THE IEEE
SIGNAL PROCESSING
SOCIETY

FIFTY YEARS OF SERVICE

1948 TO 1998

by

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Contents

Preface

The IEEE Signal Processing Society is now 50 years old. When it began in 1948 as the Professional Group on Audio of the Institute of Radio Engineers, there was no discipline of signal processing. Over the next decades, as the IRE Professional Group on Audio evolved into the IEEE Signal Processing Society, it helped create the discipline of signal processing, which today is a vital and rapidly growing branch of engineering. The Society history, then, is an important part of the history of signal processing. It is valuable also for members of today's Signal Processing Society. It provides many examples of dedicated and unselfish service to the profession. It describes difficulties that Society leaders faced and overcame. It shows how a professional organization adapted to rapid technological change, to the emergence of quite new technologies, and to changing social, political, and economic conditions. These are worthwhile things to know for today's and tomorrow's leaders of the Society, since the next 50 years are hardly likely to be more settled, and dedication, resourcefulness, and adaptability will certainly be required.

This monograph tells the story of the Signal Processing Society. A companion monograph tells the story of signal-processing technologies over the same 50-year period.[1] Neither could have been written without the help of a great many people—giving interviews, providing documentary materials, and reviewing chapter drafts. The members of the Signal Processing Society's Ad-Hoc Committee for the History Project should be thanked by name: David C. Munson, Jr. (Chair), Dan E. Dudgeon, Tariq S. Durrani, Don E. Johnson, and H. Joel Trussell. Most of the surviving Society Presidents contributed: besides Ad-Hoc Committee members Munson, Durrani, and Johnson, this group includes John Ackenhusen, Oliver Angevine, Leo Beranek, John Bouyoucos, Donald Brinkerhoff, Ronald Crochiere, Thomas Crystal, Rex Dixon, Delores Etter, James Flanagan, Cyril Harris, Howard Helms, William Ihde, Reg Kaenel, William Lang, Daniel Martin, Lawrence Rabiner, Charles Rader, Ronald Schafer, and Frank Slaymaker. Of these Beranek, Flanagan, Lang, Rabiner, and Rader contributed oral-history interviews; others who did were

1 Frederik Nebeker, *Signal Processing: The Emergence of a Discipline, 1948 - 1998* (New Brunswick, NJ: IEEE History Center, 1998).

Maurice Bellanger, James Cooley, Alfred Fettweis, Ben Gold, Thomas Huang, Fumitada Itakura, Thomas Kailath, James Kaiser, Bede Liu, Sanjit Mitra, Hans Georg Musmann, Alan Oppenheim, Enders Robinson, Manfred Schroeder, Hans Wilhelm Schuessler, Stan White, and Bernard Widrow.[2] A special thanks to Beranek, who made available his unpublished manuscript "History of the beginnings of the Professional Group on Audio", and to Kaiser, who helped to answer what must have seemed to him as countless questions. The professional staff of the Society, headed by Mercy Kowalczyk, gave invaluable assistance. Many others gave informal interviews, answered questions, offered advice, and helped in other ways. I would like to acknowledge also the special assistance given by Michael Geselowitz, Andrew Goldstein, Daniel Katz, David Morton, and Sheila Plotnick, all at the IEEE History Center.

The story is told chronologically. The first chapter tells how the Professional Group on Audio came to be founded, an important story not only for the Society but for all of IEEE in that it was the first of the professional groups of the IRE. Since the IRE structure of professional groups carried over to the IEEE structure of technical societies (following the merger of the IRE and the American Institute of Electrical Engineers in 1963 to form the IEEE), the Signal Processing Society has a claim to the title of the oldest of the IEEE Societies. Each of the other chapters covers one decade, naming Society Presidents, discussing Society publications, conferences, workshops, and other activities, and describing changes in scope, structure, and governance of the organization. An appendix contains lists of Society Presidents, award winners, and editors.

Note to the reader: Full references are given in the footnotes, except when an article or book has already been cited in that chapter, so the reader need never go far to find the full reference. All sources cited are listed alphabetically after the Appendix; this listing, in many cases, contains more information, such as indication of the reprinting of an article or book.

2 The oral-history transcripts referred to were all conducted by staff of the IEEE History Center at Rutgers University. Many of them were conducted as part of a project, supported by the IEEE Signal Processing Society, to research the history of signal processing and the Signal Processing Society.

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Chapter 1

Birth of the Society:
The IRE Professional Group on Audio

The IEEE, with more than 300,000 members in 150 nations, is the world's largest technical society. It is also one of the oldest, having begun as the American Institute of Electrical Engineers (AIEE) in 1884. Its other parent organization, the Institute of Radio Engineers (IRE), was founded in 1912, and the two merged in 1963. Over the last century the IEEE has grown steadily, as has its area of interest—electrical, electronic, and computing technologies. The scope of this interest has necessitated an internal IEEE structure: today 37 IEEE Societies, such as the Computer Society, the Communications Society, and the Power Engineering Society, represent particular areas of technology. The Signal Processing Society has a claim to being the oldest of these, and we may take up its story with the end of World War II.

Electronics, which exploits the passage of electrons through vacuum, gas, or semiconductor, came out of the war a much larger branch of engineering than it entered. Before 1939, radio was by far the largest area of electronics, though electron tubes were used also for long-distance telephony and carrier telephony, for sound movies, in phonographs and public-address systems, and in many instruments. During the war there arose new applications of electronics— such as radar, sonar, and computing—and earlier areas of application—such as communications, electronic navigation, instrumentation, and control systems—expanded enormously. Just after the war, industrial electronics emerged as a major field, and television and FM radio seemed poised for commercial success.

The burgeoning of electronics affected the American Institute of Electrical Engineers. Most of its members worked in electric power, industry applications, wired communications, or instrumentation, and these and the other fields of electrical engineering came increasingly to involve electronics. Indeed, by 1963, when the AIEE and the IRE merged, half of AIEE members were concerned with electronics.[1]

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1 Ivan S. Coggeshall, "IEEE's endowment in electronics from AIEE" (*Electrical Engineering*, vol. 82 (1963), pp. 2-20).

The burgeoning of electronics affected the Institute of Radio Engineers even more. As its name suggests, it had a narrower focus than the AIEE. (It differed from the AIEE also in that, from its inception, it aimed to be a transnational organization, hence there was never an "American Institute of Radio Engineers").[2] Because it was often radio engineers who pioneered new areas of electronics, it was natural that the IRE represent the new areas. The IRE grew rapidly both in numbers and in technical areas during and after the war, and it became increasingly desirable that there be established groups of members in particular specialties. There had, indeed, already been specialized meetings, such as for IRE engineers interested in television.[3]

> ... I recall... the Rochester Fall Meeting of the IRE back at the time when Peter Goldmark introduced the LP record. An engineer from Philco, who had had a hand in the design of the first commercial LP record player, was giving a paper on the design of the pick-up. As a demonstration he played the "Phonetic Punctuation" selection from the new Victor Borge record. At the time for questions, the first question was "What was the name of that record?"
>
> *Frank H. Slaymaker,*
> *personal communication, 25 February 1998.*

At the suggestion of Raymond A. Heising, the Board of Directors on 5 February 1947 empowered the President of the Institute, Walter R.G. Baker, to appoint a planning committee to survey the activities of Institute and suggest improvements.[4] Heising chaired the 6-person committee, which produced a report on 7 October 1947 recommending that "the Institute members belong to technical divisions called 'groups' according to the members' interests." The report pointed out that radio engineering had grown so vast that engineers necessarily specialized, hence there was a demand for specialization in meetings and publications. Heising's report warned that if the IRE did not meet this demand, specialized groups would break off and form their own technical societies, just as the IRE itself was formed 35 years earlier.[5]

The Board of Directors accepted this recommendation on 8 October and asked the committee to formulate detailed plans for what was called the

2 John Ryder and Donald G. Fink, *Engineers & Electrons: A Century of Electrical Progress* (New York: IEEE Press, 1984), pp. 209-215.

3 Leo L. Beranek, "History of the beginnings of the Professional Group on Audio" (unpublished 11-page manuscript, written 1 September 1996, copy available at the IEEE History Center).

4 Minutes of the IRE Board of Directors, 5 February 1947.

5 Beranek, *op. cit.*, and Minutes of the IRE Board of Directors, 8 October 1947. Heising's group had looked at the practices of the American Society of Mechanical Engineers, which had sub-societies, each with its own constitution and membership.

Professional Group System.[6] These plans were presented and approved at the meeting of the Board of Directors on 12 November. A Committee on Professional Groups was set up, with William L. Everitt as the chairman. Two people, Leo Beranek and Karl Kramer, represented a potential "Audio Group".[7] On 3 February 1948 the IRE Executive Committee changed the name of this potential Group to "Audio, Video, and Acoustic Group" and added Oliver L. Angevine, Jr. to the Committee on Professional Groups.[8]

This committee met first on 22 March 1948. Beranek was a principal proponent of the innovation. He had earlier pointed out to Everitt, "...I am sure that you are aware of the fact that part of the agitation for a division of the I.R.E. has stemmed from those who are interested in the audio end of the spectrum. We are witnessing the growth of recording groups on both the East and West coasts, and in the growth of a magazine called *Audio-Engineering*."[9] Three days later the committee presented a report to the Board of Directors, expressing its view that "early action was urgent in view of movements which are under way to found new societies covering areas of technical interest now important to the Institute."[10]

There had earlier been IRE technical committees for different specialties—these committees were concerned mainly with defining standards and procuring papers for the *IRE Proceedings* but the plan for Professional Groups was new in that each would be a semi-autonomous membership organization (open to IRE members) that could publish its own transactions and organize its own conferences. As we will see in subsequent chapters, it was the IRE Group System, adopted by the IEEE at the time of the merger in 1963, that evolved into the present system of IEEE Technical Societies.[11]

The Institute began publicizing the new Group System, and the IRE Executive Committee soon received its first petition for the formation of a Group. This was for the Audio Group—the simpler, initial name was chosen—and on 2 June 1948 the Executive Committee approved the petition. It called for the establishment of a Group "concerned especially with the technology of communication at audio frequencies and with the audio frequency portion of radio systems..."[12] A month later the Executive Committee approved a petition to form the Broadcast Engineers Group, and on 9 September the IRE Board of Directors gave its approval of the formation of these two technical groups.[13]

6 Minutes of the IRE Board of Directors, 8 October 1947.

7 Minutes of the IRE Board of Directors, 12 November 1947.

8 Minutes of the IRE Executive Committee, 3 February 1948.

9 Beranek, *op. cit.*

10 Minutes of the IRE Board of Directors, 25 March 1948.

11 Ryder and Fink *op. cit.*, pp. 216-217.

12 Minutes of the IRE Executive Committee, 2 June 1948.

13 Minutes of the IRE Executive Committee, 7 July 1948, and Minutes of the IRE Board of Directors, 9 September 1948.

An organizing committee of the Audio Group included Oliver Angevine, Benjamin Bauer, Leo Beranek, Art Curtiss, and John A. Green.[14] The committee prepared a constitution and presented it to the IRE Board of Directors on 9 September 1948. Article III, Section 1 read

> The field of interest of the Group shall be the technology of communication at audio frequencies and of the audio-frequency portion of radio-frequency systems including the acoustic terminations and room acoustics of such systems and the recording and reproduction from recordings at audio frequencies.[15]

After some changes, the constitution was approved in 1949. In addition to the members of the organizing committee, John Hilliard and Dan Martin worked to establish the new Group.[16]

The Group on Audio served as a model for Groups in other fields.[17] In late 1949 there were already seven other Professional Groups: Antennas and Propagation, Broadcast and Television Receivers, Broadcast Transmission Systems, Circuit Theory, Nuclear Science, Quality Control, and Vehicular and Railroad Radio Communications.[18] The Groups were given a large measure of autonomy, as they were authorized to organize sessions at IRE conferences and to hold their own meetings and conferences. The Groups published newsletters, occasional papers, and, before long, their own transactions.[19]

At a meeting of the organizing committee of the Group on Audio on 7 March 1949, Angevine was named Chairman, though later that year, because of a change in his business, he resigned, and Leo Beranek became Chairman. In early 1950, for the first time, a Chairman was elected through a polling of members; Beranek was elected.[20] (See Table 1.)

The first activities of the Group were to organize sessions at conferences. It sponsored a symposium on high fidelity at the Radio Fall Meeting of the IRE, held in Rochester, New York on 10 November 1948, and at the next year's Radio Fall Meeting, held in Syracuse, New York on 31 October 1949, the Group sponsored a session on audio techniques.[21] For the National IRE

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14 Oliver L. Angevine, Jr., "Comment on the history of the PTGA" (*IEEE Transactions on Audio,* vol. 11 (1963), p. 213).

15 Beranek, *op. cit.*

16 "Brief history of PGA, 1949-1962" *IEEE Transactions on Audio,* vol. 11 (1963), pp. 99-100.

17 "Brief history of PGA, 1949-1962" *op cit.*

18 Beranek, *op. cit.*

19 A. Michal McMahon, *The Making of a Profession: A Century of Electrical Engineering in America* (New York: IEEE Press, 1984), p. 216.

20 Angevine *op. cit.*, and Beranek *op. cit.*

21 Angevine *op. cit.*, and *IRE Audio Professional Group Newsletter,* no. 1, 6 March 1950.

Table 1
The first two Chairmen of the Professional Group on Audio

Oliver L. Angevine was born in Rochester, New York on 28 April 1914. He received a B.S. in electrical engineering from MIT in 1936 and then worked at the Stromberg-Carlson Company until 1951, first in the Telephone Laboratory, then as Assistant to the Vice President of Engineering, and then as Chief Engineer of the Sound Equipment Division. Angevine was Vice President and Chief Engineer of the Caledonia Electronics Company from 1951 to 1960. He later joined a consulting firm that became Angevine Acoustical Consultants. In 1969 he received an M.S. degree from the State University of New York at Buffalo, and between 1989 and 1994 he did extensive work on the active cancellation of the hum of large transformers. In 1949 Angevine served as Chairman of the newly formed IRE Professional Group on Audio. He is a fellow of the Acoustical Society of America and a founding member of the National Council of Acoustical Consultants and of the Institute of Noise Control Engineering.

Leo L. Beranek was born in Solon, Iowa on 15 September 1914. He received a B.A. from Cornell College, Iowa in 1936. From then until 1946 Beranek was associated with Harvard University. There he received an M.Sc. and a D.Sc., in 1937 and 1940 respectively, and became director of the Electro-Acoustics Laboratory and of the Systems Research Laboratory. From 1947 until 1958 he was Associate Professor of Communications Engineering at the Massachusetts Institute of Technology, where he also directed the Acoustics Laboratory. In 1948 Beranek co-founded Bolt Beranek and Newman, a consulting firm for architectural acoustics, and served as President and Chief Executive Officer from 1953 to 1969 and Director from 1953 to 1983. In 1948 Beranek worked with a number of other engineers to establish the IRE Professional Group on Audio, and he served as Chairman from 1949 to 1951. He has worked as director for Mueller-BBM, Boston Broadcasters, Wang Laboratories, and Technology Integration. From 1989 to 1994 he was President of the American Academy of Arts and Sciences. Among his many honors are the U.S. Presidential Certificate of Merit, the IEEE Fellow Award, the Wallace Clement Sabine Award of the Acoustical Society of America, the Gold Medal Award of the Audio Engineering Society, the Gold Medal Award of the Acoustical Society of America, and the Honorary Doctor of Public Service Degree of Northeastern University.
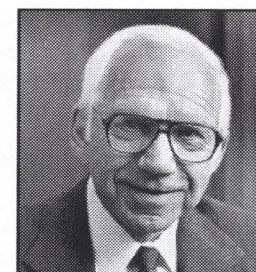
Convention in March 1949 it organized a session on audio.[22] A year later for the National Convention it organized a symposium and a technical session; each consisted of five papers, and each was attended by some 500 people.[23] And later that year the Group arranged for a session on electroacoustics at the National Electronics Conference in Chicago.[24]

In 1950 the Group began publishing a newsletter, edited by Jordan J. Baruch of MIT's Acoustics Laboratory. It appeared four times in 1950 and began bimonthly publication the next year. On occasion, the Group also mailed technical papers to its members.[25]

From the beginning, the Professional Group encouraged the formation of local subsections. The local IRE organization was known as a Section, and the subsection or chapter, as they soon came to be called, were under the jurisdiction of the Section. In 1948 a subsection was formed in Boston, and not long afterwards one was formed in Milwaukee. In early 1950 it was reported that in Boston an average of 250 members attended the monthly meetings, in Milwaukee an average of 150 members.[26]

Thus, in just a year and a half from the circulation of a petition for its formation, the IRE Professional Group on Audio was a vigorous organization acting at both national and local levels.

After much lively discussion [at the meeting on 9 March 1950] it was moved and passed that the Audio Professional Group will treat audio in a professional sense. It was pointed out, however, that the professional interests of the radio engineer dealing with audio are closely related to the avocational interests of the serious hobbyist, and that there would be much of our work which would be both interesting and informative to those for whom audio is an avocation.

IRE Professional Group on Audio Newsletter, no. 2, 9 June 1950, p. 1.

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22 Angevine *op. cit.*
23 *IRE Audio Professional Group Newsletter*, no. 1, 6 March 1950, and no. 2, 9 June 1950.
24 *IRE Audio Professional Group Newsletter*, no. 3, 25 October 1950.
25 *IRE Audio Professional Group Newsletter*, no. 6, 4 May 1951.
26 *IRE Transactions on Audio*, vol. 9 (1961), p. 184, and *IRE Audio Professional Group Newsletter*, no. 1, 6 March 1950.

Leo Beranek: The audio group felt that loudspeakers and microphones and recording were related to radio. At least it was a branch of the radio work. They certainly had to have, in all radio broadcasting, loudspeakers and microphones. Recording was maybe more related to the movies, but it was moving into also being important in the broadcasting studios. So broadcasting belonged to radio. It didn't belong to electrical engineering. At that time, it was radio engineering.

O.L. Angevine was with the Stromberg-Carlson Company. Angevine was very interested in the audio problem. I went to MIT in February of 1947 after the war and became a tenured professor there. I stayed at Harvard until 1947 in February on their faculty. And we were in communication with Angevine. We had our own section we'd set up. We called it the Audio Section. It was a Section of the Institute of Radio Engineers, and its main interest was audio. Angevine was interested in this out at Stromberg-Carlson. We communicated with each other, and we decided to communicate with the staff. We learned that there was talk going on already about the groups. They had appointed in October 7th, 1947 R.A. Heising as chairman of a planning committee, and he said that there were already six specialized meetings of radio engineers going on, mainly in broadcast engineering.

...Angevine said he'd take care of putting the paperwork through. And so he learned, in talking with headquarters, that they would consider setting up professional groups, and the provision was that the groups had to first have a petition that was signed by the required number of IRE members, and secondly that we'd adopt some universal bylaws and code of operations. Angevine submitted this petition sometime about April 1, 1948, and on June 2, 1948 the IRE formally established the audio group.

Our feeling was, in Cambridge at least, that audio was important enough in broadcasting that there at least ought to be activity in the field so that broadcast engineers could keep up to date. We didn't feel that IRE ought to drop that field and let it all go to the Acoustical Society, which was the only other one—there was no Audio Engineering Society then. We felt that this was an important thing to do, to keep our own members informed and to keep them active in the audio field. Well, at almost the same time the Audio Engineering Society was formed. The Audio Engineering Society decided to take over recording as their big thing, and in the process they took over broadcasting, really the audio part of broadcasting—the studios and the microphones and whatever they needed audio-wise, such as control panels and so on. So it turned out then that audio had a short life, really just until it became obvious that what was important was signal processing, and then that gradually took over.

Leo Beranek oral-history interview, 22 November 1996, pp. 42-44.

Chapter 2

An Organization for
Audio Engineering and Electroacoustics:
The 1950s

The 1950s saw the height of the hi-fi movement, and audio engineering made many advances. For example, those concerned with disk recording made improvements associated with the new LPs and 45s, such as better recording, mastering, and processing techniques and a new lower-force pickup. For the first time the phonograph industry adopted standardized tests of recording characteristics, making it easier for engineers to communicate and for listeners to judge the relative merits of different phonograph sets or components.[1] Stereo records were introduced in 1957. Tape recorders (of the reel-to-reel type) were sold in large numbers, and pre-recorded tapes began to be sold in 1954. Loudspeakers and microphones —including directional and wireless microphones—were improved. And there were important advances in speech-communication systems: telephony, radio broadcasting, public-address systems, and bandwidth-conserving systems.

These were all matters of interest to the IRE Professional Group on Audio (PGA).[2] It grew substantially in the 1950s, from 1126 members in 1950 to 4551 members in 1960. (See Table 1). In this decade the electronics industry as a whole saw spectacular growth, and this was reflected in the growth of the IRE, whose membership tripled in the 1950s, reaching 90,000.[3] The main activities of the Group on Audio remained publishing and organizing meetings and conference sessions.

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1 William S. Bachman, Benjamin B. Bauer, and Peter C. Goldmark, "Disk Recording and Reproduction" (*Proceedings of the IRE*, vol. 50 (1962), pp. 738-744).

2 See, for example, the subjects of the eight papers contained in the 50th anniversary issue of *Proceedings of the IRE* (May 1962) in "Section 3: Audio", which was prepared with the assistance of the Professional Group on Audio.

3 John Ryder and Donald G. Fink, *Engineers & Electrons: A Century of Electrical Progress* (New York: IEEE Press, 1984), p. 216.

Table 1
Membership in the IRE Professional Group on Audio[4]

Year	Members	Year	Members	Year	Members
1950	1126	1954	2510	1958	4348
1951	1330	1955	2996	1959	5403
1952	2031	1956	3809	1960	4551
1953	2147	1957	4324		

In the first years the Group had two forms of publication: the newsletter and technical papers that were occasionally sent to members. Each paper had a cover page entitled 'Transactions of the IRE Professional Group on Audio'.[5] In addition, the Group worked to place important papers in the *IRE Proceedings*, which appeared monthly.[6] In March 1952 the newsletter and the occasional 'Transactions' were combined in a bimonthly publication. The following year this publication, adopting a format already in use by other IRE Professional Groups, became the *IRE Transactions on Audio*.[7] Through this publication many papers on audio and electroacoustics achieved a worldwide distribution.[8] The editors of the PGA publications in the 1950s are listed in Table 2.

