautiful area geographically. Right now is not the best of times. There is a lot of social and economic unrest. We had an internal struggle within the family and within myself for several years deciding whether to stay or return to the States. However, I never stopped working. There is something within me that the bigger the difficulties, the more I work and persevere and say, “I’ve got to do it.” Don’t ask me why.

Nebeker: What position did you have at Tucumán?

Valentinuzzi: First I went with a contract as a full professor.

Nebeker: Was this in the Engineering Department?

Valentinuzzi: In the Electrical Engineering Department. There were a number of details in between not worth going into here, but almost immediately I became the head of

the Laboratory of Bioengineering. It was a small laboratory, with only a couple of students and myself. It was really nothing. Essentially, we built everything up from zero to what we have now. I consider the birth of our laboratory to be in 1974, so we now have been in existence for twenty-five years.

Nebeker: Did you change its name?

Valentinuzzi: It went from Laboratory of Bioengineering to Institute of Bioengineering to what it is now, which is the Department of Bioengineering. This is because of the faculty organizations in the university. There is, for instance, the Faculty of Social Sciences, Faculty of Engineering, Faculty of Medicine. It is the European scheme. Within the Faculty of Engineering we now have the departmental organization, so we say Department of Electrical Engineering. We report directly to the Dean of the Faculty.

Nebeker: Were you within Electrical Engineering as an Institute before that?

Valentinuzzi: No. It was an institute, but the faculty all had institutes. After the big changeover the institutes became departments. Before that it was the Laboratory of Bioengineering within the Institute of Electrical Engineering. The funny thing is the current Department of Electrical Engineering does not accept bioengineering as a relative of electrical engineering. Therefore, we really were forced to split.

Nebeker: Would you summarize those twenty-five years of development? You had very little in the way of equipment or staff when you arrived. How has that progressed in regard to getting money for equipment and increasing the staff?

Valentinuzzi: We have not received large amounts but we never have been totally dispossessed.

We always had access to funds and do what we wanted to. Sometimes, it was better and sometimes it was worse, but we always had some money.

Nebeker: You were able to do the experimental work that you wanted to do?

Valentinuzzi: Yes, definitely. Most of the money has come from government grants. One important source of such grants is the National Research Council of Argentina, which is called the CONICET (Consejo Nacional de Investigaciones Científicas y Técnicas).

Nebeker: Does that correspond to something like National Science Foundation in the U.S.?

Valentinuzzi: Yes, more or less the U.S. equivalent, but it is even more similar to what is found in Italy, France or Spain in the form of National Councils of Research. They all have the same name. The objective of these councils is to support and promote research in different areas. They range from the social sciences to the hard sciences. In Argentina, for example, there is the Career Investigator. I got in after applying in 1977. Therefore, I am both a full Professor at the university and a Career Investigator of the National Research Council. These two roles are fully compatible to be within the same place. There are different levels in the position of Career Investigator.

Nebeker: What does having that title confer?

Valentinuzzi: The salary is higher.

Nebeker: Oh, I see. You are actually an employee of the National Council.

Valentinuzzi: Definitely. As a professor one gets a given salary, and then as a Career Investigator, according to the level of one's position, there is an extra stipend. It is

a significant amount. In fact, it can approximately double the salary, depending on the level or category. In my case it almost doubles what I get at the university. They also have Fellowship programs, and you can apply for grants as well. We have had grants from the National Research Council since 1975 practically continuously. There are other sources too.

Nebeker: Are there other faculty positions in your Department?

Valentinuzzi: A former student who started with me very early on and is now an associate professor. He is also a career investigator at a lower level. He is my right hand man. He is about 41 or 42 years old now. He has his own money and his own subject. We started together, and now I like very much having him working by himself with his group. He is working on a nice technique in biotechnology. His group has already applied for two patents, and they are publishing in good journals. Actually, the subject is the application of the concept of electrical impedance to microbiology. You know what electrical impedance is about.

Nebeker: Yes.

Valentinuzzi: With electrical impedance you can detect the presence of microbes in different kinds of materials, especially liquid samples. It started what is now called 'impedance microbiology', with its origins stemming in a paper by Stewart back in 1899. For the next fifty to sixty years probably no more than five or six more papers were published on the idea. I recall Amiram Ur calling me from England, we talked over the phone for one hour and I never heard from him again because, by those days, 1982, we had the unfortunate Malvinas-Falkland War, which got in the middle and ended any possible exchange. That was another unhappy event in

our lives in Argentina. Ur had resurrected the idea in 1970 when he published a couple of papers. A new era of impedance microbiology was launched off.

