

WILLIAM LANG

An Interview Conducted by

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Interview: William Lang
Interviewer: Andrew Goldstein
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Goldstein: Could you start off by telling me something about the history of the original Professional Group on Audio?

Lang: The history of the IRE Professional Group on Audio started in 1949. I had nothing to do with it until 1959, but the history is well documented. I'm sure that if you refer to the IEEE Transactions on Audio for May-June 1963, you will find a very good history of the PGA. The PGA was started by Leo Beranek. It mentions Ben Bauer, John Hilliard, and Dan Martin. Those are the key people, and they got it going. PGA was number one, so in the IRE this was the first professional group.

At about the same time, the Audio Engineering Society was being established. There was always a recognition within the IRE that these were the professionals who were also IRE members and interested in audio, whereas the Audio Engineering Society appealed primarily to people who were not electronics engineers, and who were not members of the IRE, and that was the role that they played.

The societies developed side by side for ten years, and at the end of 1959, or early 1960, the IRE had a very well-developed standards structure. They had several dozen standards-developing committees. I'm looking at my own map on the board there. The PGA had been followed by several other professional groups on various other disciplines. One is mentioned in here on broadcasting, and there were half a dozen or more, but audio was number one.

In 1959, there was a separate IRE organization for standards, and the reason that I got involved is that at that time the IRE had actively published a number of standards. In 1959, some standards for the computer industry came out. The IRE had published a standard in the computer world, and there was no participation by IBM whatsoever. So a number of us from the lab here were asked by IBM management to participate. They wanted us to look at the various disciplines that we were working in (I was working in acoustics), to see what the IRE was doing, and to see if IBM should participate more, because at that time AT&T's Bell Labs was basically running the IRE standards structure. They were doing a great job, but I would guess that of the dozens of standards committees, probably sixty to seventy percent of the participants came from Murray Hill. So IBM said, "Gee, can't we, IBM, make some contributions here?"

So I was sent to New York in late '59 or early '60. I had really nothing to do with the PGA up to that time except that I'd been a member of it, and I still have early issues of the Transactions. I looked at what the standards folks were doing, and in this particular standards committee of the IRE, called "Committee 30 on Audio and Electroacoustics," I thought that the work that was going on was very relevant to what IBM was interested in. They were interested in the processing of short time signals, and we were interested in the processing short time signals. This was long before the FFT came along. And I said, "Yes, I think it would be a great idea." IBM encouraged me to become active, and I did. I worked on the standards side of the IRE house until the merger. The merger came along in 1962, and then PGA was put together with this standards operation, which had been totally separate up to that point.

Goldstein: You mean the standards operation on the AIEE side?

Lang: No. Nothing to do with the AIEE; on the IRE side. The IRE standards operation was completely separate from the professional group structure.

Goldstein: Oh, I see.

Lang: But because the AIEE was also out there with a large number of committees, it was decided by the powers that be that the audio and electroacoustics standards committee of the IRE should become part of PGA. So that's what happened. It was a forced merger. Actually it worked out quite well, because there were some interlocking people on it. Iden Kerney was probably primarily responsible. He was the chairman of Committee 30, and he ultimately became chairman of the Professional Group on Audio.

So here we were with IRE on the masthead, and then the next issue had the IEEE on the masthead. Volume AU-11 Number 3 is where the brief history of the PGA appeared. Then the new chairman, who was the chairman at that time, was Frank Commercey [sp?], he had really nothing to do with it, because the one who came in the following year was Iden Kerney. So the issue that I want to show you that really is extremely important is this one, because this really dates it. The editorial is entitled "Help," and appeared in the May/June '64 issue. I would say this was the low point. It is quite relevant, because the PGA just about ceased to exist at that point.

Goldstein: We're looking at volume AU-12, issue Number 1.

Lang: This is where things were pretty grim. This was one year before the Cooley-Tukey article in the Annals of Mathematics, "Rediscovering the Fast Fourier Transform." So basically this is the absolute low point. The guy on the administrative committee who stepped in was Iden Kerney, who was vice chairman in '64. He introduced a lot of changes, and the first thing that becomes quite evident is that the cover changed, and he wrote a rather good article here in AU-13, Number 4, in 1965, on the major changes that had taken place. What this said was that, as a result of the merger, the PGA structure has absorbed the standards committee on audio and electroacoustics.