Table 2
The editors of the PGA publications in the 1950s

IRE PGA Newsletter
1950-1951	Jordan J. Baruch
1951-1952	Benjamin B. Bauer

IRE Transactions on Audio
1953-1955	Daniel W. Martin
1955-1958	Alexander B. Bereskin
1958-1963	Marvin Camras

The *IRE Transactions* in the various technical fields met an important need in the 1950s as many new branches of electronics grew rapidly. By mid decade more pages were published annually in the various *IRE Transactions* that in the *IRE Proceedings*, and the latter assumed a new character, with many review articles and with many issues devoted to a single topic.[9]

As befitted a Group concerned with magnetic recording, the PGA tried, in the early 1950s, a new form of publication in the distribution of tape-recorded talks. It was expected that many Sections and Chapters would want to present the recorded lectures at their meetings. The PGA formed a Tapescripts Committee (initially called the Recorded Papers Committee) "to act as a clearing house in the preparation and distribution of recorded papers."[10] In 1954 nine recorded lectures were made available, and these were presented a total of 50 times.[11] Some of these talks became multimedia presentations—this at a time before the word 'multimedia' existed.[12] At a 1954 meeting of the Atlanta PGA Chapter, accompanying slides were shown while the tape recording was played.[13] Those attending greatly approved of the performance, and thereafter the Tapescripts Committee provided slides with a number of the recorded lectures.[14] By the end of the decade, however, interest in recorded talks had flagged.[15]

The Group continued to organize sessions at professional meetings. For example, at the 1951 IRE National Convention there were two sessions on audio.[16] One of the papers described an early example of automatic signal-analysis. This was a "speech silencer for radio receivers", which switched off the radio speaker after one or two syllables of speech and reactivated it when the speech stopped. One could thus listen to music without hearing commercials, except perhaps "singing commercials".[17] The first PGA-sponsored session at a conference outside the United States was one at the Radio Fall Meeting held in Toronto in October 1951.[18] In mid decade

> Those of us who have served the PGA in various ways—as members of committees, as officers, or as participants in technical sessions—have found it to be a stimulating and rewarding experience. I especially treasure the friendships and the comradeship developed in this association as one of the important values beyond the measure of any conventional yardstick. In a very real sense I can say that the Professional Group on Audio has done much more for me than I have done for it.
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> *Benjamin B. Bauer,*
> *IRE Transactions on Audio, vol. 3 (1955), p. 88.*

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4 The data are from *IEEE Transactions on Audio*, vol. 11 (1963), no. 3, p. 100.

5 "Brief history of PGA, 1949-1962" (*IEEE Transactions on Audio*, vol. 11 (1963), pp. 99-100).

6 *IRE Professional Group on Audio Newsletter*, no. 3, 25 October 1950.

7 "Brief history of PGA, 1949-1962" (*IEEE Transactions on Audio*, vol. 11 (1963), pp. 99-100). In 1954 *Transactions* assumed the same print quality as *Proceedings*, with letterpress format and photographic reproduction [*IRE Transactions on Audio*, vol. 3 (1955), pp. 21, 87].

8 "Brief history of PGA" *op. cit.*

9 Dean B. Anderson, ed., *A History of the IEEE Lasers and Electro-Optics Society* (New York: IEEE, 1993), p. 2.

10 *Newsletter of the IRE Professional Group on Audio*, vol. 3, no. 1, January 1952.

11 *IRE Transactions on Audio*, vol. 3 (1955), p. 21.

12 The earliest use of 'multimedia' known to the Merriam-Webster staff was in 1962.

13 *IRE Transactions on Audio*, vol. 2 (1954), pp. 155-156.

14 *IRE Transactions on Audio*, vol. 3 (1955), p. 89.

15 See, for example, the reports of the Tapescripts Committee in *IRE Transactions on Audio*, vol. 6 (1958), p. 51, and vol. 8 (1960), p. 76.

16 *IRE Professional Group on Audio Newsletter*, no. 5, 15 February 1951.

17 *IRE Professional Group on Audio Newsletter*, no. 6, 4 May 1951.

18 *Newsletter of the IRE Professional Group on Audio*, vol. 2, no. 4, July 1951.

the Group was, every year, organizing a session for the major IRE conference on the West Coast (WESCON), a session at the National Electronics Conference in Chicago, and two or more sessions for the IRE National Convention in New York.[19] In 1956 PGA joined with a number of other organizations in putting on the Second International Congress on Acoustics in Cambridge, Massachusetts, where many researchers from Europe presented papers.[20]

The Group continued to encourage the formation of Chapters, and to the first ones in Boston and Milwaukee were added ones in Detroit, Cincinnati, and Seattle by the end of 1951.[21] By 1960 there were no fewer than 17 Chapters.[22] The Chapters held regular meetings and contributed on occasion to local and regional conferences.

> Unfortunately, not enough young engineers are entering this field. Acoustics can hardly hold its own in attracting young men against the competition of atomic energy, computers, solid state devices and other disciplines which lately have become the subject of spectacular publicity. One of the important tasks confronting the PGA, in my opinion, is expansion of its activities among students for the purpose of encouragement and motivation of those with adequate mental and emotional equipment to enter the world of sound.
>
> *Benjamin B. Bauer,*
> *IRE Transactions on Audio, vol. 3 (1955), p. 88.*

In the mid 1950s the Cleveland Chapter initiated an experiment with stereophonic sound. The thought was that two sound channels could not do justice to an orchestra and that three channels would be better. So one of the members, Herbert Heller, built 3-channel heads for his tape recorder and persuaded the conductor of the Cleveland Orchestra, George Szell, to let him tape the orchestra's concerts, with the support of the Cleveland PGA Chapter. The experiment, which lasted a year and a half, was judged a success except by the musicians, who seemed not to have liked the ability it gave Szell to scrutinize their performance.[23]

The Group was headed by a Chairman, elected each year by mail ballot. Leo Beranek was Chairman until mid 1951; the other chairmen who served during the decade are listed in Table 3. Amendments to the Constitution and Bylaws were approved on 5 January 1955.

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19 *IRE Transactions on Audio*, vol. 4 (1956), p. 47.
20 *IRE Transactions on Audio*, vol. 4 (1956), pp. 47, 84.
21 *Newsletter of the IRE Professional Group on Audio*, vol. 2, no. 4, July 1951; vol. 2, no. 6, November 1951; and vol. 3, no. 1, January 1952.
22 *IEEE Transactions on Audio*, vol. 11 (1963), pp. 106-107.
23 Personal communication from Herbert Heller to Mercy Kowalczyk 9 July 1997.

Table 3
Chairmen of the Professional Group on Audio during the 1950s

Benjamin B. Bauer was born in Odessa, Russia on 26 June 1913. He received the B.S. degree from Pratt Institute in Brooklyn in 1932 and the E.E. degree from the University of Cincinnati in 1937. In 1936 he joined Shure Brothers, manufacturers of electroacoustical devices in Evanston, Illinois; he became chief engineer in 1940 and vice president in 1950. In 1957 he joined CBS Laboratories in Stamford, Connecticut, and the next year he was appointed vice president in charge of audio, acoustics, and magnetics research. Bauer served as Chairman of the Professional Group on Audio from 1951 to 1952. His honors include the IRE Fellow Award and the IRE Audio Achievement Award.

Marvin Camras was born 1 January 1916. He earned B.Sc. and M.Sc. degrees from the Illinois Institute of Technology (earlier known as the Armour Institute of Technology). For most of his career he was researcher at the Armour Research Foundation and professor at the Illinois Institute of Technology. He is widely regarded as one of the most important developers of magnetic recording. He was named an IRE Fellow and an AIEE Fellow, and in 1990 he received the National Medal of Technology. From 1953 to 1954 he was chairman of the Professional Group on Audio, and he served the Group in many other capacities, notably as editor of the *Transactions* from 1958 to 1963. Camras died on 23 June 1995.
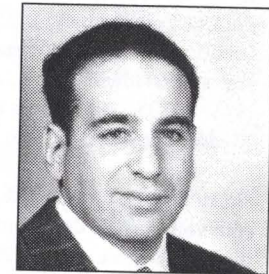
Vincent Salmon was born in Kingston, Jamaica on 21 January 1912. He received a Ph.D. in theoretical physics from MIT in 1938. From 1939 to 1949 he worked at the Jensen Manufacturing Company in Chicago, where he was in charge of research and development. In 1949 he accepted a position at the Stanford Research Institute, where he worked until 1971. In that year he co-founded Industrial Health, Inc. From 1954 to 1955 he was chairman of the Professional Group on Audio. He was also chairman of the IRE Group on Sonics and Ultrasonics (1961-1962) and President of the Acoustical Society of America (1970-1971). His honors include the IRE Fellow Award and the Silver Medal in Engineering Acoustics of the Acoustical Society of America.
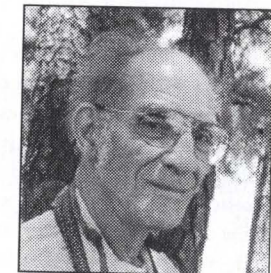
Table 3 (continued)
Chairmen of the Professional Group on Audio during the 1950s

Winston E. Kock was born on 5 December 1909 in Cincinnati, Ohio. He received E.E. and M.S. degrees from the University of Cincinnati in 1932 and 1933 respectively, and a Ph.D. from the University of Berlin in 1935. From 1942 to 1956 he worked at Bell Labs, where he became Director of Acoustics Research. In 1956 he became chief scientist for Bendix corporation. Kock served as Chairman of the Professional Group on Audio from 1955 to 1956. He was elected an IRE Fellow in 1952 "In recognition of his contributions in the field of electromagnetic-wave lenses and antennas."

Daniel W. Martin was born on 18 November 1918 in Georgetown, Kentucky. He received an A.B. degree from Georgetown College and M.S. and Ph.D. degrees from the University of Illinois, where he studied under F.R. Watson and R.H. Bolt. He then worked as an acoustical engineer for RCA Manufacturing Company from 1941 to 1949, when he joined the Baldwin Company in Cincinnati. He served as Chairman of the IRE Professional Group on Audio from 1956 to 1957, as President of the Audio Engineering Society from 1964 to 1965, and as President of the Acoustical Society of America from 1984 to 1985. His honors include the IRE Fellow Award and the IRE Audio Achievement Award.

Harry F. Olson attended the University of Iowa, where he received the B.E. degree in 1924, the M.S. degree in 1925, and the Ph.D. degree in 1928. From the same institution he received the professional degree of E.E. in 1932. Olson joined the Radio Corporation of America in 1928 and became head of the RCA Acoustical and Electromechanical Research Laboratory in Princeton, New Jersey. He was president of the Acoustical Society of America in 1952 and 1953, and from 1957 to 1958 he was Chairman of the IRE Professional Group on Audio.

Frank H. Slaymaker was born 22 April 1914 in Lincoln, Nebraska. He earned the B.S. degree and later the E.E. degree from the University of Nebraska. He joined the Stromberg-Carlson Company in 1941, where he long remained, most of the time in the Research Department. His work, resulting in many publications and patents, concerned noise-reducing microphones, electronic carillons, ultrasonic transducers, and other topics. He was named an IRE Fellow. From 1958 to 1959 he was chairman of the Professional Group on Audio, and he served the Group in many other capacities.
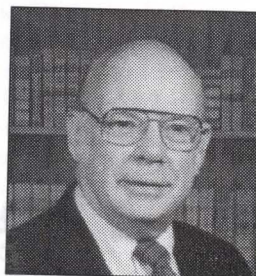
Table 3 (continued)
Chairmen of the Professional Group on Audio during the 1950s

Alexander B. Bereskin was born 15 November 1912 in San Francisco, California. He earned the B.S. and M.S. degrees from the University of Cincinnati. He worked with the Commonwealth Manufacturing Company and the Cincinnati Gas and Electric Company before returning to the University of Cincinnati as Professor of Electrical Engineering. Much of his research concerned audio and video amplifiers. Bereskin served as Chairman of the Professional Group on Audio from 1959 to 1960 and as an IRE Director from 1961 to 1962. His honors include the IRE Fellow Award and an honorary doctorate from the University of Cincinnati.

[Leo Beranek was Chairman until mid 1951; a biographical sketch of Beranek appears in Chapter 1.]

Much of the work of the Group was carried out through committees. Though the list of committees changed almost every year, we may take the 1954 list as representative. Table 4 shows the seven committees that reported to the Administrative Committee.[24] At the beginning of the decade, to pay for the mailing of the newsletter and technical papers, the Group instituted an annual assessment of $2 for each member.[25]

Table 4
The Committeess of the Professional Group on Audio in 1954

Administrative Committee

Awards Committee
Chapters Committee
Editorial Committee
Finances Committee
Membership Committee
Program Committee
Tapescripts Committee

[The Tapescripts Committee was earlier called the Recorded Papers Committee.]

In the 1950s the interests of the Professional Group gradually expanded beyond particular audio technologies. In 1951 the newly elected Chairman, Benjamin Bauer, wrote, "The goal of the Group is to advance Audio Technology among Radio Engineers as part of the larger field of communications rather than to promote the narrow specialization which is all-

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24 *IEEE Transactions on Audio*, vol. 11 (1963), p. 103.
25 *IRE Professional Group on Audio Newsletter*, no. 6, 4 May 1951.

too-prevalent today."[26] The technical concerns of the Group in the early 1950s are shown in Table 5, which is a classification of subjects used for an index to the *IRE Transactions on Audio* and the audio portion of the *IRE Convention Record*.

Table 5
Classification of subjects for the
"IRE Professional Group on Audio combined index for 1954"[27]

Classification of Subjects	
1. IRE-PGA	6. Loudspeakers
1.1 General	6.1 General
1.2 Constitution and By-Laws	6.2 Direct-Radiator Units
1.3 National and Regional Meetings	6.3 Horn-Driver Units
1.4 Chapters	6.4 Horns, Enclosures, Baffles
1.5 Membership	6.9 Special Types
1.6 TRANSACTIONS	7. Disc Recording and Reproduction
1.7 People	7.1 General
2. Bibliographies, Reviews, Standards, Tapescripts	7.2 Discs
2.1 Bibliographies	7.3 Recording
2.2 Reviews	7.4 Pickups and Tone Arms
2.3 Standards	7.5 Pre-emphasis and Postequalization
2.4 Tapescripts	7.9 Special Mechanical Recorders
3. Sound Systems	8. Magnetic Recording and Reproduction
3.1 General	8.1 General
4. Microphones	8.2 Tape and Wire
4.1 General	8.3 Recording and Erasing
4.2 Condenser	8.4 Playback
4.3 Magnetic	8.5 Pre-emphasis and Postequalization
4.4 Crystal	8.9 Special Magnetic Recorders
4.5 Moving—Coil	9. Acoustics
4.6 Ribbon	9.1 General
4.9 Special Microphones	9.2 Room Acoustics
5. Amplifiers	9.3 Sound Waves and Vibrations
5.1 General	9.4 Speech
5.2 Preamplifiers and Voltage Amplifiers	9.5 Music
5.3 Power Amplifiers	9.6 Hearing
5.4 Frequency-Range Dividing Networks	10. Broadcast Audio
5.9 Special Amplifiers	11. Audio Measuring Equipment and Techniques
	12. Electronic Musical Instruments

The audio technologies, such as amplifiers, loudspeakers, and magnetic recording, were the main interests of the Group. As the decade passed, other interests emerged, particularly in electroacoustics, measurement techniques, speech communications, and electronic music. Topics of some *Transactions* papers can suggest the increasing technical range of the Group: an acoustic lens, a wireless microphone, a device to make speech visible, a system for recording and reproducing television signals, impedance matching to transformers and filters, the phasing of microphones, determination of equal-loudness contours, speech bandwidth compression techniques, and the response and approximation of Gaussian filters.

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26 *Newsletter of the IRE Professional Group on Audio*, vol. 2, no. 4, July 1951, p. 4.
27 *IRE Transactions on Audio*, vol. 2 (1954), p. 176.

> Following "Scheherazade," the [San Francisco Symphony Orchestra] presented "Rhapsodic Variations for Tape Recorder and Orchestra" by Ussachevsky-Luening. the sounds provided by the recorder were generally of a character which would be difficult or conceivably impossible to produce from the instruments of a normal orchestra. These ranged from massive bell-like reverberations through chattering sounds similar to what one might expect in a jungle, to deep windy sighs somewhat like a steam locomotive emerging from a tunnel.
>
> *IRE Transactions on Audio,*
> *vol. 4 (1956), pp. 49-50.*

In 1958 the expansion of the Group's interests was stressed by the Group's Chairman, Frank Slaymaker: "...there is the rapidly growing field of audio electronics based on speech studies and information processing methods which is peculiarly suited to a Professional Group on Audio. I hope PGA can become the home environment for those working in this branch of audio."[28]

The commonality of interests with the Acoustical Society of America (ASA) and the Audio Engineering Society (AES) was recognized, and many members of PGA belonged to these organizations as well.[29] News of ASA and AES conferences and abstracts of papers in the ASA and AES journals were regularly provided to PGA members. Papers published in Europe were also called to the attention of PGA members.[30]

> Accidentally, during the early 1940's, we discovered something... We were monitoring a wire recording as it was being made, with a pickup head spaced a fraction of a second after the recording head. If the announcer wore the monitoring headphones, he immediately became speechless. ...One could beat the machine by blurting out brief phrases intermittently, with a pause after each burst to collect one's thoughts, or by speaking very slowly. ...There are differences among individuals in the degree of confusion or frustration generated by delayed listening. Women are less susceptible than men, which supports the theory that some of the more voluble talkers never got into the habit of listening even to themselves.
>
> *Marvin Camras,*
> *IRE Transactions on Audio, vol. 7 (1959) p. 89.*

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28 *IRE Transactions on Audio*, vol. 6 (1958), p. 47.
29 Vincent Salmon, for example, besides being Chairman of PGA, was editor of *Journal of the Audio Engineering Society* and patent reviewer for *Journal of the Acoustical Society of America* [*IRE Transactions on Audio*, vol. 3 (1955), p. 3].
30 See, for example, *IRE Transactions on Audio*, vol. 3 (1955), p. 3, and vol. 6 (1958), p. 52.

In 1954 the Group instituted an awards program consisting of three annual awards.[31] The highest honor was the IRE-PGA Achievement Award for "outstanding contributions to Audio Technology documented by papers in IRE publications."[32] Table 6 lists the winners of this award to the end of the decade.

Table 6
Achievement Award

1954	Benjamin B. Bauer
1955	Harry F. Olson
1956	Henry E. Roys
1957	Marvin Camras
1958	Daniel W. Martin
1959	Alexander B. Bereskin and Peter C. Goldmark

The two other awards were for outstanding papers that appeared in IRE publications: the IRE-PGA Senior Award could be given to an author of any age, the IRE-PGA Award could be given only to authors less than 30 years old (on the date of the acceptance of the paper).[33] To encourage young people to pursue research, in 1956 the PGA established an annual Student Papers Competition in Audio.[34] PGA members were also, of course, eligible for IRE Awards, such as the Medal of Honor, the Harry Diamond Memorial Award, the Morris N. Liebmann Memorial Award, and the Vladimir K. Zworykin Award. (Peter Goldmark, a PGA member, won both the Liebmann and the Zworykin awards.)

One of the perquisites of PGA membership in 1951 was a free "Sound Surveyor" slide rule, which permitted "the instant determination of the amplifier power required in any sound system installation, as a function of background noise level or specific application, the room volume, the sound treatment of the room, and the type of speaker to be employed." Upon receipt of certification that the person was a member in good standing of the PGA, the manufacturer would send the slide rule free of charge. It normally sold for 25 cents.[35]

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31 *IRE Transactions on Audio*, vol. 3 (1955), p. 21. The awards involved presentation of a certificate and a cash prize ($200 for the Achievement Award, $100 each for the paper prizes).
32 *IEEE Transactions on Audio*, vol. 11 (1963), p. 101.
33 *IEEE Transactions on Audio*, vol. 11 (1963), p. 101.
34 *IRE Transactions on Audio*, vol. 4 (1956), p. 108.
35 *IRE Professional Group on Audio Newsletter*, no. 6, 4 May 1951. In later newsletters, other special-purpose slide rules were offered, free of charge, to PGA members, such as a reactance slide rule, made by Shure Brothers, which solved problems "involving C, R, L, Q, and f" and which usually sold for 35 cents [*Newsletter of the IRE Professional Group on Audio*, vol. 2, no. 4, July 1951].

As the decade came to a close there was a move to split off part of the Professional Group on Audio by forming a new Professional Group on Magnetic Recording, since, it was argued, magnetic recording had many applications besides audio, as with computers, in instruments, and for video recording.[36] Change was indeed ahead for the PGA, but it was of an expansive rather than a contractive nature. This is the subject of Chapter 3.

ALICE was greeted by a courteous sales-technician as she entered the high-fidelity auditioning room. The courteous sales-technician nodded his head wisely and began his story. "In ancient times," he explained, "people used one loudspeaker and all the sound seemed to come from a hole in the wall. Now we call it monophony, which suggests such things as monogamy, monotony, monopoly, *et cetera*."

He continued, "Now I'd like to have you hear stereophonic sound with two loudspeakers." He pressed a button and a loud version of "Gaite Parisienne" issued from two speakers, one on each side of the room. "Why must it be so loud?" exclaimed Alice.

"I've often wondered myself," said the courteous sales-technician. "Maybe that's what hi-fi means—that the volume must be high. It depends a lot on whether you are a demonstrator or a demonstratee. The demonstrators like it loud, and since they are the ones who own the set, it's usually played loud."

"You'll notice that the orchestra is now spread over the entire wall of the room," he went on.

To Alice, everything seemed to come mainly from one loudspeaker—the closer one. She wondered whether she would hurt the attendant's feelings by telling him. After all, he was so courteous. Finally she told him. "I'm glad you mentioned it," he said, "You are supposed to stand on an imaginary line equally distant from both speakers."

Marvin Camras, IRE Transactions on Audio, vol. 7 (1959), pp. 137-138.

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36 See, for example, the discussions in *IRE Transactions on Audio*, vol. 8 (1960), p. 2 and pp. 72-73.

Chapter 3
The Group Embraces Digital Signal Processing: The 1960s

The 1960s was a momentous decade in the history of the Signal Processing Society. There were organizational changes, notably the 1963 merger of the IRE and the AIEE to form the Institute of Electrical and Electronics Engineers (IEEE) and the continuing expansion of the field of interest of the Professional Group on Audio, reflected in its change of name in 1965 to 'Group on Audio and Electroacoustics'. Electronics and computing made great strides, due in part to the development of integrated circuits. Two more specific technological advances had the greatest long-term influence: the discovery of the fast Fourier transform and the realization that it was possible to process signals in the digital domain in much the same way they had been processed in the analog domain.[1] The decade included the publication of the bible of speech communication by James Flanagan and ended with the first textbook on digital signal processing by Ben Gold and Charles Rader.[2]

As discussed in Chapter 1, electronics in the postwar world ramified into many new engineering specialties, and the Institute of Radio Engineers came to represent engineers in many fields other than radio. At the same time, electronic techniques were rapidly adopted by the traditional branches of electrical engineering, so that at the beginning of the 1960s, as already mentioned, half of the members of the American Institute of Electrical Engineers were concerned with electronics. In the 1950s a great many engineers belonged to both the IRE and the AIEE, and in the case of some technical specialties, such as aerospace applications and computing, there were corresponding entities in the IRE and the AIEE (called Professional

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1 Lawrence R. Rabiner, "The Acoustics, Speech, and Signal Processing Society—a historical perspective" (*IEEE ASSP Magazine*, January 1984, pp. 4-10).
2 James L. Flanagan, *Speech Analysis: Synthesis and Perception* (Berlin: Springer-Verlag, 1965); Bernard Gold and Charles M. Rader, *Digital Processing of Signals* (New York: McGraw-Hill, 1969).