One day, twenty years ago or so, a biochemist and colleague of mine, Dr. Richard (Ricardo) Farías called me up and said, “There is a paper in the *Journal of Applied Microbiology*. Apparently, they are doing something with that thing that you mentioned so many times. I do not know what it is about.” I told him to send it over. It was a short paper, two or three pages in length. I read it and said, “Easy, we can do this in two or three months.” Never say that! Well, it has taken us twenty years to fully understand what it is, how it works and how it should be developed. Now we are at the stage in which we can really do many things. There are other laboratories working on this topic. It is full of possibilities, especially in the food industry (Felice CJ, Madrid RE, Olivera JM, Rotger VI, Valentinuzzi ME, 1999, Impedance microbiology: Quantification of bacterial content in milk by means of capacitance growth curves. *J Microbiological Methods*, 35(1):37-42; Morucci JP, Valentinuzzi ME, Rigaud B, Felice CJ, Chauveau N, Marsili PM, 1996, Bioelectrical Impedance Techniques in Medicine, *Critical Reviews in Biomedical Engineering*, 24(4-6):221-677. Begell House, Inc., 79 Madison Avenue, New York, NY 10016, USA).

Nebeker: Has this been commercialized?

Valentinuzzi: There are a couple of instruments already being used, one in England and another in California. We can actually separate out the impedance components of the growth curve. Now, we have an instrument that combines the impedance technique with turbidity, which measures opacity. The thing is a transparent

medium is needed. However, if the medium is milk, turbidity cannot be used and the only possibility is the impedance.

We are now able to separate the different components introduced by the electrode-electrolyte interface. This interface is tremendously complex. There is a resistive component, a capacitive component, and there is also the component of the medium bulk. We can actually get three growth curves. There are mathematical relationships between these components and they can be calibrated. To give an idea of the possibilities in the dairy industry, here is one example. Say there is a dairy plant that receives thousands of liters or gallons of raw milk from the farms every day. The final output is the product that goes into the market (homogenized and pasteurized milk, yogurt, cheese, and what have you). The milk that goes from the farm to the plant is always contaminated. Always.

Nebeker: There are always some bacteria.

Valentinuzzi: They even know exactly what species they are. There are about twenty species. There is an accepted level of contamination. In Europe, especially France, the official accepted level is low, and that is 10^4 bacteria per milliliter.

Nebeker: That sounds like a lot.

Valentinuzzi: It's really not very many. If you want to export milk to France and it has more than 10,000 bacteria per milliliter you are out of business. They sample it, and it cannot be more than that. The specific number makes no real difference. It is either below or above 10^4 , or below or above 10^5 . Milk can actually be consumed with a level of 10^5 .

Nebeker: Would you notice any bad taste?

Valentinuzzi: No, you wouldn't know. Many markets do not accept that level, and others do. In Argentina there is a competition between 10^4 and 10^5 . In fact, there is a company now advertising that they have the quality control below 10^4 . The economic importance of that is very significant. More than that, if a higher level of contamination is allowed it can change the taste of the yogurt and milk and so on. It may taste a little strange, but nothing will happen to you if you eat it. However, it changes the organoleptic characteristic of that yogurt. If the concentration of bacteria is as high as 10^6 , it will definitely affect the quality of the final product. What the dairy plant must do is develop sampling quality criteria to detect the level of contamination of milk as soon as possible. The traditional microbiological methods are relatively complex and expensive, and it takes between 24 to 72 hours to get a full report on the quality of raw milk.

Nebeker: The dairy plant wants to have it processed by then.

Valentinuzzi: Exactly. By the time you have the result, the yogurt may be already at the supermarket. Detecting that contamination as soon as possible is important, because it is better (more economical) to dispose of a day's input of milk and pour it down the drain than to remove the yogurt from supermarket shelves.

Nebeker: Are you developing instrumentation for this purpose?