It was clear that something needed to be done at that point, so the first thing that was done was to get the PGA to change its name, probably in early '66. It became the Group on Audio and Electroacoustics. At that time, after the mergers, the word "professional" was dropped from all of the committees, and it became a group. So it became the Group on Audio and Electroacoustics as of roughly 1966. That didn't really change an awful lot, but there had been a lot of people involved in the standards part of the business who came into the professional group on audio and that had a synergistic effect. Putting those people together made things click.

Now, about that time the outside world was rapidly changing, and we had in 1966 the first recognition that there was something coming called the fast Fourier transform. There was no hardware to it, it was all in software, but the recognition was clear that this was going to revolutionize the field. Cooley was from IBM, but Tukey was from Bell Labs, a professor at Princeton and a consultant at Bell Labs. The people from Bell Labs who were most up on this technology and who knew both Tukey and Cooley knew what was coming. In 1966 it was really necessary to do something to take this into account, and the first offer was made to the Acoustical Society of America. In the spring of 1966 there was a special session held at the spring meeting of the Acoustical Society on the fast Fourier transform.

Goldstein: When you say the first offer, you mean an offer of what?

Lang: Well, it looked like a new technology was coming down the pike and didn't have a home, and so the attitude was "Gee it would sure be nice if somebody gave it a home."

Goldstein: But who extends this offer?

Lang: Well, there was nobody extending the offer. It was just recognized, primarily by people from Bell Labs, that there was this new field coming and there was no signal processing society. Signal processing was spread over various different areas within the IEEE, and so there was no real home for this great development that was coming down the pike. In '66, the logical home for this would have been the Acoustical Society of America, which basically covers all aspects of the science of sound. So we held a special meeting through the Technical Committee on Noise of the Acoustical Society of America.

We held the meeting in Boston. It was a special half day session, and it was so popular that there were people—I can remember this—sitting on the floor in the auditorium. The auditorium was too small, and probably 150 people crammed into a space that would hold 100 comfortably. This was the first recognition that something that was really hot was coming. But the Acoustical Society was really not terribly interested, because this society is basically an academic society. I have great loyalty to the Acoustical Society. One of my present jobs is as its treasurer, so I know a lot about it. But its management at that time was not terribly interested in this area. So that meeting was a one-shot affair.

The Acoustical Society went out of the signal processing business from 1966 until 1995. Then they decided that "Gee, this really was something," and so in 1995 they formed a technical committee on signal processing. Larry Rabiner, who was the vice president of the Acoustical Society at the time, and I both thought this was crazy. The horse had left the barn thirty years before, but academics sometimes move in strange ways. That was their one chance to take over a burgeoning development, and they didn't rise to the occasion.

At that time the Group on Audio and Electroacoustics was struggling, and I mean struggling, because it inherited the background from the PGA. They didn't have much in the way of a publication, didn't have much of a program, and had no meeting of their own. The only meetings that they held were the IEEE international conventions which were usually held in New York once a year. The Group on Audio and Electroacoustics would sponsor a couple of sessions at the international convention, and that was it.

Well, it turned out that we had an opportunity to go to Arden House. You've gotten the story, I think, of the Arden House workshops. The Group on Audio and Electroacoustics sponsored the first and second, and I guess there was a third, workshops on fast Fourier transform and signal processing. It is well documented in the IEEE transactions. I wasn't the editor, and I wasn't directly responsible, but I think this is what saved the Group on Audio and Electroacoustics from disappearing. I think that it was so weak in the mid-'60s that when it took over from the PGA it really wasn't going to last very long. Now, the IEEE had some very dynamic leadership in the late '60s, early '70s, and the guy that I was most directly involved with was Jim Mulligan. What is most important to today's world and the IEEE is that he caused the restructuring of the technical activities. The Technical Activities Board came into being, or at least into flower, when he was vice president, and then he became president. Through the Technical Activities Board of the IEEE, he said, "Look, we've got to change this structure. We have inherited from the AIEE and the IRE some pretty weak sisters, and therefore we have got to reorganize the whole thing."