Groups in the IRE and Technical Committees in the AIEE). And in a number of ways, the IRE and the AIEE were working together: in 1950 they authorized the formation of joint student branches so that students did not need to join two organizations (and by 1962 there were 130 joint student branches), and in 1952 they formed the Joint AIEE-IRE Coordination Committee to promote cooperation.[3]

There were therefore good reasons for merging the two societies, and this occurred on 1 January 1963 with the formation of the Institute of Electrical and Electronics Engineers. The Professional Group system of the IRE was adopted in its essentials by the IEEE, and thus came into being the IEEE Professional Group on Audio.[4] The expansion of the Group's interests led to a new name in 1965: the Group on Audio and Electroacoustics (G-AE). The size of the Group was fairly stable in the 1960s. (See Table 1.) Those who served as Chair of the Group are listed in Table 2.

Table 1
Membership in the Professional Group on Audio[5]

Year	Members	Year	Members	Year	Members
1960	4551	1964	4054	1968	4572
1961	4193	1965	4230	1969	5075
1962	4405	1966	4302	1970	5299
1963	4308	1967	4488		

At the old World's Fair in Chicago, in 1933, Bell Telephone had an exhibit of speech scrambling set up with the microphone on one side of the room and the loudspeaker on the other side, so that the person at the mike could not hear what came out of the speaker. The procedure was to ask someone in the audience where he was from, and to pronounce the name of the home town into the microphone so as to amaze the spectators with the outcome. However, it was also the practice to refuse to use certain words. Being nosy, I got into a huddle with the Bell crew after the demonstration, and it seems that a few days before there had been a lady from Oshkosh. When Oshkosh was put in, some of the audience snickered, and some of the women blushed (remember this was over 26 years ago). The crew tried it afterwards and Oshkosh always came out ***kiss.

Edward W. Logan, Jr., IRE Transactions on Audio, vol. 8 (1960) p. 1.

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3 John Ryder and Donald G. Fink, *Engineers & Electrons: A Century of Electrical Progress* (New York: IEEE Press, 1984), pp. 209-231, and A. Michal McMahon, *The Making of a Profession: A Century of Electrical Engineering in America* (New York: IEEE Press, 1984), p. 239-243.
4 Ryder and Fink *op. cit.*, pp. 216-217.
5 Data for 1960, 1961, and 1962 are from *IEEE Transactions on Audio*, vol. 11 (1963), no. 3, p.100. Data for the remaining years are from the *Annual Report of the Secretary of the Institute.* The totals include student members but not affiliate members (of which there were fewer than half a dozen each year in the 1960s).

Table 2
### Chairmen of the Professional Group on Audio during the 1960s

Hugh S. Knowles was born on 23 September 1904 in Hynes, Iowa. He received an A.B. degree from Columbia University in 1927. He worked for a number of companies, including the Jensen Manufacturing Company, where he was chief engineer from 1931 to 1950. From 1936 on he worked also as a consulting engineer. Knowles served as Chairman of the Professional Group on Audio from 1960 to 1961. He received the photo IEEE Fellow Award for "engineering leadership in the field of acoustics and its radio applications." His other honors include the G-AE Achievement Award, the Gold Medal of the Audio Engineering Society, and an honorary doctorate from Northwestern University.

Cyril M. Harris was born on 20 June 1917 in Detroit, Michigan. He received the B.A. and M.A. degrees from the University of California and the Ph.D. degree from MIT. From 1941 to 1945 he did war research at MIT, where he also worked as a teaching fellow. From 1945 to 1951 Harris was a research engineer at Bell Labs, and in 1952 he became a professor at Columbia University. He served as Chairman of the Professional Group on Audio from 1961 to 1962. His honors include the IRE Fellow Award, the Franklin Medal, the Wallace Clement Sabine Award of the Acoustical Society of America, the Gold Medal of the Audio Engineering Society, and the Gold Medal of the Acoustical Society of America.

Robert W. Benson was born on 21 January 1924 in Grand Island, Nebraska. He received the B.S.E.E., M.S.E.E., and Ph.D. degrees from Washington University in St. Louis. From 1948 to 1954 he was a researcher at the Central Institute for the Deaf in St. Louis and from 1954 to 1960 at the Armour Research Foundation in Chicago. In 1960 Benson joined the faculty of Vanderbilt University. He served as Chairman of the Professional Group on Audio from 1962 to 1963.
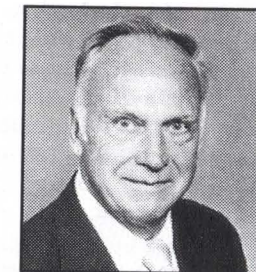
[In 1960 Alexander B. Bereskin was Chair of the Group.]

Look where you will in any industry and you will find the same lack of vision, the same mental inertia, the same preference for complacent peace over the brain sweat in learning (like old dogs) the new tricks of Progress. The deeper is their entrenchment, the more resistant is their determination to stick with what they have. Like the Colorado River in the Grand Canyon, their vision, if any they have, to far horizons is blocked by the results of their own past energies, and they cannot escape.

Benjamin Miessner, IRE Transactions on Audio, vol. 9 (1961), p. 133.

Table 2 (continued)
## Chairmen of the Professional Group on Audio during the 1960s

Frank A. Comerci was born in Newark, New Jersey on 18 January 1920. He earned the B.S.E.E. degree from Newark College of Engineering in 1943, and from 1943 to 1946 he served the U.S. Army as Communications Officer, installing and maintaining cryptographic speech communications systems. In 1946 he joined Rangertone Corporation where he worked on the design of a magnetic tape recorder. In 1947 he began work at the Navy Material Laboratory in Brooklyn, where he headed the Acoustics and Communications Section from 1950 to 1959. Afterwards he worked as Senior Electronic Engineer at Audio Devices, Inc., in Glenbrook, Connecticut and then as Manager of the Magnetics Branch of Columbia Broadcasting System Laboratories in Stamford, Connecticut. Comerci served as Chair of the Group on Audio from 1963 to 1964.

William M. Ihde was born on 29 September 1923 in Sapporo, Japan. He received the B.S. and M.S. degrees in electrical engineering from MIT in 1948. While in graduate school he studied under Leo Beranek, who was his thesis adviser. Ihde joined the General Radio Company in 1948 and in 1955 became manager of the Mid West District Office in Chicago for that company. He served the Group on Audio in many capacities, including as Chairman from 1964 to 1965.

Iden M. Kerney was born in Iowa and attended Harvard University, where he received a B.S. degree in communications engineering in 1923. From 1923 to 1934 he was employed by the Department of Development and Research of AT&T and from 1934 until his retirement in 1963 by Bell Labs. An active member of IRE and IEEE, Kerney served as Chair of the Group on Audio and Electroacoustics from 1965 to 1966.
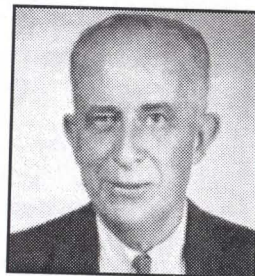
Donald E. Brinkerhoff was born in Bryant, Indiana on 6 December 1921. He earned B.S.E.E. and M.S.E.E. degrees from Purdue University. During World War II, after completing the Army Officers Electronics School at Harvard University and the MIT Radar School, he worked as an instructor in the MIT Radar School. In 1945 he joined Delco Radio Division of General Motors; in 1952 became head of Acoustical Engineering, and in 1962 Supervisor of Audio Systems Development. Brinkerhoff served on the Group's Administrative Committee through much of the 1960s and as President from 1966 to 1967.
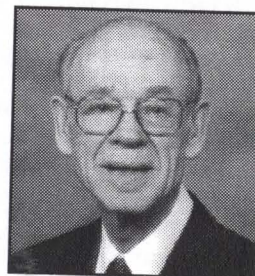
Table 2 (continued)
Chairmen of the Professional Group on Audio during the 1960s

William W. Lang was born on 9 August 1926 in Boston. He received the B.S. degree from Iowa State University, the S.M. from MIT, and the Ph.D. from Iowa State. From 1949 to 1958 Lang worked for Bolt Beranek and Newman, as an instructor for the U.S. Naval Academy, and as a consultant for DuPont. He joined IBM in 1958, where he became head of the Acoustics Laboratory in Poughkeepsie, New York. He has played a major role in the development of international standards for environmental noise. When he retired from IBM in 1992 he was Program Manager - Acoustics Technology. Lang served as Chair of the Group on Audio and Electroacoustics from 1967 through 1968. His honors include the G-AE Achievement Award and the IEEE Fellow Award ("For contributions in engineering acoustics, noise control, digital processing of acoustic signals, and in establishing acoustical standards").
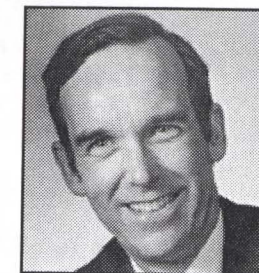
James L. Flanagan was born on 26 August 1925 in Greenwood, Mississippi, and he earned the B.S. degree from Mississippi State University. At MIT, where he studied under Leo Beranek, Dick Bolt, and Ken Stevens in the Acoustics Laboratory, he received the S.M. and Sc.D. degrees. Flanagan worked for 33 years at Bell Telephone Laboratories, where he headed the Speech and Auditory Research Department from 1961 to 1967 and the Acoustics Research Department from 1967 to 1985, when he became a Director of Research. His book *Speech Analysis, Synthesis and Perception* is widely regarded as the classic presentation of the scientific and technical aspects of speech processing systems. After retiring from Bell Labs in 1990, Flanagan joined the faculty of Rutgers University, where he is Vice President for Research and Director of the Center for Computers Aids for Industrial Productivity. Flanagan was Chair of the Group on Audio and Electroacoustics in 1969 and 1970. His honors include the IEEE Fellow Award, the IEEE Edison Medal, the Gold Medal of the Acoustical Society of America, the L.M. Ericsson Prize, and the National Medal of Science.
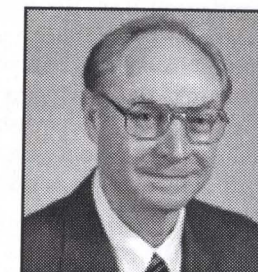
> *Thomas Huang:* We held the first image coding conference in 1969 at MIT. I organized it along with my colleague Oleh Tretiak, who is now at Drexel University. We called it something like a picture coding symposium. It was the first such meeting and it was very successful. We had people coming from all over the world, including some now-famous names in the field like Hans Musmann from Hanover, Germany. At that time he was a young guy. The symposium was sponsored by the IEEE, I think the Boston chapter, and since it was so successful it continued annually or every one and a half years. It's still going on.
>
> *Thomas Huang oral-history interview 20 March 1997, p. 30.*

The organizational structure of the Group at the time of the merger was similar to what it had been a decade earlier, with six committees in addition to the Administrative Committee.[6] (See Table 3.)

Table 3
The Committees of the Professional Group on Audio in 1963

Administrative Committee

Awards Committee
Chapters Committee
Constitution and Bylaws Committee
Editorial Committee
Finance Committee
Program Committee

In September 1965 the editorship of the *Transactions* was put on a professional basis (as had occurred earlier with other *IEEE Transactions*), and Frederick Van Veen took over from Peter Tappan.[7] (See Table 4.) This change brought with it an increase in the size of the *Transactions*, from 151 pages in 1965 to 546 pages in 1968.[8] The increased publication costs were in large part responsible for an increase in G-AE dues, from $2 to $5 annually.[9] The *Transactions*, since it included timely and G-AE information, also served as a newsletter. In 1967, however, the Group resumed publication of a separate newsletter.[10]

> *William Lang:* It was clear that something needed to be done at that point in time [1964 or 1965], so the first thing that was done was to get the PGA [Professional Group on Audio] 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.
> William Lang oral-history interview 15 April 1997, pp. 4-5.

6   *IEEE Transactions on Audio*, vol. 11 (1963), p. 105.
7   *IEEE Transactions on Audio*, vol. 13 (1965), p. 71.
8   *IEEE Transactions on Audio and Electroacoustics*, vol. 17 (1969), p. 1. As Group members continued to pay only the $3 annual assessment, the Group sought other ways to pay the increased costs of publication; one means, instituted in 1969, was a voluntary page-charge of $50 per printed page (to be paid, it was hoped, by the company or institution with which the author was associated).
9   *IEEE Transactions on Audio and Electroacoustics*, vol. 19 (1971), p. 199.
10   *IEEE Transactions on Audio and Electroacoustics*, vol. 15 (1967), p. 1.

Table 4
The editors of the Group Publications in the 1960s

IRE Transactions on Audio
1958-1962 Marvin Camras

IEEE Transactions on Audio
1963 Marvin Camras
1963-1965 Peter Tappan
1965 Frederick Van Veen

IEEE Transactions on Audio and Electroacoustics
1966-1971 Frederick Van Veen

IEEE Newsletter on Audio and Electroacoustics
1967 A. Costanzo
1968-1975 Irving Rosenblatt

[For most of the 1960s the only regular publication of the Group was the Transactions, which appeared quarterly. In 1967 the Society resumed publication of a newsletter.]

The Group underwent momentous changes in scope in the 1960s because of two factors. First, the traditional fields of audio and electroacoustics were languishing within the IEEE, with most of the growth occurring in the Audio Engineering Society. Second, a completely new field of research, called digital signal processing, was emerging, but it had no effective home within the IEEE where it could be nurtured and grown. Thanks to the foresight of William Lang, James Flanagan, and Reg Kaenel, and some members of the G-AE Subcommittee on Measurement Concepts (notably Charles Rader, James Kaiser, David Bergland, Kenneth Steiglitz, and Howard Helms), the G-AE energetically sought to become the home

> Sitting in the next room as I scrawl these words with my goosequill pen... is an old portable record-player, which cost like 60 bucks over 10 years ago and has never bust once. I would never attempt to compete in the modern record-playing race. You do not simply play a record today. You have to take a two-year course at M.I.T. before they will sell you a really hip modern noise-maker. This machine cannot be bought whole, like an automobile. It must be put together, or other people's children sneer at your children. Strictly between me and my flux density... I am going to lie down on my wire-wound L-pad and turn on Old Faithful again and play a little scratchy Bing Crosby. Old Faithful may not have much in the way of sound-pressure level characteristics... but it plays in the rain and can hit with men on base.
> *Robert C. Ruark, IRE Transactions on Audio, vol. 11 (1963), p. 185.*
> *[Originally published in the Miami Herald]*

group for the emerging field of digital signal processing, as well as for the associated areas of speech and audio processing.[11]

In order to achieve this goal, the Group leaders took several steps. They created a Technical Committee on Digital Signal Processing and invited leaders in the field to join. They set up a series of workshops on digital signal processing. They created a Technical Committee on Speech Communication and held special meetings on speech processing. They sponsored an influential session on DSP-based spectral analysis at the 1967 meeting of the Acoustical Society of America. And they promoted publications on DSP and speech processing in the *Transactions*.

> Many have characterized the emphasis of this *Transactions* on digital signal processing as a departure from the traditional grazing grounds of audio and electroacoustics. It may seem so at first glance, but in the light of the likely eventual impact of this exciting new tool, it is more probable that we are simply leapfrogging ahead to stake a solid claim in audio's future.
>
> *Frederick Van Veen,*
> *IEEE Transactions on Audio and Electroacoustics, vol. 17 (1969), p.56.*

A number of technical accomplishments stimulated the rapid growth of DSP and speech processing. First and foremost was the rediscovery of the fast Fourier transform (FFT) in 1965. There was the publication of key papers on digital filtering by James Kaiser and by Ben Gold and Charles Rader. There was the invention, independently by John Stockham and Howard Helms, of fast convolution, which firmly linked the FFT and methods of digital filtering and convolution. There was the discovery, independently by Bishnu Atal and Fumitada Itakura, of the technique of linear predictive coding. Each of these technical achievements revealed new horizons and contributed to the signal processing revolution of the following decades. These points are considered in more detail here and in the next chapter.

The biggest boost to the new field was the rediscovery, in the mid 1960s, of a particular algorithm, the fast Fourier transform (FFT). The straightforward calculation of a discrete Fourier transform of N points requires $4N^2$ multiplications. In 1965 Jim Cooley and John Tukey showed how to do the calculation with just $2N \log_2 N$ multiplications.[12] Thus, even for a

11 Much of the information in this and the following two paragraphs comes from a personal communication from Lawrence Rabiner on 29 January 1998.

12 James W. Cooley and John W. Tukey, "An algorithm for the machine calculation of complex Fourier series" (*Mathematics of Computation*, vol. 19 (1965), pp. 297-301). Cooley has authored or co-authored several articles on the re-discovery and acceptance of the FFT: James W. Cooley, Peter A.W. Lewis, and Peter D. Welch, "Historical notes on the fast Fourier transform" (*IEEE Transactions on Audio and Electroacoustics*, vol. 15 (1967), no. 2, pp. 76-84); James W. Cooley, "The re-discovery of the fast Fourier transform algorithm" (*Mikrochimica Acta*, vol. 3 (1987), pp. 33-45); and James W. Cooley, "How the FFT gained acceptance" (*IEEE Signal Processing Magazine*, vol. 9 (1992), no. 1, pp. 10-13).

> *Bede Liu:* Around that time, the Cooley-Tukey paper was published. There's really no inherent reason why digital filters and FFT should be tied together, no more than a lot of fields should be tied together. But a lot of people who were interested in FFT were also interested in digital filters. So after Cooley and Tukey's paper, a bunch of people organized a workshop called Arden House. I think that the push to publicize DSP really owes a lot to this group of people.
>
> *Bede Liu oral-history interview*
> *10 April 1997, p. 18.*

thousand-point transformation, the FFT reduces the calculation required by a factor of 200, and for larger sample sizes the reduction factor is much greater. Rabiner writes "...the algorithm remained a mathematical curiosity to most electrical engineers until an engineering interpretation was given to the procedure by Charlie Rader and Tom Stockham..."[13]

But engineers needed to learn about the new possibilities. William Lang and other G-AE leaders seized the opportunity, and the Audio and Electroacoustics Group, through workshops, conferences, and publications, came to play a central role in popularizing the FFT.[14]

In the spring of 1966 the Group co-sponsored with the Acoustical Society of America a special workshop on the FFT and spectral analysis, and in 1967 papers from this workshop were part of a special issue of the G-AE *Transactions*, which included a classic tutorial paper on the FFT written by members of the G-AE Subcommittee on Measurement Concepts.[15] In 1968 the Group organized the first of the so-called Arden House Workshops; a hundred researchers exchanged ideas about the FFT, and many of the papers were published in a special issue of the G-AE *Transactions* in 1969.[16] James Cooley has written of the Arden House Workshops, "These were unique in several respects. One was that they included people... from many different disciplines. Another thing that was unique was that work was really done. People got together to formulate and work out solutions to problems."[17]

One of the reasons G-AE members were quick to adopt the FFT was its value in measuring the power spectra of stochastic processes, which was

13 Rabiner *op. cit.*, quotation from pp. 4-5.

14 Rabiner *op. cit.*

15 G-AE Subcommittee on Measurement Concepts, "What is the fast Fourier transform? (*IEEE Transactions on Audio and Electroacoustics*, vol. 15 (1967), pp. 45-55).

16 Rabiner *op. cit.* The two special issues were the following: Special Issue on Fast Fourier Transforms and Applications to Digital Filtering and Spectral Analysis, *IEEE Transactions on Audio and Electroacoustics*, vol. 15, no. 2 (June 1967), and Special Issue on Fast Fourier Transforms, *IEEE Transactions on Audio and Electroacoustics*, vol. 17, no. 2 (June 1969).

17 James W. Cooley, "The re-discovery of the fast Fourier transform algorithm" (*Mikrochimica Acta*, vol. 3 (1987), pp. 33-45), quotation on pp. 40-41.

From a glossary of organization terminology for engineers:

"*Dedicated*: 1) Willing to make extraordinary efforts without special compensation or recognition, present or future; 2) Willing to accept responsibility without asking for the necessary authority; 3) Naive (said of employees).

Employee: A person who is paid for regular attendance at a designated place, rather than for the results he achieves.

Fact: A situation or condition which it is unnecessary to conceal, or which cannot be concealed.

Modern Research Facility: A one-story, windowless building having landscaped grounds, located twenty miles from home and five miles from the nearest restaurant."

IRE Transactions on Audio, vol. 11 (1963), p. 76.

a concern of the G-AE Standards Committee. Since 1960 that committee had worked to improve practices for measuring power spectra of short-duration signals.[18]

The IRE actually had two different technical structures: the Group system and a set of committees that developed IRE standards. One of the standards committees, Technical Committee 30 or TC30, was charged with developing standards for audio and electroacoustics. It was quite distinct from the Professional Group on Audio. Early in the decade, TC30 worked intensely on analog signal processing, and it produced two important recommended practices—Burst Measurements in the Time Domain and Burst Measurements in the Frequency Domain. The measurements of short-duration signals taxed the available (analog) instrumentation to the limit.[19]

The Group on Audio and TC30 continued to go their separate ways after the 1963 merger of the IRE and the AIEE, and most of the people on TC30 were not part of the leadership of the Group on Audio. In 1965, however, William Lang, chair of TC30, and Iden Kerney, chair of the Group on Audio, brought about a merger of the two organizations, with TC30 becoming the G-AE Standards Committee. The latter continued to deal

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18 *IEEE Transactions on Audio and Electroacoustics*, vol. 15 (1967), p. 44.
19 Much of the information in this and the following paragraph comes from a personal communication from William Lang on 24 February 1998.

with signal processing, considering digital as well as analog techniques. It was therefore extremely quick to recognize the possibilities of digital signal processing and the fast Fourier transform.[20]

In the March 1970 issue of the *Transactions*, the editor Frederick Van Veen wrote the following:[21]

A Guest Editorial written by Bruce Bogert for our June 1967 issue began, "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*." That milestone issue (our first special on the Fast Fourier Transform) was followed in September 1968 by a special issue on digital filters, a second special issue on FFT in June 1969, and many papers on digital signal processing scattered throughout the issues of the past three years. Today, this journal is one of the *first* places one would look for material on digital signal processing. Two more special issues scheduled for June and December will further establish our claim on this territory.

Van Veen goes on to say that digital signal processing became the province of the Group through the determined, relentless effort of a few leaders: "The driving force was unquestionably past G-AE Chairman Dr. William Lang, and accessories before and after the fact were Drs. James Flanagan and Reg Kaenel, our present Chairman and Vice Chairman [and others too]."[22]

Alan Oppenheim: ...It was what was happening with the audio and electroacoustics group. It was a Group, not a Society, and it was almost dead. Bill Lang at IBM was looking for some ways to revive it, and the FFT had just gotten exposed, so this community got pulled together from people who were looking for exciting ways of using the FFT and also for ways of reinvigorating this audio and electroacoustics group. So there was a mindset among these people to look at anything optimistically rather than pessimistically—you know, there's a pony in there someplace. Then there was the Arden House conference, which was the first [of its kind].