Valentinuzzi: Yes. Other people have done it, but we think that ours is better. We have gotten two patents for that. In fact, we did some calibration with one of the big dairy plants in Argentina. It's a beauty, it works perfectly. In less than six hours you get the results. Not only that, you can detect which farm's milk was too contaminated. Probably, their milking techniques are not hygienic enough. Then you can say,

“You have X number of days to correct it. Otherwise, we will no longer buy your milk.” It has an important feedback effect.

Nebeker: I’m sure there are other industries as well where this kind of constant monitoring would be useful.

Valentinuzzi: Yes. Ten years ago I spent a month in Vienna. I studied German again and I visited their *Technische Universität*. (I studied German again!). In Austria, everyone is tall, so I ended up with a pain in my neck from always looking up. I got an appointment with a guy who, behold, was shorter than I am. I said to myself, “Great. We will communicate fine.” I learned from this guy that they were developing a bactometer or bacteriometer and told him we were working on the same subject, but noticed he pulled down the screen. Obviously, he did not want to talk because he saw me as a competitor. He showed me the equipment. I asked, “Could I take a picture?”, and he said, “You better not.”

Nebeker: Is this because of the commercial market for such work?

Valentinuzzi: I think so. When I went back to Argentina, I wrote him a letter. He had given me a very short communication just one page long. It was nothing new to us. I sent him all the papers we had. Would you believe it? He never answered a single word.

Nebeker: Yes, I have heard people complain that in some areas scholarly openness and sharing of results has suffered. In the pharmaceutical industry is one obvious example, but also in many other areas. Have you seen other instances in your work where people are playing their cards close to their chest?

Valentinuzzi: Oh, yes. One of the characteristics from which I profited a lot at the old Department of Physiology at Baylor with Dr. Hoff and Dr. Geddes was the openness of mind. The spirit of academic freedom we enjoyed was superb. There was always openness for discussion and even fight, but in a good sense. It was an environment with healthy discussion. One might hear, “If you want to perform an experiment, go ahead. You are going to fail.” Then one might come back with, “See? I didn’t fail. My result is true.” Things like that. I have not seen that in many other laboratories, though I have visited many laboratories in my life. I have spent some time in several of them, and it’s not always like that. Sometimes there are rooms next door to one another with the people saying to each other, “Now look at this, this is mine. I don’t want to see my result in your paper.”

Nebeker: What are your views in general on bioengineering in Latin America?

Valentinuzzi: This is something that is fresh in my mind because of a report I recently wrote. Bioengineering as we now know it essentially did not exist back in 1956-57. There were a few, but very few, isolated groups doing something that could be called electronics applied to biological systems. The professional group of Medical Electronics of the IEEE started around 1957.

Nebeker: I think it was actually in the early ‘50s. It was the Institute of Radio Engineers.

Valentinuzzi: Yes. It was the Institute of Radio Engineers, and there was a professional group for medical electronics.

Nebeker: Right.

Valentinuzzi: Maybe that began in 1955. Perhaps, you can go back and find the *Transactions*. It was a little journal, with no more than two or three papers per issue and two or

three issues per year, something like that. The International Federation started in 1958 with a meeting in Paris. This was written in booklet that was published last year, I believe. However, there was nothing in Latin America. In 1964, in the University of Tucumán, these two guys I mentioned earlier, the physician and the engineer, created a small laboratory of bioelectronics. That was very early. I would say that in Latin America there was nothing, except that rather isolated laboratory. Those two men produced what was probably one of the first cardiac pacemakers in Latin America. I know of some people also in Uruguay, with a small factory still in operation. Wilson Greatbatch had built before the first cardiac pacemaker in the US. There are other names, too.

Nebeker: Earl Bakken?

Valentinuzzi: He was involved. It was 1961 or 1962 when they produced a pacemaker at that laboratory in Tucumán, and they actually implanted a few of them in patients. They continued until 1972 when I went back to Argentina, and we started the Laboratory of Bioengineering. I am sure that in Mexico they started biomedical engineering in 1975, and in Brazil they started perhaps in 1975. We started our Laboratory of Bioengineering in Tucumán in 1974. In fact, in 1975 we helped the people at the Mexican university called Universidad Autónoma Metropolitana at Izapalapa. You've seen some of the people here this morning. I went to Mexico in '76 and spent three months there. It coincided with those awful years in Argentina, because I seriously considered their offer for me to stay there. They had just started the undergraduate program in biomedical engineering. They

already have something in the order of 800 to 900 graduates, easily, with a degree equivalent of a Bachelor in Biomedical Engineering.