He came up with the concept that we were going to put all these entities through the hoop and they were going to convert themselves from groups to societies. In order to go from group to society, you had to show a certain amount of activity in what you were doing. In those days each of the groups of the IEEE was rated as high thirds, middle thirds, or lower thirds. When I became chairman of the group, which would have been maybe '66, the Group on Audio and Electroacoustics was in the lower third, and it may very well have been near the bottom. The warning was given, shape up or ship out.

Goldstein: The message was clear.

Lang: The message was clear that something had to be done. When the FFT came along, it looked like this was going to revolutionize the field of acoustical signal processing, which was very close to audio and electroacoustics, so we grabbed onto it. Finally we had a mission. Bruce Bogert wrote an editorial which appears the June '67 issue that's sitting on the table here. It says, "Audio and Electroacoustics. What in the world?" The question he asks in his editorial is why all this stuff on signal processing and the fast Fourier transform is appearing in the IEEE Transactions on Audio and Electroacoustics. And he goes about answering it very well. He wrote that "I suspect that one of the last places one might look for a discussion of digital frequency analysis would be in the IEEE Transactions on Audio and Electroacoustics. Up until now there have been good reasons for this." So this gives the rationale for how the FFT and its associated technologies were featured by the Audio and Electroacoustics group.

It was only a matter of time before the whole thing revolutionized the field of electronics and the IEEE, and it became much too important and much too big for little old audio and electroacoustics. First of all the group went through the hoop and became a society, and that would have been about early '70s. But when it went through the hoop and became a society, they changed the name. So it became the Society on Acoustics, Speech and Signal Processing, I believe. That was the first thing. Audio disappeared, electroacoustics disappeared, and acoustics, speech and signal processing seemed to be good for the '70s. Then along around 1990 the acoustics and speech disappeared and it became the society on signal processing.

Goldstein: I have heard people discuss the crisis in the Professional Group on Audio, from the early '60s, and the explanation for the crisis that they always give is that it was a mature technology, there wasn't too much more to add. I wonder if that's an opinion that you have in retrospect but not at the time.

Lang: Well, one of the problems is that that area was terribly competitive commercially. Macy's didn't want to tell Gimbel's what it was doing, so to speak. There were a lot of trade secrets, and the technology was relatively mature. That's why there was a great difficulty in publishing anything, because they thought they would be giving away the store if they published too much. There was almost no interest in this field by academics. The only academics who were involved were those who were doing it as a sidelight hobby and happened to be making their living doing something else. This was fun to fiddle around with, because they were all IRE members and subsequently IEEE members, but they weren't making a living at it.

So there are many, many reasons that the PGA suffered. I think it also suffered because in order to become a member of the PGA you had to be an electronics engineer or you needed to have some formal background in the field. On the other hand, the Audio Engineering Society, although it had people who were very, very skilled, had no academic requirements in order to become a full member. You could be a disc jockey and become a full member with zero background. There was no discrimination if you were not an engineer, even though the title was "Audio Engineering Society." It didn't require an engineering background, just like locomotive engineers don't have to know anything about engineering. You could be an audio engineer without knowing anything about engineering. That wasn't true in PGA, because to be a member of the IEEE you had to have some passing acquaintance with the field.

So you had this expanding society, the Audio Engineering Society, appealing to the audiophiles, and then you had an in-house group of electronics engineers who were interested in sort of the same thing. I think this is what almost caused its demise, the fact that the audiophiles were saying "Why are you being so discriminatory against the guys who have all this interest in audio and just don't happen to have any engineering background? Why won't you let them in to participate in whatever you are doing." But there was no vehicle for them to participate in anyway, because the only thing that the PGA was running was a couple of sessions at the IEEE international convention. You would not find hi-fi nuts going to the IEEE international convention, because there would not be anything of interest for them there.

Goldstein: You just said "hi-fi nuts." Can you tell me what issues the PGA was interested in, in the late '50s and very early '60s?

Lang: Yes. They were interested in the same things that the Audio Engineering Society was interested in, in my view.

Goldstein: Could you just reel some of them off?

Lang: Well, distortion in systems, and design of improved loudspeakers. They were interested in room acoustics in the sense that the room has a vital role to play. They were interested in the whole gamut of acoustical problems related to audio. I think it died more of internal suffocation; it had no way to get to the outside world. It was sort of a "kept" organization within the IRE and later the IEEE. I don't think the Group on Audio and Electroacoustics would ever have survived if this technology looking for a home hadn't come along.