Alan Oppenheim oral-history interview 28 February 1997, pp. 17-18.

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20 The first special issue of the *Transactions* on the fast Fourier transform contained the statement "Implausible as it may appear at first glance, this special issue is an outgrowth of STANDARDIZATION activities in audio and electroacoustics" [*IEEE Transactions on Audio and Electroacoustics*, vol. 15 (1967), p. 44]. One of the subcommittees of the G-AE Standards Committee was the Subcommittee on Measurement Concepts (mentioned above). This subcommittee, concerned with characterizing acoustic noise, worked to bring statistical techniques into this engineering context. It recognized that the FFT made easy what had previously been difficult, and it broadened its mission to the promotion of the new possibilities. [Charles Rader personal communication 2 January 1998.]
21 *IEEE Transactions on Audio and Electroacoustics*, vol. 18 (1970), p. 1.
22 *IEEE Transactions on Audio and Electroacoustics*, vol. 18 (1970), p. 1.

Following the Arden House Workshop, a Digital Signal Processing Technical Committee was established.[23] This committee included most of the prominent researchers in the DSP field, including David Bergland, James Cooley, Howard Helms, Leland Jackson, James Kaiser, Alan Oppenheim, Larry Rabiner, Charles Rader, Ronald Schafer, Harvey Silverman, Ken Steiglitz, and Clifford Weinstein. It assumed responsibility for the subsequent Arden House Workshops, for workshops and sessions at other meetings, for a project to standardize terminology, for reviewing papers, and for various publications. Some of these activities, which were extremely influential, are described in the next chapter.

Even before the FFT-related activities, the field of interest of the Group was changing. In 1961 the PGA amended its constitution by adopting a revised statement of field of interest (Article 3, Section 1):[24]

> The Field of Interest of the Group shall be the technology of communications at audio frequencies and of the audio-frequency portion of radio-frequency systems, including the acoustic terminations and room acoustics of such systems, and the recording and reproduction from recordings and shall include scientific, technical, industrial or other activities that contribute to this field, or utilize the techniques or products of this field, subject, as the art develops, to additions, subtractions, or other modifications directed or approved by the IRE Committee on Professional Groups.

Alan Oppenheim: So Arden House was a happening, you know. There was tremendous excitement. The people who were there really sensed that there was something magic that was happening, and that it was an opportunity. In some sense, we had a tiger by the tail. There's another piece to it. Do you know how often there is the feeling that with the good ideas you have mined you've got to be really careful about what you say, because other people may run with it. So you have to be very protective. The spirit at Arden House was: "There is a gold mine here. There is more than enough for everybody! If I give away my five good ideas this morning, I'll have another five good ideas tonight, so I'm not worried about that." The excitement, the synergy, the spirit of collaboration, that was all really very, very strong at Arden House. And of course that kind of thing builds on itself. So there was definitely the feeling that something was really going on, and there was also the sense—it was clear with the Audio and Electroacoustics Group and the Digital Signal Processing Committee— that there was a tremendous amount of work to be done and that we all had to roll up our sleeves and put our shoulder to the wheel.
Alan Oppenheim oral-history interview 28 February 1997, p. 20.

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23 The DSP Committee was formed in 1967, and its original members were G. David Bergland, James W. Cooley, Howard D. Helms, James F. Kaiser, Lawrence R. Rabiner, Charles M. Rader, Ronald Schafer, and Kenneth Steiglitz. Those who served on the Committee in the 1970s are listed in footnote 18 of Chapter 4.

24 *IRE Transactions on Audio*, vol. 9 (1961), p. 62.

The previous statement of field of interest was simply "recording and reproduction from recordings at audio frequencies". The new statement took account of the fact that recording, even when done for audio signals, was often at high frequency, and it also made room for the technical areas of speech communications and electroacoustics.

The move to split off part of the Professional Group on Audio by forming a new Professional Group on Magnetic Recording, mentioned at the end of Chapter 2, did not succeed, as PGA members argued that the Group had always been interested in applications of magnetic recording other than audio and pointed out, as an example, a PGA-organized session in the mid 1950s on video recording.[25] Just after the merger of AIEE and IRE, since IEEE headquarters wished to hold down the number of professional groups, the administrative committees of PGA and the Professional Group on Broadcasting met to consider merging the two Groups, but after discussion there was agreement on both sides that a merger was inadvisable.[26]

In the 1966 revised constitution, the definition of the field of interest was still broader:[27]

> The technology of transmission, recording, reproduction, processing and measurement of audio-frequency waves by electrical, electronic, acoustic, mechanical, and optical means; the components and systems to accomplish these aims, and the environmental, psychological, and physiological factors concerned therewith.

As mentioned in Chapter 2, there were two organizations outside IEEE whose interests overlapped with those of the G-AE: the Acoustical Society of America and the Audio Engineering Society. The former was concerned principally with the science of acoustics (including electroacoustics), the latter with practical audio systems. The Acoustical Society was

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William Lang: No, I think what we were doing was of interest to the practicing engineers. I think it [signal processing] 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*.
William Lang oral-history interview 15 April 1997, pp. 1-4.

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25 *IRE Transactions on Audio*, vol. 8 (1960), pp. 72-73.

26 *IRE Transactions on Audio*, vol. 11 (1963), pp. 123, 151.

27 *IEEE Transactions on Audio and Electroacoustics*, vol. 15 (1967), p. 147.

> *Charles Rader*: The only objection to changing the name from Audio and Electroacoustics to Acoustic Speech and Signal Processing came from libraries. But the Society was perfectly happy to do that. There were some other IEEE Societies who worried that we were cutting in on their scope.
>
> *Interviewer*: Are there any examples? Can you remember?
>
> *Rader*: I think Circuits and Systems might have been concerned. Or Information Theory. I'm not sure. But Societies infringe on one another's scope all the time.
>
> *Charles Rader oral-history interview 27 February 1997, p. 18.*

composed mainly of academics, and for most of them scientific understanding was the goal. G-AE, by contrast, was concerned with technologies, that is, with practical techniques and the scientific understanding of them. Differentiation from the Audio Engineering Society was harder, since the interests of the Audio Engineering Society were those that had been the main ones for the IRE Professional Group on Audio in the 1950s and had remained important to the G-AE in the mid 1960s. The interests of G-AE, however, had become much wider, while the Audio Engineering Society focused on the incremental improvement of particular systems.[28]

The Group came to have greater and greater involvement with the speech processing community. In 1961, for example, it collaborated with the Acoustical Society in organizing a session, consisting of five papers, on speech compression systems.[29] The Acoustical Society, however, was not as receptive to this rapidly growing area, and in the 1960s many papers on speech processing were rejected by the speech editor of the *Journal of the Acoustical Society of America*, perhaps because they were seen as too technological.[30] The favorable reception such papers received from editors of the G-AE *Transactions* was therefore quite welcome. In 1969 the Group had five technical committees. (See Table 5.)

<div align="center">

Table 5
The Technical Committees of the Group on Audio and Electroacoustics in 1969

Audio Frequency Noise
Digital Signal Processing
Electroacoustic Transducers
Speech Communication and Sensory Aids
Underwater Acoustics

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28   *IEEE Transactions on Audio and Electroacoustics*, vol. 15 (1967), p. 147.
29   *IRE Transactions on Audio*, vol. 10 (1962), pp. 2-3.
30   Daniel Martin personal communication 31 March 1998.

> In the presentation of papers at technical conventions, authors frequently utter phrases which sound deceptively like English but which are actually in a strange tongue called Paperese. We present here some of the more common phrases in Paperese together with their English translations.
>
> | Thuh dezine ubjectivz wur az followz: | When we finally got the prototype working, it had these characterisitics: |
> |---|---|
> | awtomattik | has an on-off switch |
> | sollid stayt | contains a diode |
> | portubbl | has a handle |
> | Purformans haz bin radicallee improved. | Last year's model was lousy. |
> | Thiss resurch haz demmunstrated thuh feezibillittee uv thiss approwch. | We couldn't make it work, but we're trying to get the government to extend the contract. |
>
> *Peter Tappan, IRE Transactions on Audio, vol. 11 (1963), p. 152.*

In the mid 1960s there was some overlap between the interests of G-AE and the IEEE Group on Sonics and Ultrasonics. William Lang wrote in 1967, "If we limit our future interests [in sonics] to frequencies well below the pretersonic [that is, below the higher ultrasonic frequencies], we will minimize any overlap with the rightful interests of the G-SU."[31] There was also some overlap with the Group on Instrumentation (which evolved into the IEEE Instrumentation and Measurement Society), since it dealt with "the electrical generation, processing, recording, reproduction and display of data in digital form".[32]

In 1965 the IEEE Technical Activities Board (TAB) came into existence with the mission of overseeing all IEEE technical activities above sectional and regional levels. The 35 Professional Technical Groups, now designated simply 'Groups', reported to TAB. The new TAB Chairman, Hendley Blackmon, suggested that the Technical Committees, which dealt mainly with standards, merge with the corresponding Groups, and in August 1965 the Audio and Electroacoustics Committee formally merged with the Audio Group, becoming the Group's Committee on Standards. Just before this occurred, the Group changed its name to Audio and Electroacoustics Group.[33]

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31   *IEEE Transactions on Audio and Electroacoustics*, vol. 15 (1967), p. 147.
32   Bernard M. Oliver, "Digital display of measurements in instrumentation" (*Proceedings of the IRE*, vol. 50 (1962), pp. 1170-1172); the quotation is from p. 1170.
33   *IEEE Transactions on Audio*, vol. 13 (1965), p. 69. The name of the *Transactions* did not change until the beginning of 1966.

The Standards Committee, headed at this time by William Lang, contin-
ued its vital work of reaching consensus on matters that would facilitate
communication among engineers. Its documents, after approval by the
IEEE Standards Committee, appeared as standards, test procedures,
recommended practices, lists of definitions, or technical reports.[34]

With the growth of electrical and electronics engineering generally, the
Audio and Electroacoustics Group increased its conference activities. As
before, it organized sessions for the large annual conference in New York
(after 1963 called the IEEE International Convention), the annual National
Electronics Conference in Chicago, and the large West Coast conference
(WESCON). It also sponsored sessions at the IEEE Annual Communica-
tions Conventions, which began in 1965.[35] In 1967 G-AE and the U.S. Air
Force co-sponsored the 1967 Conference on Speech Communication and
Processing, held in November at MIT; this was the first time G-AE was the
sole IEEE sponsor of a conference.[36] There were also activities at the local
level, through Chapters.

The Group continued to recognize outstanding work through its Achieve-
ment Award, renamed the Technical Achievement Award in 1967. (See
Table 6.) Also in 1967 the Group created a special award, the Pioneer in
Speech Communication Award, and presented it to Homer Dudley.

Table 6

Achievement Award

1960	William B. Snow
1961	J. Ross Macdonald
1962	John K. Hilliard
1963	Donald F. Eldridge
1964	C. Dennis Mee
1965	Hermon Hosmer Scott

Technical Achievement Award

1967	Daniel R. von Recklinghausen
1968	Murlan S. Corrington
1969	Hugh S. Knowles

In the 1960s the Institute—and with it the Group on Audio and Electro-
acoustics—became more international. For example, in 1960 the Benelux
Section of the IRE held an International Symposium on Data Transmission at

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34 *IEEE Transactions on Audio and Electroacoustics*, vol. 14 (1966), pp. 58-59.
35 *IEEE Transactions on Audio*, vol. 13 (1965), pp. 69-70.
36 *IEEE Transactions on Audio and Electroacoustics*, vol. 15 (1967), p. 1. Many of the papers presented at that conference became papers that appeared in the first two issues of *Transactions* in 1968.

Delft, The Netherlands. Concerned with the transmission of information in
digital form, the Symposium considered such topics as types of codes, choice
of modulation, and the behavior of links and networks under test.[37] In 1967 a
group of G-AE members began plans for what became the International
Seminar on Digital Processing of Analog Signals, held in March 1970 in Zürich.[38]

The direction taken by the Group in the 1960s was confirmed in the 1970s.
As the possibilities of digital signal processing began to be more widely
explored, the Group expanded its role in cultivating the new technology
and adopted a new name to reflect this.

> *William Lang*: Signal processing was spread over various different areas
> within the now IEEE, and so there was no real home for this great development
> [the FFT] 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.
>
> ... 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.
>
> ... 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
> 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 Electroacous-
> tics 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.
>
> *William Lang oral-history interview 15 April 1997, pp. 5-7.*

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37 *IRE Transactions on Audio*, vol. 8 (1960), p. 71.
38 The conference had twelve other sponsors, including the IEEE Switzerland Section. The program chairman was the G-AE representative in Zürich, Ernst H. Rothauser. Only eight of 31 papers presented were given by U.S. participants. Versions of many of the papers appeared in the December 1970 *Transactions* special issue on digital signal processing. [*IEEE Transactions on Audio and Electroacoustics*, vol. 18 (1970), pp. 337-339.]

Chapter 4

From the Group on Audio and Electroacoustics to the Acoustics, Speech, and Signal Processing Society: The 1970s

In the 1970s, for the first time, large numbers of people became aware of digital signal processing. In Japan, the recordings of Nippon Columbia began to be digitally mastered in 1972.[1] The same year in Britain, the BBC began using an 8-track digital audio recorder with error correction.[2] In 1975 Tom Stockham showed how digital signal processing could improve historical recordings of Enrico Caruso,[3] and digitally restored recordings began to appear the following year.[4] And in 1978 Texas Instruments introduced a toy called Speak & Spell, which taught a child to spell by pronouncing a word and indicating whether an attempted spelling was correct.[5] Such a device was practical only because there was an efficient algorithm for speech compression (linear predictive coding) and because

> Another collaboration that I have enjoyed is with Al Oppenheim. We wrote a textbook on digital signal processing which has just been published by Prentice-Hall. He wrote his part between ski runs in Grenoble, and I wrote mine in the wee hours of many nights back in New Jersey.
> *Ronald W. Schafer, Newsletter, no. 32, February 1975, p. 7.*

1 Peter J. Bloom, "High-quality digital audio in the entertainment industry: an overview of achievements and challenges" (*IEEE ASSP Magazine*, vol. 2 (1985), no. 4, pp. 2-25).

2 Guy M. McNally, "Digital audio in broadcasting" (*IEEE ASSP Magazine*, vol. 2 (1985), no. 4, pp. 26-44). Professional audio equipment went digital before the consumer products: in 1975 real-time digital reverberation systems became available, and in 1977 several professional digital audio recorders were being sold [Bloom *op. cit.*].

3 Thomas G. Stockham, Thomas M. Cannon, and Robert B. Ingebretsen, "Blind deconvolution through digital signal processing" (*Proceedings of the IEEE*, vol. 63 (1975), pp. 678-692).

4 Bloom *op. cit.*

5 'Speak & Spell' is a trademark of Texas Instruments Incorporated.

Figure 1. This November 1970 image shows (left to right) Ron Schafer, Jim Flanagan, and Larry Rabiner listening to speech synthesized by computer. Flanagan writes, " the computer in the background is a Honeywell DDP516. This was the first integrated circuits machine that we had in the laboratory. It was a 1MHz 16 bits with memory of 8K words (one-half of which was occupied by the Fortran II compiler). It had a card reader and an ASR33 teletype with 8-bit punched paper tape for input. If I remember correctly, the disk had a capacity of 700K words."[6] (Bell Labs photo reproduced by permission.)

it could be implemented on an integrated circuit. Figure 1 shows three Bell Labs engineers at work on speech processing; all three of them, it may be noted, served in the highest office of the IEEE Group on Audio and Electroacoustics.

It was a decade of advances in all the areas of interest to the IEEE Group. For speech processing, adaptive differential pulse code modulation (ADPCM), subband coding (SBC), and echo cancellation (EC) were introduced. The design of digital filters made great advances: transversal filters, multirate filters, filters for image processing, and many others. It was the decade of the first real-time DSP computer and the first use of integrated circuits for signal processing. It was the decade in which two landmark books on DSP—Oppenheim and Schafer (1975) and Rabiner and Gold (1975)—and one on digital speech processing—Rabiner and Schafer (1978)—were published.[7]

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6 James Flanagan personal communication 20 February 1998.

7 Alan V. Oppenheim and Ronald W. Schafer, *Digital Signal Processing* (Englewood Cliffs, NJ: Prentice-Hall, 1975); Lawrence R. Rabiner and Ben Gold, *Theory and Application of Digital Signal Processing* (Englewood Cliffs, NJ: Prentice-Hall, 1975); and Lawrence R. Rabiner and Ronald W. Schafer, *Digital Processing of Speech Signals* (Englewood Cliffs, NJ: Prentice-Hall, 1978). These textbooks made it easier for students and practicing engineers to learn the field and become active in it.

The decade was an eventful one also for the IEEE Professional Group on Audio and Electroacoustics. Its growth in numbers (Table 1) was overshadowed by changes in emphasis in its technical areas, reflected in two name changes. By the end of the decade, digital signal processing was the principal concern of most of its members.

Table 1
Membership in the Group on Acoustics, Speech, and Signal Processing[8]

Year	Members	Year	Members	Year	Members
1970	5299	1974	5704	1978	6899
1971	5151	1975	6012	1979	7585
1972	5261	1976	6227	1980	8619
1973	5350	1977	6336		

James Kaiser: Following the [Arden House] workshop on the FFT in 1967, that group organized a technical committee on digital signal processing, which they asked me to join. That technical committee was Al Oppenheim, Larry Rabiner, and Ron Schafer, and a couple of other fellows from Bell Labs including Ron Crochiere, Leland Jackson, Howard Helms, and Dave Bergland. Al was up at MIT and Cliff Weinstein, Ben Gold, and Charlie Rader were at Lincoln Laboratory. Ken Steiglitz was there from Princeton, and then Jim Cooley and Harvey Silverman were there from IBM Yorktown Heights. There were also Russ Mersereau, Joe Fisher, and Steve Lerman. The committee was a very significant force in DSP. It got together every two months; two times in the United Engineering Center in New York, at the IEEE's offices up there on the tenth floor, and the third time it would be up in the Boston area, and then this cycle would be repeated. It was convenient because you could take the shuttle up to Boston for the day and return in the evening. It was at those meetings that we planned the IEEE press books, the program book, the selected papers on DSP books, and we planned the Arden House workshops we organized and ran three workshops there that came about two years apart. We also did the normal technical committee work, which is reviewing the papers for the annual ICASSP. Moreover, when we'd get together we would interact with one another.
*James Kaiser oral-history interview 11 February 1997, pp. 30-31.*

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8 Data are from the *Annual Report of the Secretary of the Institute*. The totals include student members but not affiliate members (of which there were fewer than a dozen each year in the 1970s).

Those who served as President of the Group in the 1970s are listed in Table 2. (Until 1972 the title was Chairman.) The organization of the Group changed only slightly from the previous decade, notably by the addition of an Advisory Board and of a European Activities Committee (some of whose actions are discussed below). (See Table 3.)

Table 2
The Head Officers of the Group in the 1970s

Reginald A. Kaenel was born on 22 October 1929 in Berne, Switzerland. He received the Diploma in Electrical Engineering and the Sc.D. degree from the Swiss Federal Institute of Technology in 1955 and 1958 respectively. He then joined Bell Telephone Laboratories, where he was concerned with data transmission over switched telephone circuits. From 1962 to 1964 he did systems engineering studies of spacecraft at Bellcomm in Washington, DC, and in 1964 he returned to Bell Labs. Kaenel served as President of the Group on Audio and Electroacoustics for 1971 and 1972 (the position was called Chair in 1971). He was active also in the IEEE Computer Group and was named an IEEE Fellow "For contributions to audio, electroacoustics, and signal processing."
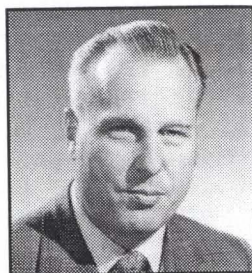
John V. Bouyoucos was born on 9 November 1926. He received A.B., S.M., and Ph.D. degrees in 1949, 1951, and 1955 respectively, all from Harvard University. He was manager of a hydroacoustics laboratory at General Dynamics before becoming in 1972 president and general manager of Hydroacoustics, Inc. in Rochester, New York. An active member of the IEEE Group on Audio and Electroacoustics, he served as President in 1973. He was active also in the IEEE Group on Sonics and Ultrasonics. Bouyoucos received the IEEE Fellow Award "For contributions to the field of hydrodynamic energy conversion devices."
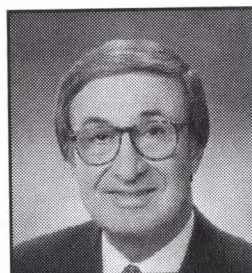
Lawrence R. Rabiner was born on 28 September 1943 in Brooklyn, New York. He attended MIT, where he received the S.B., S.M., and Ph.D. degrees, the last in 1967. From 1962 to 1964 he participated in the cooperative plan in electrical engineering at Bell Labs. He later joined Bell Labs, where he worked on speech communications and digital signal processing. He is currently Bell Labs Vice President for Speech and Image Processing Services Research. Long an active member of the Group on Acoustics, Speech, and Signal Processing, Rabiner served as President for 1974 and 1975. His honors include both of the highest honors of the Signal Processing Society (the Society Award and the Technical Achievement Award), the IEEE Fellow Award, and the IEEE Emanuel R. Piore Award.
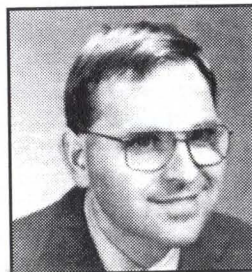
Table 2 (continued)
The Head Officers of the Group in the 1970s

Howard D. Helms was born on 30 July 1934 in Chicago. He received the B.S. and Ph.D. degrees from Princeton University in 1956 and 1961 respectively. He joined Bell Labs in 1961, where he was concerned with processing of signals in radar and sonar systems. He later worked at the Quality Assurance Center of Bell Labs, where he formulated procedures for assuring the quality of large time-division switching systems. A member of the Digital Signal Processing Technical Committee, Helms served also as President of the Society for 1976 and 1977.
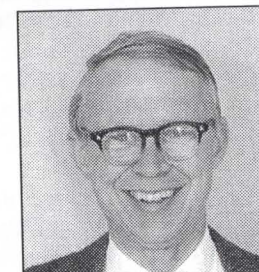
Ronald W. Schafer was born on 17 February 1938 in Tecumseh, Nebraska. He received the B.Sc.E.E. and M.Sc.E.E. degrees from the University of Nebraska in 1961 and 1962 respectively and the Ph.D. degree from MIT in 1968. He then joined the Research Department at Bell Labs, where he worked on digital speech processing techniques. In 1974 he joined the faculty of the Georgia Institute of Technology, and he is now Regents Professor in the School of Electrical and Computer Engineering. Schafer served the Society as President for 1978 and 1979 and in many other capacities over many years. His honors include both of the highest honors of the Signal Processing Society (the Society Award and the Technical Achievement Award), the IEEE Fellow Award, the IEEE Emanuel R. Piore Award, and the IEEE Education Medal.
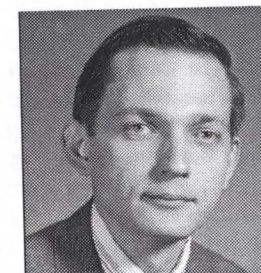
[The Head Officers were called Chairman until 1972, when the title President was adopted. In 1970 James L. Flanagan was Chairman of the Group; a biographical sketch of Flanagan appears in Chapter 3.]