Nebeker: That is impressive.

Valentinuzzi: They have had perhaps fifty to sixty students with the level of Master, and probably twenty to thirty with the level of Doctor. There are several universities in Mexico offering programs. They have mostly oriented themselves to clinical engineering, and that is well developed in Mexico. You can visit several hospitals there and find signs saying Clinical Engineering Department or Biomedical Engineering Department. In that respect, Mexico is well ahead of the rest of the Latin American countries.

Nebeker: You have been president of the Latin American Regional Council of Biomedical Engineering.

Valentinuzzi: Yes. I was one of the organizers of the Council.

Nebeker: Has there been good cooperation between Latin American countries in this field?

Valentinuzzi: Yes. It has been ten years since we started with the project of the Regional Council. By 1989-90 I was Regional Representative for the developing countries to the Developing Countries Committee of the International Federation. At the same time, I was Regional Representative of Region 9 within EMBS. That was a happy coincidence. At the same time, I was also president of the Argentine Society of Bioengineering. That was almost simultaneously and continued for four years. Within my hands I had considerable power to pull things together. For example, I had good contacts with people like Robert Nerem, who was president of the Federation, and Charlie Robinson, who was president of the EMBS

Society. I was able to get financial help from both organizations. We held our first organized meeting in Argentina coinciding with the National Congress of our Society. I believe that was in May or June, I don't recall exactly, but it was 1990. It was the beginning of the Regional Council (CORAL). It went beautifully. This year (1999) by coincidence I was in Lima, Peru when they (CORAL) had the tenth meeting.

Nebeker: Do they have a meeting every year?

Valentinuzzi: Yes, every year. Right now there are nine or ten Latin American countries that are official members of the Regional Council. Those countries are Argentina, Brazil, Mexico, Cuba, Chile, Venezuela, Peru, Uruguay, and Colombia.

Nebeker: What has the attendance been like at these meetings?

Valentinuzzi: Good. Always they try to have it during a National Conference. Its influence has been very positive. It has made it possible for us to stimulate the organization of laboratories, programs and societies in each place, both the national societies and regional groups within the IEEE structure. It's been highly beneficial. For example, in Peru we started in 1994. They now have a laboratory of bioengineering, a Master's degree program in Biomedical Engineering, and one of the newest societies. I attended the meeting we had in Lima last month (September 1999) as the representative from Argentina. The current president of the Regional Council is Argentine and is a former student of mine. Last year, in Mazatlan, Mexico we had the first Latin American meeting. Somewhere around four hundred people attended that meeting on biomedical engineering. Some

invited persons from other countries also attended. I was unable to go to that meeting.

Nebeker: What do you have to say about deconvolution? You said there was a story there.

Valentinuzzi: Yes. It is a very old story. As I told you, when I returned to Argentina the situation was really bad. However, there were a few stimulating things. The university gave me a house in a very nice environment. You need to know a little bit about the geography of Tucumán to understand.

Nebeker: We can do that later.

Valentinuzzi: The eastern side is plains, and the western side is mountains. The city is right on the limit. The university is within the city limits. Right where you start to climb up the mountains there is a beautiful reservation. Our university owns many square miles of forest that are invaluable.

Nebeker: That's very nice.

Valentinuzzi: Within that environment, there is a little village with something like forty houses and a building. The history behind it is political. Argentinians like the Egyptian-like projects. In the days of Perón, back in 1950-51, someone wanted to build in the hill area the biggest building ever seen there, up in a mountain (San Javier) and also some kind of development at a lower level. That place is inadequate, because of the climate and for the location. The mountain is about 1,400 meters above sea level and the university was to sit up there. It was a crazy idea. There is a road to get there, but it would not be able to absorb the back and forth traffic every day.

They started to construct a building ... and quit; now a huge monster is there which was never finished. It's a concrete mass that is almost 50 years old. After Perón was ousted in 1955, the whole project was abandoned, even cursed. It was tainted by the dirtiness of the old government. All kinds of plants grew up and it became infested with snakes and reptiles of all kinds. Thereafter, when the blooming period I mentioned earlier came about after 1955, a new university president said, "We can remodel at least the lower level portion and use it as a hook to bring professors to the university." Well, he did, and it was a blooming period for the university. If you were in the States or on the other side of the country the bait was, "We offer you a position of professor and we are going to give you a house for free."