Goldstein: Well, did you participate in any conversations where people said, "Hey, take a look at this FFT. This can be a new direction for our society"?

Lang: Oh, sure.

Goldstein: Can you recreate those scenes?

Lang: Well, the best thing I can do is to look at the special issue that came out. These people were basically the people that came into the Group on Audio and Electroacoustics from the IRE standards committee on audio and electroacoustics. Jim Cooley was on it, but you will notice he was not a member of the IEEE at that time. Dave Favin participated. Howard Helms was a particular leader. He may have been Tukey's student, I'm not sure, but he at least was involved with Tukey. Charlie Rader from MIT was involved, as was Peter Welsh from IBM; basically this was the subcommittee on measurement concepts. This was a direct successor to the old IRE standards operation. The reason that this was so important was that in June of 1967 nobody really understood what the fast Fourier transform was. It had been published in the Annals of Mathematics. It had not been popularized, nobody had written any books yet, and therefore the whole challenge was to try to pin down what this was. Signal flow graphing was in its infancy.

Here is the issue that I mentioned. It says that on June first, '66, the "Uses of the Power Spectral Analysis" special session was held at the seventy-first meeting of the Acoustical Society of America. That was the first time that there was a public discussion. The keynote paper was by Bingham, Godfrey and Tukey. These were Tukey's students, and that was followed by short discussions by members of a panel. The panelists included Bruce Bogert, Jim Flanagan, Parsons, Allen Powell, Peter Welsh, and M. R. Weiss. This came out of that workshop. This was before the first Arden House workshop. These people were the ones who were responsible for identifying the rediscovered technique as one that was going to have profound influence.

Goldstein: Did you all think that this was a technology that was quite obviously related to audio as it had been understood by the society, or were you saying, "Let's take on a new technology?"

Lang: Oh, no. This was audio. We were interested in audio, because in this lab we were interested in being able to do our signal processing digitally. We were unable to do it at that time, because all the instrumentation was analog. We were living in an analog world. Signal converters were just appearing on the scene but they were very slow and inefficient. Our intent was to work into the new digital world with our problems in audio, electroacoustics, and noise control. That's what happened. Noise control is a very, very small part of acoustics.

So the answer is we were not opportunists in the sense that we were looking at a technology that was unrelated to anything we wanted to do, and we were going to give it a home because we didn't have any other place to go. This was directly in line with where we wanted to go with our own work. In fact, some of the first FFT analyses were done in software right in this lab. I remember the analysis in those days was done on a mainframe. We had the output for one second of signal, and we stretched it out in a long strip of paper from one end of the lab to the other. Just to analyze one second worth of signal with a software program was very laborious. So we were already very interested in it.

The problem was that the genie got out of the bottle. It was such an enormous thing. The fact that it was related to acoustics or related to noise control was just forgotten. The people who are running the Signal Processing Society today have zero interest in noise control and I would say very little interest in acoustics. It has become an academic discipline in its own right. Whereas PGA forty or fifty years earlier was very definitely not an academic discipline. And I think this is important, because academics march to different drummers than do people in industry.

Goldstein: Well, that raises a question I was curious about. When you started publishing papers like this on the FFT or things that are more what we would now call signal processing, were you able to get any sense of what use they were to the members of the society. How was the audience for your Transactions using the information? Was it reforming the practice for rank and file engineers, or was it an academic subject?

Lang: No. I think what we were doing was of interest to the practicing engineers. I think it became a more academic discipline later on, because the engineers had a lot of practical problems and wanted to be able to solve them. That was where the motivation came from. The IEEE itself helped a lot, because the Proceedings for October '67 and for February '67 picked up the FFT, and republished most of what had previously appeared in the Transactions. Yes, this paper has been reprinted from the June issue of the IEEE Transactions on Audio and Electroacoustics. So there were people at headquarters who recognized that the FFT was something that was going to have a profound influence.

Goldstein: Does an event like this, where the Proceedings picks up an article from your Transactions, does that require initiative from the society, or does that come from the editors of the Proceedings? Do they decide what they want to do?

Lang: In that case it came from editors of the Proceedings. It was not from the society at all. But compare the issue with "Help" as the editorial with one of these issues. Now by this time Fred Van Veen was the editor. Fred was the editor for at least ten years; he immediately preceded Wheeler, who was the one who took over in the mid-'70s. You know the history better than I do. Fred Van Veen took over, and he did a really splendid job. I think that the reason that the Proceedings picked that up is that they see all the publications. So it was initiated by somebody outside the group.