Table 3
The Committees of the Acoustics, Speech, and Signal Processing Group in 1975

Administrative Committee
Advisory Board

Awards Committee
Chapters Committee
Conferences and Meetings Committee
Constitution and Bylaws Committee
European Activities Committee
Membership Committee
Nominations Committee
Publications Committee

There were only slight changes in the set of Technical Committees: the Audio Frequency Noise Committee became the Digital Measurement of Noise Committee, and the Speech Communication and Sensory Aids Committee became the Speech Processing Committee. (See Table 4.)

Table 4
The Technical Committees of the Acoustics, Speech, and Signal Processing Group in 1975[10]

Digital Measurement of Noise Committee
Digital Signal Processing Committee
Electroacoustic Transducers Committee
Speech Processing Committee
Underwater Acoustics Committee

In the late 1960s and early 1970s as the Group vigorously promoted digital signal processing, it concerned itself less and less with audio engineering in part because of the decline of the U.S. audio industry and changed its name to the Acoustics, Speech, and Signal Processing Group in 1974. Most members felt that the new name better reflected the range of interests represented by the Group.[11] In part, no doubt, to justify the new name, the February 1974 issue of the Newsletter contained the chart shown in Figure 2.[12]
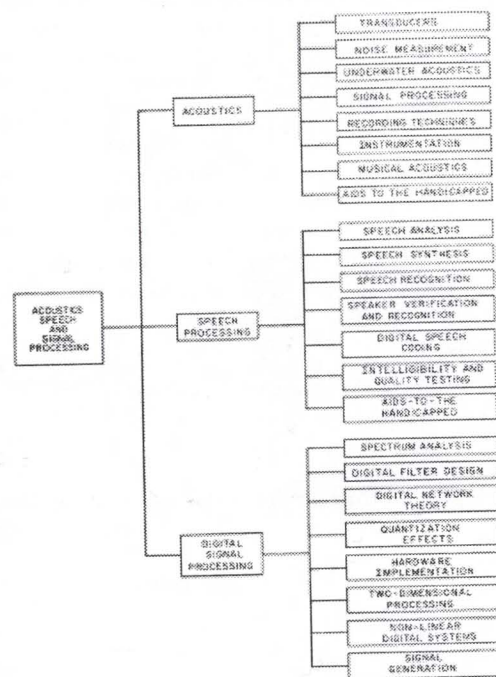

Figure 2. This chart appeared in the first issue of the Newsletter after the Group changed its name to Acoustics, Speech, and Signal Processing Group. At the time there were five Technical Committees: Digital Signal Processing, Digital Measurement of Noise, Electroacoustic Transducers, Speech Processing, and Underwater Acoustics.

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10 *IEEE Transactions on Acoustics, Speech, and Signal Processing*, vol. 23 (1975), no. 6.

11 Larry Rabiner and Charles Rader prepared and circulated petitions calling for the name change, which was approved at the 11 October 1973 meeting of the Group's Administrative Committee [*Newsletter*, no. 28, February 1974, p. 2].

12 *Newsletter*, no. 28, February 1974, p. 9.

There soon followed another name change, which was a result of changed IEEE practice. In the early 1970s the largest IEEE Group, the Computer Group, asked for greater independence than was normally accorded a Group. IEEE therefore created Society status and set requirements on Group, meetings, other technical activities, membership, finances, and long-range planning in order for a Group to receive this status. It was thus regarded as a significant achievement when, on 1 January 1976, the ASSP Group became the ASSP Society.[13] At the same time a new constitution and bylaws went into effect.

Along with growth in number of members (180,000 in 1978), the IEEE contained more and more technical Groups and Societies. There was concern that the diverse interests of these Groups and Societies might not be represented on the IEEE Board of Directors. So in the mid 1970s a Technical Division structure was created: the Groups and Societies were placed into seven Divisions those in a Division having some commonality of technical interest and each Division was represented on the IEEE Board of Directors by a Division Director. ASSP was placed in Division I, along with Circuits and Systems, Control Systems, and Information Theory.[14]

IS FOUR CHANNEL A QUADRIFIZZLE?

The development of four-channel home entertainment systems has been motivated by the marketplace and accomplished without a thorough engineering feasibility study.

To the engineers and particularly the engineering managers responsible for audio equipment development, I send a plea to heed these words of Abraham Lincoln:

"If you once forfeit the confidence of your fellow citizens, you can never regain their respect and esteem. It is true that you may fool all of the people some of the time; you can even fool some of the people all of the time; but you can't fool all of the people all of the time."

J. Robert Ashley, Newsletter, no. 38, December 1976, pp. 1-6.

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13 Lawrence R. Rabiner, "The Acoustics, Speech, and Signal Processing Society—a historical perspective" (*IEEE ASSP Magazine*, January 1984, pp. 4-10).

14 *Newsletter*, no. 44, December 1978, p. 2-4. At this time the distinction between Groups and Societies was disappearing; soon they would all be called Societies.

Publications in the 1970s were, as earlier, the *Transactions* and the newsletter, with name changes to reflect the new name of the Group. (See Table 5.) The December 1970 issue of the *Transactions* contained a phonograph record of computer-generated speech and music, prepared by Leo Beranek. The size of the *Transactions* continued to increase. In mid 1972 it went from quarterly to bimonthly publication, and in 1979 the issues totaled almost 800 pages.[15] An innovation with the newsletter was the inclusion in some issues in the mid 1970s of an application-oriented tutorial paper, often describing engineering practices or a particular product of a company, but this did not become a regular feature.[16]

Table 5
Editors of the Group Publications the 1970s

IEEE Transactions on Audio and Electroacoustics
1966-1971 Frederick Van Veen, Editor-in-Chief
1972-1973 William E. Collins, Editor-in-Chief

IEEE Transactions on Acoustics, Speech, and Signal Processing
1974-1984 William E. Collins, Editor-in-Chief

IEEE Newsletter on Audio and Electroacoustics
1968-1973 Irving Rosenblatt

IEEE Acoustics, Speech, and Signal Processing Newsletter
1974-1975 Irving Rosenblatt
1976-1978 John W. Simms
1979 Charles M. Rader

[The Transactions went from quarterly to bimonthly publication in 1972.]

Technologists are faced with the significant problem of expanding their professional education. It is not only vital for the individuals themselves, but also for their companies. Companies which rigidly adhere to analog techniques will find competitors offering improved products utilizing modern signal processing techniques.
from a notice about two seminars offered by the
Signal Processing Institute, Newsletter, no. 31, November 1974, p. 8.

15 *Newsletter*, no. 48, December 1979, p. 1.
16 The first four such articles were "What is Fourier analysis?", "How the Fourier analyzer works", "A versatile recording analyzer system", and "An introduction to correlation". The first two appeared in 1973, the other two in 1974. (See *Newsletter*, no. 30, August 1974, p. 3.)

Charles Rader: The annual conference [ICASSP] certainly had a huge influence, because it always had a substantial non-U.S. participation and many, many excellent papers.
Charles Rader oral-history interview 27 February 1997, p. 32.

The winners of the Technical Achievement Award in the 1970s are listed in Table 6. In 1972 the Group presented the special award Pioneer in Speech Communication, which had been presented only once before, to Franklin S. Cooper for his work in synthesis as a tool for studies of speech patterns.[17] In 1975 a new annual award, the Society Award, was instituted; it was regarded as a successor to the Pioneer in Speech Communication Award and as the Society's highest award. The recipients are listed in Table 7.

Table 6
Technical Achievement Award

1970	William W. Lang
1971	James L. Flanagan
1972	Ben Gold
1973	no recipient
1974	no recipient
1975	Bishnu S. Atal and James W. Cooley
1976	Alan V. Oppenheim and Charles M. Rader
1977	Augustine H. Gray, James F. Kaiser, and John D. Markel
1978	Lawrence R. Rabiner
1979	Ronald W. Schafer

Table 7
Pioneer in Speech Communication Award

1967	Homer W. Dudley
1972	Franklin S. Cooper

Society Award

1975	James L. Flanagan
1976	no recipient
1977	Henry S. McDonald
1978	Hans Wilhelm Schüssler
1979	Alan V. Oppenheim

[The Pioneer in Speech Communication Award, granted only twice, was a forerunner of the Society Award, first granted in 1975.]

17 *IEEE Transactions on Audio and Electroacoustics*, vol. 21 (1973), p. 134.

Beginning in 1970 an award honored outstanding service to the Group, calling attention to some of the people whose efforts over an extended period made possible the many professional activities of the Group and their continual improvement. The winners in the 1970s are listed in Table 8.

Table 8
The Meritorious Service Award

1970	Robert H. Rose II
1971	no recipient
1972	William Chapman and Frederick Van Veen
1973	Henry S. McDonald
1974	John J. Earshen
1975	William Chapman
1976	Lawrence R. Rabiner Charles F. Teacher
1977	Howard D. Helms
1978	James F. Kaiser
1979	James Cooley and N. Rex Dixon

As mentioned in Chapter 3, the Digital Signal Processing Committee was responsible for a wide range of activities.[18] There were the Second, Third, and Fourth Arden House Workshops, held in 1970, 1972, and 1974 respectively. These workshops attracted researchers from around the world, and the proceedings made up three special issues of the transactions of the IEEE Group on Audio and Electroacoustics.[19] Since DSP was a new field and its practitioners had quite different backgrounds, the terminology was not fixed, with different words being used for the same thing and the same word being used in slightly different ways. The DSP Committee helped to remedy this situation with the publication in 1972 of detailed recommendations for the use of some 200 terms.[20]

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18 The DSP Committee was so productive and its actions were so important for the future both of the technology and the Group (later Society) that its members should be listed. Those who served on the Committee in the 1970s were G. David Bergland, James W. Cooley, Ronald Crochiere, Joseph Fisher, Ben Gold, Howard D. Helms, Leland B. Jackson, James F. Kaiser, Steve Lerman, James McClellan, Russell Mersereau, Alan V. Oppenheim, Lawrence R. Rabiner, Charles M. Rader, Ronald W. Schafer, Harvey Silverman, Kenneth Steiglitz, Jose Tribolet, Clifford J. Weinstein, and John Woods. In addition, two computer programmers—Marie Dolan of Bell Labs and Carol McGonegal of MIT—took part in the work of the Committee.

19 Rabiner *op. cit.* The special issues of the transactions appeared in June 1970, October 1972, and June 1975.

20 Lawrence R. Rabiner, James W. Cooley, Howard D. Helms, Leland B. Jackson, James F. Kaiser, Charles M. Rader, Ronald W. Schafer, Kenneth Steiglitz, and Clifford J. Weinstein, "Terminology in digital signal processing" (*IEEE Transactions on Audio and Electroacoustics*, vol. 20 (1972), pp. 322-337).

The DSP Committee worked with IEEE Press to publish two volumes of reprints, since many of the important pioneering papers in DSP were otherwise hardly available.[21] Another project of the DSP Committee was to publish a bibliography of the new field in 1972, and three years later it published a revised version, twice as large.[22] In 1979 a DSP Committee project resulted in an influential book by IEEE Press of *Programs for Digital Signal Processing*, along with a magnetic tape containing 29 computer programs in machine-readable form.[23] (The book in paperback form cost members $17.95, while the tape cost $50.00.)[24]

> **Alan Oppenheim:** We use ICASSP as the first platform to put ideas on the table, and then we publish them in appropriate places. I would say ICASSP is probably, for this group, the typical way of starting to disseminate information.
> *Alan Oppenheim oral-history interview 28 February 1997, p. 33.*

Speech communication was another area of great activity. At the 1972 International Conference on Speech Communication and Processing, jointly sponsored by G-AE and the Air Force Cambridge Research Laboratories, 114 papers were presented, and versions of many of them appeared in the June 1973 special issue of the *Transactions*.[25] In 1974 the Group collaborated with Carnegie Mellon University in Pittsburgh in putting on a 5-day symposium on speech recognition, which resulted in, among other things, a special issue of the *Transactions* on that topic.[26] In the 1970s IEEE Press also published four reprint volumes of papers on speech communications.[27]

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21 Lawrence R. Rabiner and Charles M. Rader, eds., *Digital Signal Processing* (New York: IEEE Press, 1972); and Digital Signal Processing Committee, eds., *Selected Papers in Digital Signal Processing II* (New York: IEEE Press, 1976).

22 Howard D. Helms and Lawrence R. Rabiner, *Literature in Digital Signal Processing: Terminology and Permuted Title Index* (New York: IEEE Press, 1972); Howard D. Helms, James F. Kaiser, and Lawrence R. Rabiner, *Literature in Digital Signal Processing: Author and Permuted Title Index*, revised and expanded edition (New York: IEEE Press, 1975).

23 Digital Signal Processing Committee, eds., *Programs for Digital Signal Processing* (New York: IEEE Press, 1979).

24 The difficulty of sharing programs in the 1970s is suggested by the following excerpt from a review by Robin B. Lake of the book and tape: "The programs adhere to standards which require a particular portable subset of ANSI FORTRAN (PFORT). Machine-dependence has been minimized by use of Bell Lab's PORT FORTRAN subprograms. The resulting programs are very likely to produce the same results on a wide variety of computers. ... We experienced some difficulty reading the magnetic tape as received from the IEEE Service Center." [*Newsletter*, no. 50, June 1980, pp. 31-32.]

25 *IEEE Transactions on Audio and Electroacoustics*, vol. 21 (1973), p. 133.

26 *Newsletter*, no. 31, pp. 4-5. The *Transactions* special issue was vol. 23 (1975), no. 1.

27 Rabiner *op. cit.* (footnote 13).

In 1976 the Society initiated its practice of holding an annual conference. Called the International Conference on Acoustics, Speech, and Signal Processing (ICASSP), it has been held every year since. It grew out of a series of conferences on speech processing that were being held every five years, the last one in 1972. In 1974 Charles Teacher and Tom Martin of the Speech Processing Committee proposed to move the conference up one year and hold it in Philadephia. Larry Rabiner, Group President at the time, seized on this as an opportunity to establish an annual conference for all technical areas. This was at the time the Group was working for Society status, and the IEEE expected a Society to hold an annual conference.[28]

In another sense ICASSP may be viewed as a continuation of the Arden House Workshops, since in 1974 it was decided not to continue the Workshops in the earlier form because the Group would be holding an annual meeting.[29] (The Fifth Arden House Workshop in 1976 was quite different from its predecessors: it was focused on specific topics and emphasized discussion rather than presentation.)[30] The first four ICASSPs were held in cities in the United States. (See Table 9.)

Table 9
The International Conference on Acoustics, Speech and Signal Processing

1976 **Philadelphia**, Pennsylvania
12-14 April
Conference Chair: Charles F. Teacher
Technical Program Chair: Thomas B. Martin

At that time Philadelphia was a principal site of celebration of the U.S. bicentennial. Of the 250 papers received, about 30 percent were from researchers outside the U.S. Almost 600 people attended.

1977 **Hartford**, Connecticut
8-11 May
Conference Chair: Harvey Silverman
Technical Program Chair: N. Rex Dixon

About 35 percent of the papers received were from researchers outside the U.S. About 640 people attended. The conference netted $17,000, not counting sales of proceedings.

1978 **Tulsa**, Oklahoma
10-12 April
Conference Chair: Rao Yarlagadda
Technical Program Chair: Thomas H. Crystal

As an aspect of its Tulsa location, the meeting featured acoustic signal processing and other areas of geophysical exploration. Of the 641 attendees, 61 came from outside the U.S.

1979 **Washington**, DC
2-4 April
Conference Chair: Anthony I. Eller
Technical Program Chair: G. Robert Redinbo

The attendance exceeded 900. Just prior to the conference banquet there was a performance of the American Underwater Band, whose members, wearing scuba gear, played (non-electrical) instruments while completely submerged in the hotel's swimming pool; the underwater music was conveyed to the audience outside the pool with the help of hydrophones.

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28   Tom Crystal personal communication 17 February 1998; Larry Rabiner personal communication 29 January 1998. Tom Crystal described the 1972 Conference on Speech Communication and Processing as the 0th ICASSP [*IEEE ASSP Magazine*, April 1987, p. 3].
29   *Newsletter*, no. 29, May 1974, p. 3.
30   *Newsletter*, no. 33, May 1975, p. 7.

At the end of the decade the Society held its first workshop on 2-dimensional digital signal processing (in Berkeley, California on 3 and 4 October 1979).[31] This area was growing so rapidly that in 1981 the Society established the Committee on Multidimensional Signal Processing, which became one of the most active Technical Committees.[32] The second workshop in the series was held on 5 and 6 October 1981 in New Paltz, New York.[33]

Another activity of the Audio and Electroacoustics Group was participation in the IEEE efforts to define standards. Figure 3 shows some of the publications on standards that were available in 1973.

The ASSP Society, like IEEE in general, made increased efforts to become more international. In 1978 the Society President, Ron Schafer, wrote, "IEEE is an international organization in name, but in many ways I think we have failed to involve our colleagues overseas in the activities of the Society."[34]

Figure 3. This is a listing of some IEEE standards publications available in 1973. (Reproduced from the back cover of the IEEE

As mentioned in Chapter 3, the Group was a principal sponsor of the First Zürich Seminar, held in 1970, and it continued in the 1970s to sponsor the biannual Zürich communications conferences (though it decided to cease sponsorship with the 1980 conference).[35] The IEEE was one of three sponsors of the Conference on Digital Processing of Signals in Communications, held at the Loughborough University of Technology in England in 1977.[36]

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31   *Newsletter*, no. 48, December 1979, p. 6.
32   *Newsletter*, no. 54, June 1981, p. 3.
33   *Newsletter*, no. 52, December 1980, p. 34.
34   *Newsletter*, no. 43, September 1978, p. 1. In 1978 some 15 percent of IEEE lived outside the United States [*Newsletter*, no. 44, December 1978, p. 4].
35   *IEEE Transactions on Audio and Electroacoustics*, vol. 20 (1972), p. 177; and *Newsletter*, no. 41, March 1978, p. 3.
36   *Newsletter*, no. 37, September 1976, p. 6.

> *Lawrence Rabiner:* It's probably the most productive committee [the technical committee for Digital Signal Processing] I've ever served on, focused and productive. We defined the technology and the field. We put out the key books. Even though committee members wrote a high percentage of the papers, every paper that got in the reprint books went through review after review. We would split hairs about whether this paper was better because it's more historic or this paper is better because it's more up to date and more factual. We were unbelievably careful. Probably we made mistakes. In hindsight, anyone's going to do that. But these are the events that built up the field.
>
> *Lawrence Rabiner oral-history interview 13 November 1996, pp. 16-17.*

The high cost of international travel limited attendance at conferences, and it limited participation in Society governance as well. Some earlier members of the AdCom were born and educated outside the United States, such as Peter Goldmark (Hungarian), Michel Copel (French), Reginald Kaenel (Swiss), and Hellmuth Etzold (German), but the first person to serve on the AdCom while residing most of the year outside the United States was Manfred Schroeder, and this was a special case in that Schroeder retained an affiliation with Bell Labs (where he continued to work part of the year) after his 1969 appointment as professor at Göttingen University.[37] Another Bell Labs scientist, Gerhard Sessler, was a member of the AdCom from 1970 through 1972 and continued to serve the Group in several capacities after that, but ceased these activities when, in 1975, he accepted a German professorship.[38]

In the late 1970s a group of European engineers and scientists, headed by Anthony Constantinides and Murat Kunt, established the European Association for Signal Processing (EURASIP) and the journal *Signal Processing*. Constantinides, Kunt, and some other founders of EURASIP were members of the ASSP Society, and from the beginning they sought cooperation and collaboration with the Society, planning a joint workshop in 1981 and a joint international conference in 1982.[39]

On its own, the ASSP Society organized a workshop on DSP held from 9 to 11 September 1980 in L'Aquila, Italy. The increasing number of papers in the Society's *Transactions* written by authors outside the United States 46 percent of the papers in 1979, for example led to the appointment of Ludwig Eggermont of Philips Research Laboratories in Eindhoven as

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37 *Newsletter*, no. 33, May 1975, pp. 16-18.
38 *Newsletter*, no. 32, February 1975, p 1, and no. 33, May 1975, p. 2.
39 *Newsletter*, no. 45, March 1979, pp. 6-7. EURASIP was founded 1 September 1978, and *Signal Processing* began publication in 1979. The ASSP newsletter published the table of contents of the EURASIP journal.

Associate Editor.[40] There was increasing involvement of Asian, especially Japanese, engineers and scientists in the activities of the Society. For example, in the last two years of the decade 15 papers written by Japanese appeared in *Transactions*.[41]

In the 1980s, as we shall see in the next chapter, the Society almost doubled in size and became much more international.

> After graduating, I accepted an engineering position at Motorola in Scottsdale, Arizona. I was hired as a circuit designer and worked on such things as receivers, broad-band amplifier and phase-locked loop design. My first change in directions arose out of an instance where I saw one of the engineers spending two days tabulating numerical values corresponding to the Fourier series of triangular pulses to look at radar side-lobe effects (keep in mind that this was 1965, just before the FFT revolution). I went rummaging through the company library and found a numerical analysis book which had the Goertzel algorithm for discrete Fourier transforms. Within a few hours, I had typed in the program and performed the triangular pulse analysis with computer printouts. My supervisor was sufficiently impressed that he allowed me to become more involved in computer simulation problems and less with circuit design.
>
> *John D. Markel, Newsletter, no. 35, November 1975, p. 8.*

> In London I met Americans for the first time... I later learned that almost all of my American friends were recipients of Fulbright, Guggenheim, or other equally meritorious awards... this exposure soon erased my mental image of Andy Hardy and replaced it with another, perhaps equally misleading, image. [In 1964] I nervously accepted an offer of employment from Bell Telephone Laboratories . Here again my statistically biased view of American university graduates was further reinforced in that all my peers were uniformly brilliant. In fact, so great was the cultural shock that I developed feelings of intellectual inadequacy that I thought only Woody Allen could experience.
>
> *Harry Levitt, Newsletter, no. 38, December 1976, p. 8.*

> *Charles Rader:* Another thing that happened around the same time I mean, all these things kind of happened one on top of another was that people became more and more interested in multidimensional signal processing. Processing pictures, for example. And multidimensional signal processing began to become more and more important. Eventually we created a separate committee to do multidimensional signal processing, along with one to do speech signal processing. Speech is more than signal processing. It has algorithms of trying to understand, and synthesize, and quality judgment, and so on. But a lot of signal processing ideas, including some of these linear predictive spectral estimation ideas were originated in the speech area. Two other areas that generated a lot of useful results were radar and seismic processing. So, the Society really helped bring these people together, exchanging concepts with one another.
>
> *Charles Rader oral-history interview 27 February 1997, pp. 25-26.*

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40 *Newsletter*, no. 50, June 1980, p. 26.
41 *Newsletter*, no. 50, June 1980, p. 14.