Nebeker: In a beautiful area.

Valentinuzzi: In a beautiful area. It was a little isolated, but for children it's a garden. When I went there from Houston, I had a problem with housing. In those days it was very difficult to get a house in Argentina." We lived in one of those houses for eight years. My daughters really enjoyed it and will never forget it. They had horses, they caught snakes, played pirates and things that children love to do. We also had a swimming pool. At the same time it was a sad period because of the violence I mentioned earlier. There was a professor from India, a mathematician, contracted by the university. His name was Shyan Kalla. He lived two houses down from us. We got into the custom of getting together to study mathematics practically every afternoon, because the situation at the university was really uncomfortable. Soon,

the idea of convolution and deconvolution came about. He was a theoretician and had never performed a single numerical calculation.

Nebeker: Not even numerical mathematics, only theoretical.

Valentinuzzi: Purely theoretical. Deconvolution was unsolvable, because to deconvolve by continuous mathematics is essentially impossible or very difficult. At that time I recalled that someone in Italy had applied to study intestinal absorption with numerical methods to deconvolve and study the ingestion of certain substances and study the kinetics of intestinal absorption. It was very nice. I dug into my files and found a little paper. We had no computers, just a little calculator, and we started to work. He got interested. He said, "I have never performed calculations like this in my life." A few papers came out of that.

Nebeker: He wrote the papers on this subject?

Valentinuzzi: We wrote them together, and then I wrote a little paper with a student (Valentinuzzi ME, Montaldo Volachec EM, 1975, Discrete deconvolution. *Med & Biol Eng*, 13(1):123-125). Thereafter, he left the University of Tucumán because the situation had gotten real bad. I think he left Tucumán in 1976 or '77, to Venezuela. I lost contact with him. I continued a little bit with a student and began to receive letters from other people who had found that the matricial methodology was applicable in renal physiology to study the so-called retention function. They had modified it with some filtering techniques. It got good reception, I got enthusiastic and we wrote the whole thing. We tried to develop a wider theory, an operator's theory. Are you familiar with the Laplace Transform?

Nebeker: Yes.

Valentinuzzi: It is in the continuous field of mathematics. It has a dual counterpart that is the discrete form of the Laplace Transform. I wrote a paper and was very proud of it. I submitted it to one of the journals of the IEEE. It went back and forth several times, reviewed by six referees. Ultimately, the paper was not accepted. Looking back on it, I think their judgment was too harsh. They said, "It's an excellent idea. If you proceed a little further you are going to rediscover the discrete form of Laplace Transform by going through this methodology." We could solve simple differential equations, but there were some problems that needed to be worked out further. I got so frustrated that I put it in the drawer and forgot about it. Eventually, we published it in a local journal (Valentinuzzi ME, Kalla SL, 1979, Discrete convolution operators, Rev Inst Cibern Soc Cient Arg, 4(1):17-35). The lesson I learned from that is that a reviewer or the editor of a journal must be very careful not to be too much of a purist on requiring this and that. I understand and accept that to keep the level of a journal at the highest possible level, the highest quality in that paper has to be required. However, you must be careful, because at the same time there is a risk that you can kill an idea. Sometimes it is very difficult to know where to draw the line, but you can sterilize a young guy if you say, "I'm not sure. Perhaps yes, perhaps not." It seems to me that you would do better to permit him to publish the paper than to reject it.

Nebeker: There have been plenty of instances where newer ideas have had great trouble being accepted by editors because they are a little bit unusual.

Valentinuzzi: In our case, I do not think it was a newer idea, because we actually got the inspiration from someone else, an Italian by the name of Segre, though I never

met him. I like to look forward and am a big believer in the young people. They are the ones who are going to proceed from now on. I try to encourage them. I don't mean one should encourage silly things. I have been editor and guest editor, and am currently a reviewer for several journals. I do not consider myself an easy reviewer, but at the same time I remember experiences I have had in my life like this. There have been other examples similar to this. I remind myself, "Max, hold your horses. Maybe you do not know enough to understand this or maybe you do not have all the information. Give it the benefit of the doubt, like in justice. Don't kill it."

Nebeker: Thank you very much.