By the late '60s, the group had become a society, it had become established, and that was important. I got a lot of personal satisfaction out of it because I saw that instead of being prioritized near the bottom of the IEEE barrel it was moving up. Now it's the second or third largest society, and if the IEEE Board of Directors does its rating anymore, I'm sure that the Signal Processing Society is very close to the top of the thirty-seven.

So to me, there's a lot of personal satisfaction that this thing that almost went out of existence suddenly got a totally new life. That was great. In 1970 this was going great guns here in the States, but Europe was very much behind us. So in 1970, '71 possibly, we got a subgroup of the Group on Audio and Electroacoustics in Switzerland to host an international symposium on the FFT and signal processing. It was held at the ETH, the Swiss Federal Institute of Technology, and it was a program where the speakers were all from the IEEE Audio and Electroacoustics group. They went over and put on a very nice three day symposium to a European audience. It was enormously successful, and the next year a second symposium was held, and I believe that a couple of Americans were invited to participate in that.

The third one was held very shortly thereafter and the organizers of this one had never even heard of the work that the Audio and Electroacoustics group had done. It was completely forgotten in history in a relatively short period of time, perhaps three to five years. The participation of the Americans was gone. The IEEE connection still held, because the IEEE has enormous prestige overseas, but the participation by American teams was lost in antiquity. I don't know whether that series is still going, because the Swiss Federal Institute of Technology was responsible for it. It was their show, but they couldn't have done the first one without the Audio and Electroacoustics group's participation.

Goldstein: Can we get a better understanding of the thinking of the people in the audio group by understanding why the Acoustical Society of America decided to pass on the FFT? Do you understand why they decided they weren't going to pursue that topic?

Lang: Well, I don't think there was any conscious decision made by the management of the Acoustical Society of America not to pursue the topic. Simply put, the Acoustical Society of America is not structured so that they could do it. The Acoustical Society depends a lot on its volunteers, and it has a small executive council of ten elected members. It just turned out that at that time there was nobody on the council who could recognize that a revolution was coming. I'm sure that if somebody had been on the council who had had a dynamic interest in this field, they could have convinced the Acoustical Society that the least they could have done would be to set up a technical committee on signal processing. That should have been done by the Acoustical Society shortly after this special meeting in 1966. But it took them thirty years to get off the dime, because there wasn't anybody around who really could see it. I can remember a conversation with the president of the Acoustical Society. In order to get that special session on the agenda, I was involved with the Acoustical Society, and the president came around and he said, "What's new in this FFT? This has been around for a long time. It's just a little bit faster."

Lang: It was a very condescending discussion. You know, "Why should we allow the Acoustical Society to be used by an outside outfit, namely the IEEE Audio and Electroacoustics group, to run something that they think is important. Show me the importance!" Well, I don't know whether we showed him or not, but that was the most popular session that was held at that meeting of the Acoustical Society. But no one on the executive council of the Acoustical Society really had the foresight to see where it was going.

Then, in 1995, Larry Rabiner was serving as vice president of the Acoustical Society, responsible for all the technical activities of the Acoustical Society. The proposal was made that we should have a technical committee on signal processing, and he said, "This is ridiculous. Signal processing is all-pervasive across all fields of acoustics, and to have a separate technical committee on signal processing is, in today's world, is the wrong thing to do." He was overruled by the members of the executive council, and they formed a technical committee on signal processing, thirty years too late.

Several organizations, including the PGA, the Audio Engineering Society, and the Institute of Noise Control Engineering, have come out of the Acoustical Society, which dates from 1929. It was the first organization in this country that covered the entire field of acoustics, and there have been many, many offspring. So in a way you can look at the IEEE Signal Processing Society today as an offspring of the Acoustical Society, and yet it's four times the size of the Acoustical Society in membership.

Goldstein: In the mid-'60s, things like the FFT, digital methods, methods for analyzing discrete data samples, were used not only in acoustics and audio, but in a variety of other things, like geophysics and radar and things.

Lang: Sure! Seismics, radar, optics.

Goldstein: Did the society on audio take those in?