Chapter 5

A Larger Society and a Shorter Name: The 1980s

Signal processing engineers will always remember the 1980s as the first decade of single-chip DSPs, which opened up many new areas of application for signal processing. They will also remember it as the decade of the CD player: for the first time, digital audio was part of a standard consumer product. Not surprisingly then, the Acoustics, Speech, and Signal Processing Society grew steadily in the 1980s. Before the end of the decade membership reached 15,000, making the Society the fourth largest of IEEE's 36 Technical Societies.[1] (See Table 1.)

Table 1
Membership in the Acoustics, Speech, and Signal Processing Society[2]

Year	Members	Year	Members	Year	Members
1980	8619	1984	11,755	1988	15,234
1981	9038	1985	12,544	1989	15,545
1982	9455	1986	13,640	1990	15,925
1983	10,372	1987	14,643		

This remarkable growth was a reflection of the overall growth of DSP and the substantial improvements in Society activities, brought about by the energy and vision of the volunteer leaders of the Society. Table 2 lists those who served as President in the 1980s. It had become the practice for a person to serve two 1-year terms as President, so in 1985 the Society's Constitution was amended to provide for a 2-year term for the President.[3]

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1 *IEEE ASSP Magazine*, January 1990, p. 3. The larger Societies were the Computer Society, the Communications Society, and the Power Engineering Society.

2 Data are from the *Annual Report of the Secretary of the Institute*. The totals include student members but not affiliate members (of which there were fewer than fifteen each year in the 1980s).

3 *IEEE ASSP Magazine*, October 1985, p. 74. The earlier constitution stated that "no more than two terms shall be consecutive"; the new constitution that "The President may not be elected for two consecutive terms."

Table 2
Presidents of the ASSP Society during the 1980s

Charles M. Rader was born on 20 June 1939 in Brooklyn, New York. He received the B.E.E. and M.E.E. degrees from the Polytechnic Institute of Brooklyn in 1960 and 1961 respectively. He then joined the MIT Lincoln Laboratory, where he worked with Ben Gold on speech processing. In 1969 Gold and Rader published the landmark text Digital Processing of Signals. Rader is today Senior Staff Member at Lincoln Lab. An active member of the Society, he served as President for 1978 and 1979. His honors include both of the highest honors of the Signal Processing Society (the Society Award and the Technical Achievement Award), the IEEE Fellow Award, and the IEEE Jack S. Kilby Signal Processing Medal.

N. Rex Dixon was born on 24 February 1932 in Ecorse, Michigan. He received the B.A. degree from Western Michigan University and the M.A. degree from Indiana University in 1958 and 1960 respectively. He then attended Stanford University, where in 1966 he received the Ph.D. degree in speech and hearing sciences and psychology. He worked as an advisory scientist at IBM research laboratories in San Jose, California, Research Triangle Park, North Carolina, and Yorktown Heights, New York. He also served on the faculties of several universities. Much of his research has concerned speech synthesis, speech recognition, and speaker verification. Active in the Society in several capacities, Dixon served as President for 1982 and 1983, and in 1984 he became an IEEE Division Director. He was named an IEEE Fellow "For contributions to speech synthesis and speech recognition."
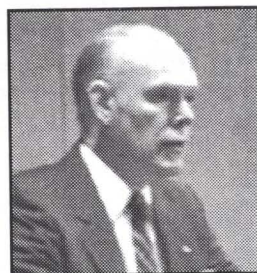
Ronald E. Crochiere was born on 28 September 1945 in Wausau, Wisconsin. He received the B.S. degree from the Milwaukee School of Engineering and the M.A. degree from MIT in 1967 and 1968 respectively. He then joined the Raytheon Company, but returned to MIT in 1970 and in 1974 completed a Ph.D. on digital signal processing. In 1974 Crochiere joined the Acoustics Research Department of Bell Labs. Long an active member of the Society, he served as President for 1984 and 1985. He was named an IEEE Fellow "For contributions to the field of digital signal processing and its application to digital encoding of speech."

Table 2 (continued)
Presidents of the ASSP Society during the 1980s

Thomas H. Crystal was born on 21 January 1938 in New York City. He attended MIT, from which he received B.S.E.E., M.S.E.E., and Sc.D. degrees, the last in 1966. As an undergraduate in the cooperative plan in electrical engineering and later as a doctoral candidate, he worked at Bell Labs, with Manfred Schroeder and then James Flanagan. Upon graduation he joined Signatron, Inc. where he worked in a variety of signal-processing areas. In 1972 he became a member of the technical staff of the IDA Center for Communications Research in Princeton, New Jersey. From 1990 to 1993 he was a program manager at DARPA. Crystal served the Society in many capacities, including as President for 1986 and 1987.
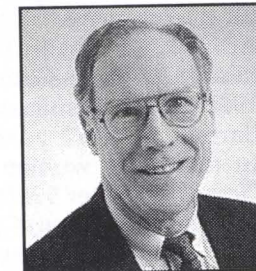
Delores M. Etter was born on 25 September 1947 in Denver, Colorado. She received the B.S. and M.S. degrees in mathematics from Wright State University in 1970 and 1972 respectively, and the Ph.D. degree in electrical engineering from the University of New Mexico in 1979. She was on the faculty at the University of New Mexico from 1979 to 1990 and since then at the University of Colorado, in both places as Professor of Electrical and Computer Engineering. Etter's many positions in the Society leadership include editor-in-chief of the magazine for 1986 and 1987, President of the Society for 1988 and 1989, and editor-in-chief of Transactions on Signal Processing from 1993 to 1995. She received the IEEE Fellow Award "For contributions to education through textbooks for engineering computing, and for technical leadership in the area of digital signal processing."
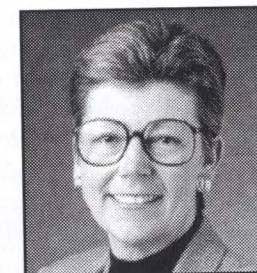
Delores M. Etter was the first woman to become President of the Society.[4] As in most areas of science and engineering, there were relatively few

> *Interviewer*: Does one need to be careful in choosing where to publish a paper, particularly since there is so much overlap in fields?
> *Thomas Kailath*: Yes. It can make a difference to the reception of a paper. I have tended to publish largely in IEEE journals. They are all carefully refereed which is an advantage. It slows down the publication process, but everyone profits, the writers and the readers.
> *Thomas Kailath oral-history interview 13 March 1997, p. 44.*

4 The SPS President always receives a large volume of correspondence from countries around the world. The unfamiliarity, for many correspondents, of sending a letter to a woman president led to some amusing salutations. One letter began "Dear Sister". Another began "President of the Signal Processing Society / Dear Miss Signal Processing". [Delores Etter personal communication 20 March 1998.]

women in signal processing until the last one ortwo decades, when their numbers increased markedly. Beginning in the 1970s, there were some papers in *Transactions* authored or co-authored by women, and Marie Dolan and Carol McGonegal contributed to the work of the DSP Technical Committee in the 1970s. The first woman member of the Group's AdCom was Edith L.R. Corliss, who served from 1973 through 1975. Besides Delores Etter, three other women served on the AdCom in the 1980s: Leah Jamieson Siegel, Maureen Quirk, and Faye Boudreaux-Bartels, whose 3-year terms began in 1981, 1986, and 1989 respectively. In the 1990s women who have served on the AdCom (the Board of Governors after 1993) include Faye Boudreaux-Bartels, Marcia A. Bush, Leah H. Jamieson, Candice Kamm, Maureen Quirk, Sarah Rajala, and Sally Wood, and in 1998 Leah Jamieson began her 2-year term as Society President.

The growth of the Society's activities led to the establishment at the beginning of the decade of two major subcommittees of the AdCom: a Publications Board to oversee the Society's expanding program of publications, and a Conference Board to assist organizers of meetings, establish general policies, and make decisions about specific plans on behalf of the Society.[5] (See Table 3.) Later in the decade a third Board was created when the Award Committee became the Awards Board.

Table 3
The Boards and Committees the ASSP Society in 1983 [6]

Administrative Committee
Conference Board
Publications Board

Awards Committee
Chapters Committee
Constitution and Bylaws Committee
Membership Committee
Nominations Committee

There were also changes in the Technical Committees in order better to cover the technical scope of the Society. In the early 1980s three new Technical Committees were established: Multidimensional Signal Processing (mentioned in the last chapter), VLSI for Signal Processing, and Spectral Estimation and Modeling. (See Table 4.) The technical areas of the Society were depicted in 1984 on the cover of the first issue of the

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5 The Publications Board was established in 1980, the Conference Board in 1981 [*Newsletter*, no. 54, June 1981, p. 28]. In 1985 the Conference Board distributed a Conference Planning Manual [*IEEE ASSP Magazine*, July 1985, p. 36].
6 *IEEE Transactions on Acoustics, Speech, and Signal Processing*, vol. 31 (1983), no. 4.

Society's magazine (Figure 1). In the 1980s the Society was not much involved with the setting of standards, and the Standards Committee was dissolved. There was, however, at least one Society standards project: the development of guidelines for evaluating speech recognizers.[7]

Table 4
The Technical Committees of the Acoustics, Speech, and Signal Processing Society in 1987 [8]

Audio and Electroacoustics Committee
Digital Signal Processing Committee
Multidimensional Signal Processing Committee
Spectral Estimation and Modeling Committee
Speech Processing Committee
Underwater Acoustics Committee
VLSI for Signal Processing Committee

[Two committees listed in Table 4 of Chapter 4 had ceased to exist: the Digital Measurement of Noise Committee and the Electroacoustic Transducers Committee.]

As before, the DSP Technical Committee was active, and beginning in 1984 it sponsored a biannual Digital Signal Processing Workshop, the first held in New Paltz, New York. The Committee on Multidimensional Signal Processing too was active, notably through the series of biannual workshops begun in 1979. At the fifth, held in 1987 in Noordwijkerhout, the Netherlands, there were 144 participants from 19 countries, and at the sixth, held in Monterey,

Figure 1. The cover of the first issue of the Society's magazine contained this depiction of the Society's technical areas.

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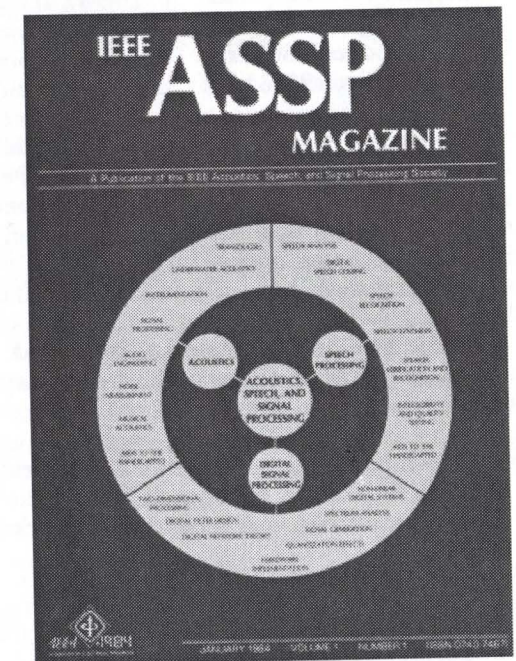
7 This project was headed by Janet Baker [*IEEE ASSP Magazine*, October 1986, p. 2].
8 *IEEE Transactions on Acoustics, Speech, and Signal Processing*, vol. 35 (1987), no. 1. The Audio and Electroacoustics Technical Committee was established before the end of 1987 and was listed in the *Transactions* beginning January 1988.

California, there were 200 participants.[9] The Spectral Estimation and Modeling Committee organized a series of workshops: in Hamilton, Ontario in 1981, in Tampa, Florida in 1983, in Boston in 1986, in Minneapolis in 1988, and in Rochester, New York in 1990. The Underwater Acoustics Committee organized a series of workshops, held typically every other year at the Alton Jones Campus of the University of Rhode Island.[10]

Increased interest in audio and acoustics was manifested in a Society-sponsored Workshop on Applications of Signal Processing to Audio and Acoustics in 1986, and not long thereafter a Technical Committee for Audio and Electroacoustics was formed.[11] The Second Workshop on Applications of Signal Processing to Audio and Acoustics was held in 1989. The program included 59 papers and three plenary talks, and more than half of the papers were given by non-U.S. researchers.[12]

> Serving as President of the ASSP Society is keeping me pretty busy. There are days when I can barely finish answering my mail. a system designed for a well-defined purpose would be most efficient if only those parts which needed to communicate with one another were interfaced and if only the minimum necessary communication took place. To provide for redundancy, and to allow for new requirements to be met, most large systems have more than the minimum number of interfaces, and these interfaces carry more than the minimum amount of information. The IEEE design is clearly of this latter type: the cross-communication channels are both numerous and busy. I sometimes wonder how the Institute can function with so much communication, rather than suffering the equivalent of an epileptic fit. As President of ASSP it sometimes seems as if the system exists to send me mail.
>
> *Charles M. Rader, Newsletter,*
> *no. 51, September 1980, p. 2.*

In December 1985 the Society held its first meeting at Arden House in ten years a Workshop on Speech Recognition, attended by 137 researchers from 12 countries.[13] A second such workshop was held at the same place in 1988.[14]

9 *IEEE ASSP Magazine,* October 1988, p. 24, and October 1990, p. 33. The second workshop was held in New Platz, New York in 1981, the third near Lake Tahoe, California in 1983, and the fourth in Leesburg, Virginia in 1985.
10 *IEEE ASSP Magazine,* October 1990, pp. 36-37.
11 *IEEE ASSP Magazine,* January 1987, pp. 33-34.
12 *IEEE ASSP Magazine,* October 1990, p. 34.
13 *IEEE ASSP Magazine,* April 1986, p. 36.
14 *IEEE ASSP Magazine,* July 1987, p. 34.

The Society began activities in an important new area, VLSI for signal processing. In 1981 it co-sponsored, with the Communications Society, the First International Workshop on VLSI in Communications, held in Santa Barbara, California.[15] In 1983 a Technical Committee on VLSI was established, and a workshop was organized biannually.[16]

In 1987 the ASSP Society joined with nine other IEEE Societies to form the Neural Network Committee, whose immediate purpose was the organizing of an annual IEEE Conference on Neural Networks.[17] In 1990 the Committee began publication of the quarterly *IEEE Transactions on Neural Networks.*[18]

> Taken as a whole, the [ASSP Workshop on Speech Recognition held at Arden House in December 1985] demonstrated that speech recognition is an active but severely factional area of research. Each faction is like one of the proverbial blind men describing an elephant: each is able to obtain some knowledge of a different part of the anatomy, but no one has explored the whole animal. What is worse is that, since the factions come from different intellectual traditions, it is difficult for them to describe to each other that part of the elephant which they are examining. It is hoped that, if nothing else, this workshop reminded the participants of the need for interdisciplinary approaches.
>
> *Stephen E. Levinson, IEEE ASSP Magazine,*
> *April 1985, p. 36.*

Society activities at the local level had declined in the 1970s and early 1980s, reaching a low point in 1985 when there were perhaps just a dozen active Chapters.[19] Charles Rader then led an vigorous effort to reactivate existing Chapters and to establish new ones. (There arose a Catch-22 in dealing with inactive Chapters: disbanding a Chapter required, by IEEE rules, its cooperation, but when the AdCom wanted to disband one, it was no longer active so could not cooperate.)[20] The Society AdCom provided funds for certain Chapter activities, and in 1986 it established a Distinguished Speakers Program. Every year three people were appointed as Distinguished Speakers, each agreeing to visit at least three Chapters in a 16-month term.[21] Many of the Chapters, including the ones in Paris, Switzerland, Central Pennsylvania, and Dallas, held a number of full-scale

15 *Newsletter,* no. 54, June 1981, p. 22.
16 *IEEE ASSP Magazine,* January 1984, p. 32. The second and third workshops were held in Los Angeles in 1984 (27-29 November) and 1986 (5-7 November).
17 *IEEE ASSP Magazine,* January 1988, p. 4.
18 *IEEE ASSP Magazine,* July 1989, p. 22.
19 *Newsletter* no. 52 in December 1980 (p. 18) reported only 11 active Chapters. The *IEEE ASSP Magazine* in July 1985 (p. 35) reported just 9 active Chapters, but just six months later the *Magazine* (January 1986, p. 18) reported 16 active Chapters.
20 *Newsletter,* no. 62, June 1983, p. 15.
21 *IEEE ASSP Magazine,* January 1986, p. 18. The travel costs were split 50-50 between the Society and the Chapter.

> Some weeks ago I walked from the mail boxes back to my office with an inaugural copy of "The International Journal of Approximate Reasoning [Elsevier, New York, NY]." This journal about the manipulation of uncertain knowledge and data promised not only reports on the latest research in the area but also news of the activities of the North American Fuzzy Information Processing Society. But then a colleague saw what I had and remarked that I finally had found a journal that was pertinent to my style of thinking. "When you stop writing the ASSPS President's letter," he asked, "are you going to use your talents as editor of a section on almost-proven theorems?"
>
> *Tom Crystal, IEEE ASSP Magazine, October 1987, p. 2.*

workshops.[22] In 1987 the number of active Chapters reached 28, and by the end of the decade there were 37 active Chapters, 12 of them outside the United States, including ones in Beijing, Finland, Korea, New South Wales, Spain, Tokyo, the United Kingdom, and Yugoslavia.[23]

In 1983 the IEEE changed its structure of Technical Divisions, and the Acoustics, Speech, and Signal Processing Society became part of Division IX, called Signals and Applications. The other Societies in this Division were Aerospace and Electronic Systems, Geoscience and Remote Sensing, Ocean Engineering, and Sonics and Ultrasonics.[24]

One of the reasons for the IEEE Technical Activities Board was to help coordinate related activities in different Societies. The ASSP Society, more than most, had overlaps of interest with other Societies: Circuits and Systems Society (digital filters); Communications Society (VLSI for communications); Computer Society (VLSI, image processing); Geoscience and Remote Sensing Society (processing of geophysical signals); Control Systems Society and Industrial Electronics and Control Instrumentation Society (signal processing in control systems); Engineering in Medicine and Biology Society (medical imaging); Information Theory Society (statistical signal processing); Systems, Man and Cybernetics Society; and no doubt others. As a rule, the Societies worked together rather than against each other, as seen in co-sponsored conferences and workshops and joint Chapters.

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22 *IEEE ASSP Magazine*, July 1985, p. 26, and January 1986, p. 18.
23 *IEEE ASSP Magazine*, October 1987, p. 3, and October 1989, pp. 2-3. A number of the Chapters were joint chapters; for example, the Swiss Chapter was for the ASSP Society, the Communications Society, and the Computer Society [*IEEE ASSP Magazine*, July 1984, p.4].
24 *IEEE ASSP Magazine*, July 1984, p. 36. At the time, Sonics and Ultrasonics was a Group rather than a Society; it is now the Ultrasonics, Ferroelectrics, and Frequency Control Society.

In 1986 the AdCom began considering changing the name of the Society to simply the Signal Processing Society.[25] The main argument for the change was that image processing was a rapidly growing field, but it was not practical to add to an already long name.[26] The change was controversial, but after polling the membership and receiving the approval of the IEEE Technical Activities Board and the IEEE Executive Committee, the Society became on 1 January 1990 the Signal Processing Society.[27] The names of the Society publications reflected the new name with the first issues of 1991; it was decided not to change the name of the annual conference. The Society's new name did much to solidify its position as the IEEE Society for signal processing.

In an unusual action, the AdCom voted in April 1980 to disassociate itself from the awarding of the IEEE Medal of Honor to William Shockley:

> Because he has long ago been very widely honored and recognized for his brilliant electronics research and because he has used this vast recognition to further a program of improving the genetic stock of mankind and because we feel this program is contrary to basic principles of human rights the AdCom of the Acoustics, Speech, and Signal Processing Society disassociates itself from the award of the 1980 medal of honor to William Shockley.[28]

In the 1980s the Society increased its publication activities. (See Table 5.) The number of pages in *Transactions* increased from 477 in 1974 to more than 1600 in 1985, and in 1987 the *Transactions* began monthly publication.[29] An important change occurred in 1984, when, at Larry Rabiner's suggestion, Pierce Wheeler, until then editor of the *Bell System Technical Journal*, became managing editor of *Transactions*. Together with his wife Barbara, Pierce Wheeler continued to manage Society *Transactions* for 13 years. At the end of this period, Monson Hayes, who served the Society

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25 *IEEE ASSP Magazine*, April 1987, p. 3.
26 David Munson was the principal proponent of the name change.
27 *IEEE ASSP Magazine*, July 1990, p. 2.
28 *Newsletter*, no. 50, June 1980, pp. 24-25. Several members of the AdCom felt that, since they had been selected by the Society for their technical leadership, they could not speak for the Society as a whole on a political issue; therefore the statement was presented as the view of the AdCom, rather than the view of the Society. The AdCom pointed out that the IEEE Board of Directors had on at least one occasion—the suspension of relations with the Soviet Union's Popov Society—put political considerations ahead of technical ones. [*Newsletter*, no. 50, June 1980, pp. 24-25.] Society President Charles Rader reported later that year that he had received a fair amount of mail concerning the Shockley award; all of the writers opposed the AdCom's action, though only one supported Shockley's theories of intelligence, heredity, and race [*Newsletter*, no. 51, September 1980, p. 3].
29 *IEEE Transactions on Acoustics, Speech, and Signal Processing*, vol. 35 (1987), p. 1.

as Chair of the Publications Board, said,

"There are few names within the society that are as widely recognized as Pierce Wheeler. As managing editor, he struggled with page budgets, worried about the length of the review process, handled incredible volumes of papers, finessed the publication schedule for papers, dealt with associate editors overburdened with "too many papers," answered phone calls and letters from disappointed authors, and interfaced with Publication Board chairs.[30]

Another change came in 1981 when the ASSP Society joined with three other Societies Engineering in Medicine and Biology, Nuclear and Plasma Sciences, and Sonics and Ultrasonics to establish a new quarterly journal, the *IEEE Transactions on Medical Imaging*, which began publication in 1982.

Table 5
The Editors of the Society Publications in the 1980s

IEEE Transactions on Acoustics, Speech, and Signal Processing
1974-1984 William E. Collins, Editor-in-Chief
1984-1991 Pierce Wheeler, Managing Editor

IEEE Acoustics, Speech, and Signal Processing Newsletter
1980-1983 Rao Yarlagadda, Editor

IEEE ASSP Magazine
1984-1985 Nuggehally S. Jayant, Editor
1986-1987 Delores M. Etter, Editor
1989-1990 S. Tom Alexander, Editor-in-Chief

[In the 1980s the Society published the bimonthly Transactions (monthly from 1987 on) and a quarterly publication, which was a newsletter before 1984 and a magazine from 1984 on.]