Lang: Absolutely. If you look at the papers from the Arden House workshops, you will find that probably more than fifty percent of the applications that were discussed had nothing to do with acoustics. These were the other fields, radar, seismics, optics, what have you, that have nothing to do with acoustics. There was no attempt to buy the acousticians or to focus it on only the things that they were interested in, or the applications they were interested in.

Goldstein: Can you give me information at the nuts and bolts level of how the Arden House workshop was organized and how they decided what papers to take, or what sessions to host?

Lang: Well, Andy, you are asking me a tough question. The reason it's tough is that I have to digress a bit first. In 1971, when the IEEE had basically outlived Arden House, a group of us used Arden House to form a new society, the Institute of Noise Control Engineering. It has got nothing to do with the IEEE, but it is the publisher of the magazine I gave you today. So I'm a little bit fuzzy about the organizational structure for the Arden House workshop on noise control engineering in 1971, and the one here. But as I recall, what happened was this. In 1965, roughly, I was sent to IBM management school, and the IBM management school was at a place called Arden House. I remember my manager telling me, "You are going to go, whether you want to or not, for two weeks." I said, "Two weeks?" And he said, "Well, they are going to be separated. They are going to be three months apart. You are going to go for one week, and then you are going to go for another week." So I spent two weeks at Arden House. I talked to the management and I said, this is part of Columbia University, and so they said, "Oh yes, sure, we have outside groups coming in all the time." When I became chairman of the Audio and Electroacoustics group, we were looking for a venue. Have you ever been to Arden House?

Goldstein: No.

Lang: It's not very far, and we needed something close, and so therefore I talked to the management at Arden House, and they said okay. We organized it through the administrative committee of the Audio and Electroacoustics group, and we got Jim Cooley involved, because he was IBM at the time. Peter Welsh was one of his colleagues, and Jim was involved with us from the beginning. We started out to structure it. Now you asked how we got the sessions together?

Goldstein: Well, it just seemed strange, because if you have sessions on all these far flung fields, how do you promote the sessions, get people to submit papers, how do you decide what the sessions will be on?

Lang: Good question. Unfortunately my knowledge is not that good here, except I know that the Bell Labs guys were extremely productive in this whole thing. Iden Kerney, who was my predecessor as chairman of the group, was from Bell Labs, and half these people are from Bell Labs. Bell Labs really participated. IBM had Cooley, but Bell Labs had Tukey, and they had a very strong research organization in this area, which IBM did not have. IBM had a research division at Yorktown, but that division was not terribly interested in what this lab in Poughkeepsie was doing. This is part of a development lab in Poughkeepsie, so basically we in IBM could look to Yorktown for the science, but we couldn't look for any help on any practical problems in an area that is only peripherally related to the main business of IBM.

The main business of IBM is the development of computational circuits and systems, not controlling the acoustical noise generated by the products which incorporate those circuits and systems. The latter is an acoustics problem, in this small lab here we were tasked to work on it. We used whatever we could get. We didn't get any help from IBM research, because they were working in a very different direction.

The people at Bell Labs were much more applied, much more closely related to what we were doing. So we found a lot of professional interaction with the Bell Labs people. There was a very active group there under Ed David, Manfred Schroeder, Jim Flanagan, and Larry Rabiner. Over a period of time they had a very sizable group, and the work that they were doing was very closely related to what our interests were. In the structuring of the initial workshops the Bell Labs people played a major role in handling it.

Goldstein: You know, I've heard from a lot of people at Bell Labs, Jim Kaiser, Larry Rabiner, about some of this.

Lang: Jim Kaiser is another one, as are Charlie Rader and Ben Gold.

Goldstein: I've heard about what Lincoln Labs was doing with these vocoder applications, but your noise control application is actually pretty new to me. Can you give me a sense of what was going on here in the mid-'60s, how you were using things like the FFT?

Lang: Well, we were not using the FFT. There was no hardware, so everything had to be done by software, and in the late '60s, early '70s, this lab was participating in the MIT Course Six cooperative program. That was a five year program leading to a master's in electrical engineering, and the students cycled through one term at MIT, then one term in industry. We had a total of eight of these students during the late '60s and early '70s, and we put them to work on trying to adapt what was going on in this burgeoning field of digital signal processing and FFT to our problems. They worked on our problems, and we got eight master's degrees from MIT out of the work. It was great for us, because with a very small group here these young folks provided us with really a very good connection to what was going on in the field, and those eight guys have gone out into various aspects of DSP. Very few of them have stuck to acoustics, but that's all right. They have done very well.