When Rao Yarlagadda became editor of the newsletter, it became a much more substantial publication, averaging 30 pages per issue during his 4-year editorship. Its success led to the establishment of a magazine in 1984, the IEEE ASSP Magazine. Modeled on the magazine of the Circuits and Systems Society, it was to take over the functions of the newsletter and to have refereed articles, principally overview articles and articles with a practical slant.[31]

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30 "The Wheeler legacy", *IEEE Signal Processing Magazine*, July 1997, pp. 102-105; quotation from p. 104.

31 *Newsletter*, no. 62, June 1983, p. 14. On the occasion of establishing the magazine, Jont Allen, Chairman of the Society's Publication Board, wrote, "The ADCOM would also like to express its deep appreciation to Rao Yarlagadda .... If he had not taken the steps that he did, we would not have moved toward producing the ASSP magazine. We dedicate the first issue of the magazine to Rao for paving the way" [*IEEE ASSP Magazine*, vol. 1 (1984), no. 1, p. 3].

The Society continued to honor outstanding achievement. The winners of the three highest awards are listed in Tables 6, 7, and 8.

Table 6
Society Award

1980	Lawrence R. Rabiner	1985	Ben Gold
1981	James F. Kaiser	1986	Kenneth Steiglitz
1982	Ronald W. Schafer	1987	Thomas W. Parks
1983	James W. Cooley	1988	John Makhoul
1984	Charles M. Rader	1989	Russ Mersereau

Table 7
Technical Achievement Award

1980	Thomas W. Parks	1985	C. Sidney Burrus
1981	Kenneth Steiglitz	1986	James H. McClellan
1982	John Makhoul	1987	Jont B. Allen and Thomas S. Huang
1983	Leland B. Jackson		
1984	Bede Liu	1988	Thomas Kailath
		1989	Benjamin Friedlander

Table 8
Meritorious Service Award

1980	Harvey Silverman and Charles F. Teacher	1985	Ronald E. Crochiere and N. Rex Dixon
1981	Rao Yarlagadda	1986	Jont B. Allen
1982	Maurice Bellanger and Claude Gueguen	1987	Hiroya Fujisaki
		1988	Mos Kaveh
1983	Charles Rader	1989	John W. Woods
1984	William E. Collins		

ICASSP, the Society's annual international conference, became even more successful in the 1980s. Toward the end of the decade the budgets for ICASSPs were near $500,000, so they became a major business venture as well as a technical conference.[32] Table 9 lists the ICASSPs of the 1980s. (See also Figure 2.) The Society continued its co-sponsorship of the Asilomar Conference on Circuits, Systems, and Computers, held annually at the Asilomar Conference Grounds at Pacific Grove, California.

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32 *IEEE ASSP Magazine*, July 1988, p. 2.

Table 9
The International Conference on Acoustics, Speech, and Signal Processing During the 1980s

1980   **Denver**, Colorado
9-11 April
Conference Chair: J. Robert Ashley
Technical Program Chair: Louis L. Scharf

970 attended. Tours were arranged to the Coors Brewery and to the Air Force Academy. A talk by M.E. "Ted" Hoff on IC technology and signal processing opened the conference. Linear-array loudspeaker systems, owned by the Society, were used and "made the ears agree with the eyes that the lecturer was at the podium." The proceedings were in 3 volumes.

1981   **Atlanta**, Georgia
30 March - 1 April
Conference Chair: Ronald W. Schafer
Technical Program Chair: Russell M. Mersereau

There were 31 technical sessions, usually in 5 parallel sessions. 950 attended, with presenters from 23 countries and 5 continents. At the Awards Banquet there was a demonstration of Homer Dudley's Voder and Vocoder.

1982   **Paris**
3-5 May
Conference Chair: Claude Gueguen
Technical Program Chair: Maurice Bellanger

The first ICASSP meeting outside the U.S., the conference drew 1653 people from 39 countries, including 51 researchers from Japan. There were 509 presentations in 55 technical sessions, and special emphasis was placed on image processing, digital audio, and signal processing in communications.

1983   **Boston**, Massachusetts
14-16 April
Conference Chair: Peter E. Blankenship
Technical Program Chair: John Makhoul

There were 1300 participants and 5 parallel sessions morning and afternoon for 3 days. Banquet attendees heard of an unusual application of signal processing in Robert Rines's talk on the search for the Loch Ness monster.

1984   **San Diego**, California
19-21 March
Conference Chair: Stanley A. White
Technical Program Chair: Y.T. Chan

The largest in the U.S. to date, this ICASSP drew 1520 participants from 40 nations. There were 560 papers in 55 sessions, also several poster sessions and 34 exhibitors in a dedicated exhibit hall.

1985   **Tampa**, Florida
26-29 March
Conference Chair: N. Rex Dixon
Technical Program Chair: Vijay Jain

For the first time, ICASSP was a 4-day conference. The longer schedule reduced the necessary parallelism of sessions, so that, with few exceptions, an attendee could attend all the sessions in a major area (General Signal Processing, Spectrum Estimation and Modeling, Speech Processing, Multi-dimensional Signal Processing, VLSI, and Underwater Acoustics). 1400 attended.

1986   **Tokyo**
8-11 April
Conference Chair: Hiroya Fujisaki
Technical Program Chair: Shuzo Saito and Jae S. Lim

Held outside the U.S. for the second time, ICASSP this year drew more than 1350 people from 33 countries. The program consisted of 776 contributed papers, 3 plenary papers, and 5 tutorials.

Table 9 (continued)
The International Conference on Acoustics, Speech, and Signal Processing During the 1980s

1987   **Dallas**, Texas
6-9 April
Conference Chair: Panos E. Papamichalis
Technical Program Chair: Masud M. Arjmand

There were more than 1400 attendees, and 645 papers were presented, which was just over half of the 1227 papers submitted.

1988   **New York**
11-14 April
Conference Chair: Jont B. Allen
Technical Program Chair: John G. Ackenhusen

The proceedings were organized topically, with each volume devoted to a technical area so that a member might keep only the volume (or volumes) of interest to him or her. The conference paper organization software written for this conference by Ackenhusen was later adopted by the IEEE Meetings Council and made available to all of IEEE.

1989   **Glasgow**, Scotland
23-26 May
Conference Chair: Tariq Durrani
Technical Program Chair: Peter Grant and Roy Chapman

This was a conference full of pagentry, and banquet, at which haggis was served, was held in the city hall. There was also a special bottling of the Scotch that bore ICASSP labels.

[The 1980s saw the Fifth through the Fourteenth ICASSP. Three of them took place outside the United States.]

Figure 2. *There were festive occasions at ICASSP86 in Tokyo. (Photograph courtesy of Delores Etter.)*

For Society leaders, internationalism was an issue. In 1986 ASSP Society President Tom Crystal wrote[33]

in the areas covered by our Society, internationalism has been a significant benefit. For example, speech analysis, coding, and recognition methods utilized for our own national benefit were invented and developed by engineers whose nationalities and countries-of-origin span the globe. What is personally more important for me in my promotion of ASSPS and IEEE transnationalism is the international fellowship of our Society.

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33 *IEEE ASSP Magazine,* July 1986, p. 3.

A large number of the Society's workshops took place outside the United States. The Workshop on Digital Signal Processing at L'Aquila, Italy in 1980, was followed by a second one, which was held at the same location in 1983.[34] The first of the ASSP Workshops on Spectral Estimation was held in Canada. The Society worked with the Acoustics Institute of the Academia Sinica to organize a workshop on acoustics, speech, and signal processing that was held in Beijing 16-18 April 1986, just after the ICASSP in Tokyo.[35] (Figure 3.)

Figure 3. The Society collaborated with the Academia Sinica in conducting a workshop on signal processing held in Beijing in April 1986. In this photograph Rex Dixon shakes hands with the Chief Scientist of China. During the workshop the Academia Sinica hosted a banquet in the Great Hall of the People at Tiananmen Square. (Photograph courtesy of N. Rex Dixon.)

In 1983 four of the 16 members of the *Transactions* Editorial Board resided outside the U.S. (in Japan, The Netherlands, Scotland, and West Germany), and Maurice Bellanger was an activemember of the AdCom, though living in France. The Society AdCom, having read a report that the U.S. Pledge of Allegiance was recited at an IEEE-sponsored conference on space technology, adopted the following resolution in 1986:

> The IEEE is a transnational organization devoted to the open exchange and publication of technical information. National oaths and pledges violate the international spirit of the IEEE, and we object to their inclusion at official functions of the IEEE.

The Society continued to lead the IEEE in becoming transnational: in 1987 29 percent of the Society membership resided outside the U.S., while that was true of only 9 percent of the IEEE membership as a whole.[36] In 1989 about one-third of the Society members resided outside the U.S.[37] The trend toward internationalism, for the Society and for IEEE as a whole, continued strongly in the 1990s.

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34 *IEEE ASSP Magazine*, July 1984, pp. 28-29.
35 ASSP Society President Tom Crystal reported [*IEEE ASSP Magazine*, July 1986, pp. 2-3]: "The workshop was supported at high levels within the government and scientific organizations of China. A videotape of the opening ceremonies became a news item on television, and the workshop banquet was held in The Great Hall of the People. … I left China with an open invitation to members of ASSPS to do what the Society was formed to do: promote the exchange of our technical expertise [for] the benefit of all involved."
36 *IEEE ASSP Magazine*, April 1987, p. 3.
37 *IEEE ASSP Magazine*, April 1989, p. 2.

Chapter 6

The Signal Processing Society at the Millennium: The 1990s

The 1990s may be remembered as the decade the human race made its greatest strides toward interconnection. The worldwide telephone network continued to grow in extent, especially in the less industrially developed parts of the world, but rather unexpectedly it grew spectacularly in density, as it connected modems, pagers, cellular phones, fax machines, and the second and third telephones that many families found they needed. To traditional broadcasting- and cable-television was added, for millions of people, television broadcast from satellites. Most remarkable, perhaps revolutionary, were the effects of the Internet, as personal computers, in addition to being stand-alone devices, became tools of access to this network, and millions of people all around the world viewed the same Web sites and joined in virtual communities concerned with almost any conceivable subject.

Signal processing played an important part in all of these changes. So it is not surprising that, after decades of steady growth and the cultivation of niche markets, signal processing achieved something of a breakout in the 1990s. In 1985 there were only three large commercial markets for DSP chips—speech coding, video compression, and modems—which, together, were a $50-million business. The growth of these three applications and the appearance of many new ones, such as cellular phones, sound boards, hard-disk drives, and medical instruments, resulted in a DSP business totaling $2.2 billion in 1995, as programmable and function-specific DSP achieved large markets.[1]

The IEEE Signal Processing Society played a large role in the growth of the new technology. The Society increased its membership. (See Table 1.) Much more significant was the increase in Society activities, especially, as we shall see, in publications and conferences.

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1 Gene Frantz and Panos Papamichalis, "Introduction to DSP solutions" (*Texas Instruments Technical Journal*, vol. 13 (1996), no. 2, pp. 5-16).

Table 1
Membership in the Signal Processing Society[2]

| Year	Members	Year	Members
1990	15,937	1994	19,281
1991	16,929	1995	20,097
1992	19,239	1996	19,465
1993	19,771	1997	19,371

Those who served as President are listed in Table 2. Tariq Durrani was the first non-U.S.-resident to serve as Society President.

Table 2
Presidents of the Signal Processing Society in the 1990s

John G. Ackenhusen was born on 13 April 1953 in South Charleston, West Virginia. In the space of three years, from 1975 to 1977, he received five degrees from the University of Michigan: B.S., B.S.E., M.S., M.S.E., and Ph.D. He worked at Bell Laboratories, where in 1981 he became head of the Speech Recognition Group and in 1988 of the Signal Processing Systems Design Department. In 1991 he joined the Environmental Research Institute of Michigan (ERIM) to lead its Image and Signal Processing Laboratory. Ackenhusen has performed and directed research and development in real-time signal processing, both developing algorithms and designing computer architectures. Besides serving as President of the Signal Processing Society in 1990 and 1991, he was IEEE Division IX Director in 1994 and 1995. He was named IEEE Fellow "For contributions in real-time digital signal processing for speech applications."
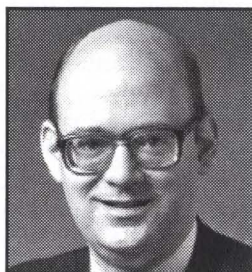
David C. Munson, Jr. was born on 19 October 1952 in Red Oak, Iowa. He received the B.S. degree from the University of Delaware in 1975 and the M.S., M.A., and Ph.D. degrees from Princeton University in 1977, 1977, and 1979 respectively. Since then he has been on the faculty of the University of Illinois at Urbana-Champaign. His research has concerned a variety of topics in signal and image processing, with an emphasis on computational imaging, especially synthetic aperture radar. For many years he has worked for the Society, including as President for 1992 and 1993 and as founding editor-in-chief of *Transactions on Image Processing* from 1992 through 1995. He was named an IEEE Fellow "For contributions to synthetic aperture radar and Fourier-offset imaging."

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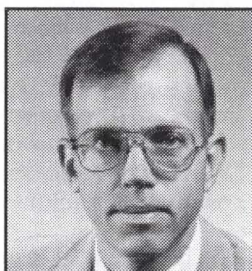
2 Data for 1990, 1991, and 1992 are from the *Annual Report of the Secretary of the Institute*. The totals include student members and affiliate members.

Table 2 (continued)
Presidents of the ASSP Society in the 1990s

Tariq S. Durrani was born on 27 October 1943 in Amraoti, India. He received a bachelor of engineering degree from the Engineering University in Dhaka, before earning M.Sc. and Ph.D. degrees in electronics at the University of Southampton. Since 1982 Durrani has been professor at the University of Strathclyde, Scotland, where he is now head of the Signal Processing Division and director of the Centre for Parallel Signal Processing. His research has concerned spectral analysis, adaptive array processing, image processing, and neural networks. Besides his many activities in the Signal Processing Society, which include the general chair of ICASSP89, various editorships, and the presidency in 1994 and 1995, he has served IEEE as Chair of the Committee on Technology Assessment Opportunity and in other capacities. In addition, he chairs the Scottish Electronics Technology Group, an entity, composed of leading industrialists and academics, created by the government in 1983 to promote the electronics industry. He was named an IEEE Fellow "For contributions to signal processing and leadership in engineering education."
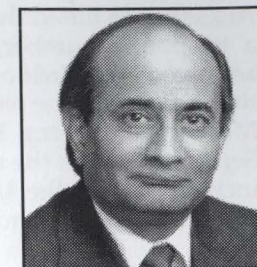
Don H. Johnson was born on 9 July 1946 in Mount Pleasant, Texas. He attended MIT, where he received the S.B. and S.M. degrees in 1970 and the Ph.D. degree in 1974. In 1977 he joined the faculty of Rice University in Houston, Texas, where he is currently Professor of Electrical & Computer Engineering and of Statistics. Johnson has served the Society in many capacities, including as President for 1996 and 1997. His research concerns statistical signal processing, particularly non-Gaussian problems. He was named IEEE Fellow "For contributions to the modeling of auditory systems and to array processing methods."
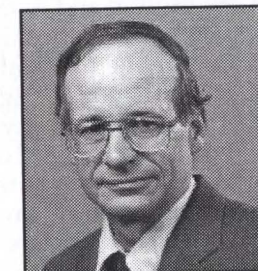
Leah H. Jamieson was born on 27 August 1949. She received the B.S. degree in mathematics from MIT. From Princeton University she received the M.A. and M.S.E. degrees and the Ph.D. degree in electrical engineering and computer science. She is currently Professor at Purdue University. Her research includes the areas of speech processing, engineering education, and the design of parallel algorithms and software tools for signal-processing applications. Jamieson has been active in the Society on the Board of Governors and on many committees, and she is President for 1998 and 1999. She was named an IEEE Fellow "For contributions to the design and characterization of parallel algorithms for speech, image, and signal processing applications."

[Panos Papamichalis, who is currently President Elect, will be President for 2000 and 2001.]

Early in the decade, because of the growth of Society activities, the AdCom began discussions with IEEE staff and volunteer leaders about creating a full-time Society staff, headed by a Chief Executive Officer.[3] In 1992 John Ackenhusen noted these advantages: "Our Society will have an address, a telephone number, a repository and distributor of information, an advocate and birddog located within IEEE, and a continuous presence that transcends the temporary terms of officers and other volunteers."[4] In March 1993 Mercy Kowalczyk, formerly Director of IEEE Corporate Services, became the new Executive Director of the Society.[5] Society staff increased with the hiring of Theresa Argiropoulos as Administrative Assistant in 1993 and Nancy Diblasi as Administrator, Publications, in 1995. Argiropoulos became Administrator, Operations, and in 1996 Deborah Blazek was hired as Administrative Assistant.

Because the Society had grown and changed in other ways, major revisions of the Constitution and Bylaws were called for. A number of Society leaders, including Tom Crystal, Leah Jamieson, Maureen Quirk, and Sid Burrus, made substantial progress toward reaching an appropriate document. In 1993 Mercy Kowalczyk, working with the guidance of then President David Munson, brought the task to completion, and the new Constitution and Bylaws were approved by the AdCom in October 1993.[6] Instead of an Administrative Committee consisting of the Society officers and nine members-at-large, the Society would be headed by a Board of Governors consisting of the Society officers and 12 members-at-large.[7] Perhaps because any 20-person entity is likely to be cumbersome and unwieldy, the Board of Governors was soon being referred to as the BoG,[8] and a smaller Executive Committee was created, which was empowered to meet and to act on Society matters between the twice-yearly meetings of the Board.[9] There were some other changes to the Society organization.[10] (See Table 3.)

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3 Richard Cox, helped especially by Maureen Quirk and David Munson, was the Society leader who did most to bring about this change.
4 *IEEE Signal Processing Magazine*, January 1992, p. 4.
5 *IEEE Signal Processing Magazine*, April 1993, p. 4. Initially, Kowalczyk's title was Chief Executive Officer; it was soon changed to Executive Director to match the practice of other IEEE Societies.
6 *IEEE Signal Processing Magazine*, January 1994, pp. 4-6.
7 The officers are the President, the President-Elect, the Past-President, the Secretary, the Vice-President for Awards and Membership, the Vice-President for Finance, the Vice-President for Conferences, and the Vice-President for Publications. Also on the Board of Governors are four people who serve ex-officio without vote: the Division IX Director (an IEEE volunteer), the Society Executive Director, the Staff Director of IEEE Technical Activities, and the IEEE General Manager (the last three IEEE staff positions).
8 Or so Don Johnson said in 1997 [*IEEE Signal Processing Magazine*, September 1997, p. 8].
9 The Executive Committee consists of the Society officers and, as non-voting ex-officio member, the Society Executive Director.
10 One important change was to insure that there would be turnover on the technical committees, which in some cases had been run by the same people for many years.

Table 3
The Boards and Committees of
the Signal Processing Society in 1997[11]

Board of Governors
Awards Board
Conference Board
Publications Board

Chapters Committee
Education Committee
Finance Committee
Membership Committee
Nominations and Appointments Committee
Technical Directions Committee

[The Technical Committees are listed in Table 4.[

In 1993 a revised statement of the Society's field of interest was approved: "The Signal Processing Society addresses the theory and application of filtering, coding, transmitting, estimating, detecting, analyzing, recognizing, synthesizing, recording, and reproducing signals by digital or analog devices or techniques. The term 'signal' includes audio, video, speech, image, communication, geophysical, sonar, radar, medical, musical, and other signals."[12] In 1996 the Society also adopted a logo (Figure 1); it became a registered mark in 1997.
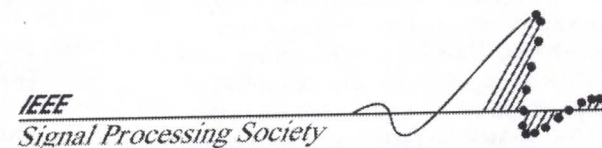
Figure 1. In 1996 the Society selected this logo, which was designed by Gabriel Thomas, at the time a graduate student in signal processing at the University of Texas, Austin.

> **Whereas few undergraduates put much stock in the idea that the twisting and mixing prescribed by convolution is a reasonable way to compute an output from an input, even fewer of them would buy the notion that this mess could be untangled, or 'deconvolved', to recreate the input ... we would completely lose our credibility with the first-time convolver by suggesting the possibility of 'blind' deconvolution.**
> **Larry Paarmann, Signal Processing Magazine, May 1996, p. 22.**

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11 *IEEE Transactions on Signal Processing*, vol. 45 (1997), no. 1.
12 *IEEE Signal Processing Magazine*, March 1995, p. 42.

Table 4
The Technical Committees of the Signal Processing Society in 1997[13]

Audio and Electroacoustics
Design and Implementation of Signal Processing Systems
Digital Signal Processing
Image and Multidimensional Signal Processing
Multimedia Signal Processing
Neural Networks for Signal Processing
Speech Processing
Statistical Signal and Array Processing
Underwater Acoustics

[In 1991 the Multidimensional Signal Processing Committee, recognizing the importance of image and video processing, voted to change its name to the Image and Multidimensional Signal Processing Committee.]

The Audio and Electroacoustics Technical Committee continued its biannual Workshop on Applications of Signal Processing to Audio and Acoustics, and the DSP Committee continued its biannual Digital Signal Processing Workshop. The Image and Multidimensional Signal Processing Committee continued its biannual Workshop on Image and Multidimensional Signal Processing, and also co-sponsored (with IEEE Circuits and Systems and EURASIP) a biannual workshop series on Visual Communications and Image Processing. The DSP Committee and IMSP Committee, together with the Circuits and Systems Society, sponsored a series, Workshop on Nonlinear Signal and Image Processing, the first held in 1993 in Tampere, Finland, the second in 1995 in Neos Marmaras, Greece, and the third in 1997 on Mackinac Island, Michigan.[14]

> *Thomas Huang*: One point I want to make again is that the trend now is for different fields to come together to work on interdisciplinary problems. Where I am at Beckman, I see several such interactions. One is signal processing, image processing and computer vision coming together with computer graphics--in many applications you need analysis as well as synthesis, like in the modeling approach to video compression. The other interdisciplinary effort is in multi-modality, the merging of image analysis with speech in solving problems. So, I think we'll see more and more of these interdisciplinary efforts. In another example, we are getting into image video databases, so we have to work together with people in computer science, data structure, and information retrieval.
>
> *Thomas S. Huang oral-history interview*
> *20 March 1997, p. 30.*

Early in the decade the Technical Committee on VLSI for Signal Processing changed its name to the Committee on the Design and Implementation of Signal Processing Systems to reflect the wider scope of the committee's activities (including the embedded software and the design methodologies). Its workshop became annual rather than biannual as in the 1980s and changed its name in 1997 to Workshop on Signal Processing Systems. Almost all of these workshops resulted in an edited volume *VLSI Signal Processing* published by IEEE Press; ten of these influential books had been published by 1998.[15]

> It is a universally accepted fact that SP engineers are charming, good-looking, and well above average in almost every way, so it's not surprising that in matters of dating and romance, we are among the most desired of partners. However, this guy was taking advantage of this fact to a degree which made this midwesterner more than bit uncomfortable. This man had so many "girlfriends" that the "Peggys" alone had to be further categorized by an identifying alphabetic character. He seemed to favor "J-Peg" and "M-Peg" because he kept offering to show me images of them created on his workstation.
>
> *Jack Deller, Signal Processing Magazine,*
> *October 1994, p. 4.*

The Neural Networks for Signal Processing Committee, formed in 1990, ran a series of annual workshops that were well attended and organized a number of special journal issues.[16] Its members represented the Society in the IEEE Neural Networks Council and contributed greatly to the Council's conferences and publications.[17]

In 1996 the Society established a new Technical Committee, for Multimedia Signal Processing, with the objective of promoting SP research for technologies that process multiple signal sources (speech, music, text, image, and video) and to bring together engineers from the communications, computer, and networking communities.[18] It soon organized its first workshop, held 23-25 June 1997 in Princeton, New Jersey, and began work toward establishing a *Transactions*.[19]

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13 *IEEE Transactions on Signal Processing*, vol. 45 (1997), no. 1.
14 *IEEE Signal Processing Magazine*, November 1996, p. 83.