Goldstein: To try to focus this scene in my mind, can you give me an example of how one of these students worked on one of the problems you had here? What was the problem, and how they tackled it?

Lang: Okay. The problem is to take the signal from a source, which was in this case a computer, and instead of using all analog equipment, such as that stuff that's sitting in the corner for demonstration purposes, to process it digitally, which is what we do today. In the '60s, there was no digital equipment at all. We had to go from the analog world to the digital world, and that was still in the future. Time series analysis was done by analog equipment.

Goldstein: The problem you just described actually doesn't sound like noise control problem. Is it?

Lang: Well, the problem is a very mundane problem, and that is that the customer is annoyed by the noise of the product. In the '60s and '70s we were selling products that went for a million dollars a piece. This was long before the thousand dollar PC came along. These didn't do very much, but they occupied a lot of landscape and they made a lot of noise. When the customer paid that much money for it, the least that the customer could expect was peace and quiet.

Goldstein: Okay, I can understand the noise control problem. I just don't see where the signal processing fits into it.

Lang: Well were able to do it more efficiently digitally than in an analog sense.

Goldstein: So you mean you analyzed the acoustical noise?

Lang: Yes. So getting back to our earlier discussion, this is how ICASSP started. In the early '70s the Group on Audio and Electroacoustics had outgrown the Arden House workshops. It was pretty obvious that Arden House, because of its very limited capacity, was not going to serve. When Reg Kaenel became chairman of the group, I recall saying to him, "Reg, you've got to have a national meeting." Now I don't know whether Reg actually did it or whether it was the following year, but the first ICASSP was a direct result of Reg Kaenel's pushing. It was obvious that the IEEE International Convention was not going to provide the kind of resource that the group needed, and Arden House workshops were great, but they could not contain the agenda.

Goldstein: So these were too small.

Lang: The genie was out of the bottle, as I said. So that was what happened in the mid-'70s. It's amazing to me that it took that long before they had the first ICASSP. Since then it has taken off like a rocket, held every year, and then it became international.

Goldstein: We had started to talk a little bit before about the first Arden House or even the second Arden House, and how the conference program came together.

Lang: It was arranged.

Goldstein: We talked about how it happened first, but in subsequent years was it any easier? You said, "The genie got out of the bottle." Were more people were approaching you for an opportunity to present their work?

Lang: Yes. It takes a while for innovations to take hold. You realize that there were no boxes that we just looked at. There was no electronics. Everything was conceptual, everything was software, and everybody was using FFT programs on large mainframe computers. The genie couldn't be put back in the bottle but the growth rate was not all that dramatic, so therefore the second Arden House workshop was not that difficult to arrange. Again, if you look at the program you will find that there were lots of people participating who had nothing to do with acoustics, noise control or audio.

Goldstein: So did the conference organizers go out and beat the bushes to try to get people?

Lang: Yes. This is the kind of things that we were doing. Burst measurements in the time domain and so on. That was the first thing that I was involved in, the standards work. This other notebook is the stuff that related to the group after the Audio and Electroacoustics standards committee basically took over the group. Dick Emberson was very much involved, and he was very helpful to us. I notice that on the second of March '67 that GAE Ad Com had an executive committee meeting, and we were wrestling with all these problems, the international convention, what was going on, and these are the minutes. Even '67 they were talking about changing the name. These are the minutes of the Administrative Committee during this very critical period.

Goldstein: Let me ask you the same question, but from a different perspective. I want to talk about these same issues from the perspective of initiative. I doubt that these changes in the society would have just happened automatically. It seems that people with clear visions about what they wanted had to force the changes through. If that's true, can you tell me who some of the people were and what some of the actions were?

Lang: Well, I can't emphasize too strongly that the direction came from the top, and Jim Mulligan really was a dynamic leader. He was followed by a couple of other IEEE presidents who didn't really do much. Mulligan became the executive officer of the National Academy of Engineering, then he went to the west coast and became a professor at the University of California at San Diego. He died last year. He was a real technical leader, and although he was not a Bell Labs guy, he had very good connections with Bell Labs. Bell Labs, Mulligan, and some of his associates said, "We need a new structure for this new IEEE." He became the president shortly after. He had been involved with the management of the IEEE at the time when the union between AIEE and IRE came about. He and a small handful of people at the top of the IEEE said, "We need a new structure and we need people with vision. Go at it, do it." He put all these groups through the hoop, established the technical structure as it exists today, and brought the first societies into being. The Group on Audio and Electroacoustics was not one of the first societies. Mulligan bowed from the scene after he'd done his normal three year tour as president-elect, president, immediate past president. By that time he had forced most of the groups, particularly the ones on the bottom third of the IEEE matrix, to shape up or ship out.

He gave me full reign over Audio and Electroacoustics. He said, "Do whatever you need, but just do it and let's see if we can get it out of the cellar." That's what it took, because you needed somebody with that kind of vision who could see what was needed. He created the structure that exists in the IEEE today, and I don't think he's gotten adequate recognition for it, because in doing this he created a lot of enemies. But I thought he was very dynamic and great.

Goldstein: I see. When you say enemies, what was the opposition?

Lang: Well, he was an academic. He was a professor at NYU. I'm not sure he ever worked in industry. Academics are a very jealous type, and they liked the AIEE as it was. They said, "What are we doing here? Why have we got all these young electronics characters in here?" The old fuddy-duddies are always around, and they don't move very rapidly.

Jim asked me to serve as an IEEE director. I wasn't elected, but you know things were fuzzy. So I did it for a year. Then I ran, because I served a year on the board. I ran for director but was defeated in a close election. I was number two out of three candidates. Joe Dillard was another person that I knew quite well, and I remember Mulligan running for vice president in the election of 1969. I've forgotten how it worked, because I really didn't know the details. After the election, I wrote to Don Fink and said, "Thank you very much. I had been a volunteer then for fourteen years, and I thought that that is enough." The reason was that I could see that the Audio and Electroacoustics group wasn't going to be around much longer, because of the success of digital signal processing. That was great.

The IEEE was really not doing anything at that time that was of particular interest to this lab. It was going off in different areas. So we needed a new organization, and we got it in 1971. So I thought it was a good time to bow out. You always like to bow out when you're ahead of the curve. So they don't have to throw you out! So I did.

Goldstein: When you were the candidate to be chairman of the Professional Group, what were some of the issues? How did you campaign, if that's the right word?

Lang: Well, there was no real big campaign. The group was a little apathetic. Today in the IEEE and the Signal Processing Society there are very dynamic, hard fought campaigns. In the mid-'60s, there weren't too many people around who wanted the job. Because it was at the bottom of the IEEE barrel, it didn't really have that aura about it. So there was no great competition. There was no platform or anything like that. Although when I became chairman in the early '60s, I did write a couple of editorials about where I thought the group was going. One was called "Whither Audio and Electroacoustics." I've forgotten whether I made a play on the words whither and wither, because we thought the society was on its way out. If the Bell Labs and the FFT guys hadn't come along it would have, in my opinion, disappeared.

Goldstein: Well, the other question I had is, once those things did come along and there was a surge of interest, was there any effort at the high levels of IEEE to assign certain new emerging technologies to different societies?

Lang: That's a very good question, and the answer is no. There was a lot of discussion among the Audio and Electroacoustics Ad Com about "What are we doing in signal processing?" The answer was, "Well, there isn't anything in the IEEE structure that is really catering to this new technology." So, after a lot of discussion the bottom line was "Let's do it!" Nobody else was. In the Acoustical Society, people could see that something was coming, but they really weren't directly involved with it and didn't know how to handle it.

Goldstein: When I read the history of the society, I got the impression that the Ad Com was unanimous in its interest in expanding the boundaries of the society. Was there any opposition on the Ad Com?

Lang: In my recollection there was no flap about why we were doing this. We were a very compatible group. It consisted of many people who came over from the PGA side too. It wasn't just the people who had come in it from the standards side. The first way we got involved in this was through the 1967 conference on speech communication and processing. This was an Air Force sponsored conference up at Bedford, Massachusetts. Homer Dudley was the guy who was responsible for it, and he was looking for some outside entity like the IEEE, to sponsor it. That's what we did.

Goldstein: Well, thank you very much for the interview.