15 Jan M. Rabaey, ed., "VLSI design and implementation fuels the signal-processing revolution" (*IEEE Signal Processing Magazine*, January 1998, pp. 22-37).
16 The workshops were held in Princeton, New Jersey in 1991, in Helsingor, Denmark in 1992, in Linthicum Heights, Maryland in 1993, in Ermioni, Greece in 1994, in Cambridge, Massachusetts in 1995, in Kyoto, Japan in 1996, and in Amelia Island Plantation, Florida in 1997.
17 Neural Networks for Signal Processing Committee, "The past, present, and future of neural networks for signal processing" (*IEEE Signal Processing Magazine*, November 1997, pp. 28-48).
18 *IEEE Signal Processing Magazine*, July 1996, p. 24.
19 The workshop proceedings, published by IEEE Press, included a CD-ROM. It not only contained all papers but also "animated demonstrations in the HTML format, which enables hyper-linking of audio, images, and video for a truly *multimedia* presentation." [Tsuhan Chen, Aggelos Katsaggelos, and Sun Yuan Kung, eds., "The past, present, and future of multimedia signal processing" (*IEEE Signal Processing Magazine*, July 1997, pp. 28-51).]

> I feel very fortunate that people like Ben Gold, Charlie Rader, and Richard Lacoss are at [Lincoln] Lab where I can see them every week. It kind of brings the technology alive for me to hear about how some of the ideas we take for granted today had to be developed, tested, and proven with the '60s technology. It makes me realize that my job is to try and be creative enough to conceive and develop the ideas that will be taken for granted in the '20s (that's 2020s) with the paltry technology of the '90s.
> *Dan Dudgeon, Signal Processing Magazine, July 1996, p. 12.*

The Speech Processing Committee organized workshops on automatic speech recognition and on speech coding for telecommunications. Among the activities of the Statistical Signal and Array Processing Committee was a biannual Statistical Signal and Array Processing Conference. It also organized a biannual series of signal-processing workshops on higher-order statistics. The Underwater Acoustic Signal Processing Committee also organized workshops.

The growth of Society publications and meetings strained existing procedures, and in 1990 a New Technology Directions Committee, chaired by David Munson, was formed to consider "options for increasing the focus of the Society on the individual needs of a diversity of members while growing in response to an ever-broadening field."[20] One such option was specialization in Society publications.

In 1982 the Society published about 1000 pages in *Transactions*. In 1986 the page total was 1687, and in 1991 it reached 2749.[21] This was about the largest number of pages annually that could be accommodated in one *Transactions*. Another, and more serious problem, was that Society members working in image processing were in many cases sending their work elsewhere because the Society had no journal focused on image processing. The proposal to establish a second Society *Transactions*, the quarterly *IEEE Transactions on Image Processing*, met with considerable opposition from other IEEE Societies, some seeing it as an intrusion on their territory and some arguing that it was not necessary. David Munson led the fight to win approval for the new journal, and when it was established in 1992 he was named Editor-in-Chief.[22] The journal was an immediate success, and it quickly moved from quarterly to monthly publication.

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20 *IEEE ASSP Magazine*, October 1990, p. 2. The quotation is from President John Ackenhusen's column. Delores Etter was the principal proponent of setting up the New Technology Directions Committee.
21 *IEEE Signal Processing Magazine*, October 1992, p. 11.
22 *IEEE Signal Processing Magazine*, October 1991, p. 2. Because image processing is a concern of other IEEE Technical Societies, a steering committee for the new *Transactions* was established with representatives from all interested Societies and Councils, its purpose being to monitor the new journal to "minimize any negative impact to existing *Transactions* that include image processing as part of their scope" [*IEEE Signal Processing Magazine*, October 1991, p. 4]. Some other IEEE journals concerned with image processing were *Transactions on Circuits and Systems for Video Technology*, *Transactions on Medical Imaging*, and *Transactions on Pattern Analysis and Machine Intelligence*.

> In the first half of this century, what engineers dreamed about doing was limited by hardware: vacuum tubes and RLC circuits. In the second half, digital computers made algorithm and computational speed the only limitations. Digital signal processing took off in the mid-1960s, when computer availability, the rediscovery of the fast Fourier transform by Jim Cooley and John Tukey, and the publication of the book by Ben Gold and Charlie Rader occurred within a few short years. During this period and years thereafter, algorithms drove applications. ...So many applications were around that finding one was easy because the underlying technology had many obvious advantages. While exceptions do exist (wavelets, for example), the field largely no longer works that way. Take it as a sign of a mature (but not ancient) field that applications drive new algorithms.
> *Don H. Johnson, Signal Processing Magazine, November 1996, p. 12.*

At the same time the Society began considering establishing a transactions on speech processing and a special type of transactions for the rapid publication of research results in all the technical areas of the Society (later called *Signal Processing Letters*). The *Transactions on Speech and Audio Processing* began publication in 1993, and *Signal Processing Letters* the following year. These publications were "unbundled" from Society membership, so that each member received, besides the magazine (which all received), only those publications he or she wanted (and was willing to pay a small amount extra for). With continuing specialization in publications and conferences, it was hoped that *Signal Processing Letters* would, as Munson put it, "be the 'glue' of our society, where a member working on any single aspect of signal processing can be exposed to concise treatments of new ideas from other areas."[23] A listing of the editors-in-chief of the Society publications is given in Table 5.

In 1994 Society President Tariq Durrani reported that the splitting of the *Transactions* was a success: "It has led to increased circulations, an increase in the total number of pages now published in Transaction form by the Society, a cutback on the backlog of publications, and a continually increasing rate of quality submissions."[24] The expansion is to continue with establishment of *Transactions on Multimedia Signal Processing*, scheduled to begin publication in 1999.[25] The Society also co-sponsored four other IEEE *Transactions*, ones on Evolutionary Computation, Fuzzy Logic, Medical Imaging, and Neural Networks. In addition, the Society produced and marketed video courses on particular topics in signal processing (based on tutorials prepared for Society conferences).[26]

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23 *IEEE Signal Processing Magazine*, October 1993, p. 8.
24 *IEEE Signal Processing Magazine*, October 1994, p. 8.
25 *IEEE Signal Processing Magazine*, July 1997, p. 10.
26 *IEEE Signal Processing Magazine*, November 1996, pp. 81-82, and March 1997, pp. 69-70.

Table 5
Editors of the Society Publications in the 1990s

IEEE Transactions on Acoustics, Speech, and Signal Processing
1984-1990   Pierce Wheeler, Managing Editor

IEEE Transactions on Image Processing
1992-1995   David C. Munson, Jr., Editor-in-Chief
1996-   Alan C. Bovik, Editor-in-Chief

IEEE Transactions on Signal Processing
1992-1995   Delores M. Etter, Editor-in-Chief
1996-   Jose M.F. Moura, Editor-in-Chief

IEEE Transactions on Speech and Audio Processing
1993-1996   Dan Kahn, Editor-in-Chief
1997-   Biing-Hwang (Fred) Juang, Editor-in-Chief

Signal Processing Letters
1994-   Ahmed H. Tewfik, Editor-in-Chief

IEEE ASSP Magazine
1989-1990   S. Tom Alexander, Editor-in-Chief
1990   John R. Deller, Jr., Editor-in-Chief

IEEE Signal Processing Magazine
1991-1992   John R. Deller, Jr., Editor-in-Chief
1993   Gregory H. Wakefield, Editor-in-Chief
1994-1996   John R. Deller, Jr., Editor-in-Chief
1997-   Aggelos K. Katsaggelos, Editor-in-Chief

[In the 1990s the Society expanded its publication program, splitting Transactions into three journals and adding Signal Processing Letters.]

Signal Processing Magazine, extremely well received by the members, became a major signal-processing journal, as some of its papers came to be among the most cited in the field. In 1995 it went from quarterly to bimonthly publication. Jack Deller, editor-in-chief for six years, was the person most responsible for this great success.[27] Society President Don Johnson wrote, "It is impossible to express the degree of sincere thanks I feel for Jack Deller's editorship. Because of him magazine articles have improved in quality and timeliness, and the magazine has become a major voice of signal processing ideas."[28]

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27 The magazine received many honors, such as the award in 1996 of the Donald G. Fink Prize (for the best tutorial paper in any IEEE publication) to Ali Sayed and Thomas Kailath for their article on adaptive RLS filtering that appeared in *Signal Processing Magazine* in July 1994, and the magazine cover of September 1996 was honored, from among 1000 entries, by the Art Directors Club of New Jersey [*IEEE Signal Processing Magazine*, May 1997, p. 16].
28 *IEEE Signal Processing Magazine*, January 1997, p. 14.

Interviewer: Isn't that a general trend, that digital signal processing is expanding its domain?
Bede Liu: Yes. People ask me, "What are you working on?" I say, "I'm doing digital signal processing," and I say it with such pride, and complacency. It's a little bit of the herd instinct. I belong to the blue tribe, which is better than the others. It's almost like computers. Computers now are so prevalent. They are almost every place. You say, "I work on computers," and it doesn't give that much information. Signal processing is getting to a point where it will be almost every place. It probably is unnecessary to toot the horn for signal processing—it's proven!
Bede Liu oral-history interview 10 April 1997, pp. 38-39.

The Society made a number of steps toward electronic publishing. In 1992 the Image and Multidimensional Signal Processing Technical Committee initiated an electronic newsletter.[29] Proceedings of ICASSP were made available on CD-ROM beginning in 1993.[30] (ICASSP was one of the first IEEE conferences for which this was done.) In 1996 Ahmed Tewfik, Mos Kaveh, Don Johnson, and other Society leaders began working with IEEE Publications staff to provide Web access to SPS journals, and this began in 1997 when *Signal Processing Letters* was one of the first IEEE publications to be made available online.[31] The next year all Society *Transactions*, as well as *Letters*, were available online.[32] In 1997 Richard Cox, SPS Vice President for Publications, began working toward the goal of having the algorithms and data associated with an article available online so that a reader could judge algorithms directly, even applying them to other data sets.[33]

Society activity at the local level increased during the 1990s. In 1994 there were 56 active Chapters; just three years later there were 71.[34]

Recognition of achievement in signal processing remained an important activity of the Society. The winners of the Society's three highest awards in the 1990s are listed in Tables 6, 7, and 8. In addition to these awards, the Society continued to recognize the authors of outstanding papers (by the Senior Award and the Paper Award, the latter restricted to authors less than 30 years of age).[35] In 1993 was added a *Signal Processing Magazine* Award to honor authors of exceptional papers that appeared in the Society magazine.

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29 *IEEE Signal Processing Magazine*, April 1992, p. 19.
30 David Munson, Barry Sullivan, and Mos Kaveh deserve much of the credit for bringing this about.
31 Don H. Johnson, "Signal Processing Letters goes online" (*IEEE Signal Processing Magazine*, January 1997, pp. 22-23). Five other *IEEE Transactions* were made available online at the same time, but *Signal Processing Letters* was the most popular [*IEEE Signal Processing Magazine*, May 1997, p. 8].
32 For each journal a member subscribes to, he or she elects whether to receive print, electronic access (with archive CD-ROM delivered later), or print plus electronic formats [*IEEE Signal Processing Magazine*, January 1998, p. 12].
33 *IEEE Signal Processing Magazine*, January 1998, p. 6.
34 *IEEE Signal Processing Magazine*, April 1994, p. 11.
35 *IEEE Signal Processing Magazine*, July 1991, p. 2.

Table 6
Society Award

1990	Thomas Kailath	1994	C. Sidney Burrus
1991	Thomas S. Huang	1995	James H. McClellan
1992	Bishnu S. Atal	1996	Fumitada Itakura
1993	Robert M. Gray	1997	Frederick Jelinek

Table 7
Technical Achievement Award

1990	Robert W. Broderson	1994	Thomas P. Barnwell, III, and Louis L. Scharf
1991	Richard A. Roberts	1995	Teuvo Kohonen and Sanjit K. Mitra
1992	Sun-Yuan Kung	1996	Murat Kunt and Petre Stoica
1993	David G. Messerschmitt and John W. Woods	1997	Robert M. Gray and Boaz Porat

Table 8
Meritorious Service Award

1990	Delores M. Etter	1994	David C. Munson, Jr.
1991	Maureen P. Quirk	1995	Panos E. Papamichalis
1992	John G. Ackenhusen	1996	James R. Deller
1993	Thomas H. Crystal	1997	Alan C. Bovik

As always, the Society participated in IEEE awards, including Fellow status.[36] In 1997 the IEEE established a new Institute honor, the IEEE Jack S. Kilby Signal Processing Medal.[37] The idea for this medal came from Tariq Durrani and Panos Papamichalis, who secured the sponsorship of Texas Instruments, and Leah Jamieson led the effort to win IEEE approval. The first Kilby Signal Processing Medal was given jointly to Ben Gold and Charles Rader.[38] In 1998 Thomas G. Stockham, Jr. received the award. The U.S. National Medal of Science and the National Medal of Technology are the nation's highest honor for scientific and technological achievement. At least four Society members (two of them former Society Presidents or Group Chairmen) have received these medals: in 1990 Marvin Camras received the National Medal of Technology; in 1996 James Flanagan received the National Medal of Science; and in 1997 Ray Dolby and Robert E. Kahn each received the National Medal of Technology.[39]

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36 As of January 1995, 358 members of the Society had been elected to Fellow status [*IEEE Signal Processing Magazine*, January 1995, p. 52]. Remarkably, Society members have won the IEEE Education Medal on five occasions: Lotfi Zadeh in 1973, Joseph W. Goodman in 1987, Alan Oppenheim in 1988, Ronald Schafer in 1992, and Thomas Kailath in 1995 [*IEEE Signal Processing Magazine*, May 1995, p. 16].

37 Tariq Durrani (Society President), Leah Jamieson, and Sally Wood (Society Vice President for Awards and Membership) played large roles in the creation of this IEEE award [*IEEE Signal Processing Magazine*, September 1997, p. 10, and January 1998, p. 6].

38 The most important achievements of the co-recipients are described in Don Johnson's article "Rewarding the pioneers" (*IEEE Signal Processing Magazine*, March 1997, pp. 20-22).

39 *IEEE Signal Processing Magazine*, July 1997, p. 10.

ICASSP maintained its excellent tradition. In the 1990s, three of them took place outside the United States, and ICASSP 2000 is scheduled to take place in Istanbul. (See Table 9.)

Table 9
The International Conference on Acoustics, Speech, and Signal Processing During the 1990s

1990 **Albuquerque**, New Mexico 3-6 April Conference Chair: Delores M. Etter Technical Program Chair: Nasir Ahmed	For the first time there was a Tutorial Day, organized by the SPS Education Committee, on the day before the conference; video tutorials were made that were later marketed. Attendance exceeded 1700.
1991 **Toronto**, Ontario 14-17 May Conference Chair: Y.T. Chan Technical Program Chair: A. N. Venetsanopoulos	Again there was a tutorial day on the day before the conference.
1992 **San Francisco**, California 23-26 March Conference Chair: Marcia Bush Technical Program Chair: Michael Portnoff and Gary Kopec	In a plenary session Jim Cooley and John Tukey presented the history of the FFT.
1993 **Minneapolis**, Minnesota 27-30 April Conference Chair: Mos Kaveh Technical Program Chair: Jan Allebach and Kevin Buckley	There were four special sessions: SP education, SP in advanced manufacturing, biomedical SP, and digital video. For the first time, proceedings were made available on CD-ROM. Attendance exceeded 2000.
1994 **Adelaide**, South Australia 18-22 April Conference Chair: Robert E. Bogner Technical Program Chair: Boualem Boashash	For the first time ICASSP was held in the Southern Hemisphere.
1995 **Detroit**, Michigan 9-12 May Conference Chair: Alfred Hero Technical Program Chair: William J. Williams and Andrew Yagle	The theme of the 20th ICASSP was Interdisciplinary Applications of Signal Processing, and there were special sessions on automotive, astronomical, biological, biomedical imaging, educational, environmental, and undersea applications.
1996 **Atlanta**, Georgia 7-10 May General Chair: Monson Hayes Technical Program Chair: Mark A. Clements	For the first time, ICASSP revisited a city, which this year was the city of the Olympics. Some 1900 attendees saw some 900 presentations. The CD-ROM proceedings included speech samples as well as the conference papers.

Table 9 (continued)
The International Conference on
Acoustics, Speech, and Signal Processing During the 1990s

1997 Munich
21-24 April
General Chair: Manfred Lang
Technical Program Chair: Josef A. Nossek

There were stately opening ceremonies in the Philharmonic Hall of the Gasteig Culture Center and a convivial banquet in a beer hall. In the final sessions of the conference, experts in the different technical areas presented summaries of and commentaries on key papers presented earlier in the conference. There were some 1800 registrants and 850 presentations.

1998 Seattle, Washington
12-15 May
General Chair: Les Atlas
Technical Program Chair: Hynek Hermansky
and Jenq-Neng Hwang

Several events at ICASSP98 will celebrate the Society's 50th birthday.

1999 Phoenix, Arizona
14-19 March
General Chair: Andreas Spanias and
Douglas Cochran
Technical Program Chair: W. Bastiaan Kleijn
and Joseph Picone

Social events will include a tour to the Grand Canyon.

2000 Istanbul
22-26 May
General Chair: Hüseyin Abut and Levent
Onural
Technical Program Chair: A. Murat Tekalp
and Bülent Sankur

For its silver anniversary, ICASSP has the slogan "Let us meet where the continents meet".

[The 1990s began with the Fifteenth ICASSP, and the millennium will close (or the new millennium will open) with the twenty-fifth ICASSP. Four of them took place outside the United States.]

Shortly after ICASSP96 took place in Atlanta, that city was the site of the Olympics Games. A member of the Society's AdCom helped carry the torch to the Olympic site. (See Figure 2.)

> "I have a confirmed reservation at this hotel, and I'm told you do not have a room for me," I said incredulously. "Yes, that's correct," he confirmed. "We're sorry." "You're *sorry*? But I have a confirmed *reservation!*" I repeated in utter frustration. The desk clerk knew what was coming. His boss was not The Manager for no reason. "Sir, there's something I must explain to you about the hotel business that apparently you don't understand." "What's that?" "Sir, a *reservation* means we reserve a room—*if we have one.*"
> *Jack Deller, Signal Processing Magazine, October 1991, p. 8.*

Figure 2. Mark J.T. Smith (right), an IEEE Fellow, Georgia Tech professor, and author of many papers on signal processing, was twice a member of the U.S. Olympic Fencing Team (in 1980 and 1984). In 1996, shortly after ICASSP was held in Atlanta, Smith was part of the chain of torchbearers taking the Olympic flame to the site of the summer 1996 Games. He was at the time a member of the Society's Board of Governors.

Alan Bovik and David Munson, with the strong support of the Image and Multidimensional Signal Processing Technical Committee, worked to establish a second major international conference series, the International Conference on Image Processing (ICIP). Though there was considerable opposition to establishing a second major conference, many people felt that ICASSP had become too big and that a major annual conference devoted to the rapidly growing field of image processing would help to focus research.[40] The first and subsequent ICIPs have been highly successful and have raised the Society's profile in image and video processing. Table 10 lists the ICIPs of the 1990s.

Table 10
International Conference on Image Processing During the 1990s

1994 Austin, Texas
13-16 November
General Chair: Alan C. Bovik
Technical Program Chair: Thomas Huang
and John Woods

The tutorials were taped under studio conditions and later marketed by the Society.

1995 Washington, DC
22-25 October
General Chair: Bede Liu
Technical Program Chair: Rama Chellappa

Papers were solicited in five areas: general techniques and algorithms, computed imaging, image scanning display and printing, video, and applications

1996 Lausanne, Switzerland
16-19 September
General Chair: Murat Kunt
Technical Program Chair: Henri Maitre

781 papers out of 1515 submitted were accepted and published. The banquet dinner was also a sunset boat ride on Lake Geneva.

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40 *IEEE Signal Processing Magazine*, January 1993, p. 4.

Table 10 (continued)
International Conference on Image Processing During the 1990s

1997   **Santa Barbara**, California
26-29 October
General Chair: Sanjit Mitra
Technical Program Chair: Robert Gray
and Bobby Hunt

Only about half of the papers submitted from 46 countries and six continents could be accepted.

1998   **Chicago**, Illinois
4-7 October
General Chair: Thomas Huang
Technical Program Chair: Aggelos
Katsaggelos and Mike Orchard

The organizers claimed that ICIP "has been recognized as the premier forum for presentation of technological advances and research results in the fields of theoretical, experimental, and applied image and video processing."

1999   **Kobe**, Japan
25-28 October
General Chair: Yasuhiro Yasuda
Technical Program Chair: Shinji Ozawa and
Yoshinori Sakai

Held in the International Conference Center, ICIP-99 will be a forum for the presentation of research results, technological advances, and image-processing applications.

2000   **Vancouver**, British Columbia
10-13 September
General Chair: Rabab Ward
Technical Program Chair: Faouzi Kossentini

ICIP-2000 will be held at the Trade and Convention Centre on the waterfront in Vancouver, a city "Spectacular by Nature".

[Three of the first seven ICIPs will be held outside the United States.]

The Society continued its efforts to become transnational. Of the 20,000 members in 1995, 58 percent resided in the United States, 19 percent in Europe, 15 percent in the Pacific Rim nations, 5 percent in Canada, and 3 percent in Central and South America.[41] In 1997 of the 40 Associate Editors of the Society *Transactions*, 17 lived outside the United States (eight in Europe, one in the Near East, five in the Far East, two in Australia, and one

> It is impossible to observe a political debate or advertisement without being barraged by a flurry of hackneyed sports metaphors... we in the signal processing community [must] learn to express ourselves in a more contemporary way. In other words, we must 'catch the wave' ... Recognizing DSP as a sport will not come easy, but the alternative is to continue to be neglected and misunderstood by the lay community. It will take a team effort, and we all must give 110%. *SP Magazine* (considering a name change to *SP Illustrated* (no swimsuit issue)) welcomes your thoughts and suggestions on this important issue. Send us your best pitch.
> *Jack Deller, Signal Processing Magazine, November 1996, pp. 4-8.*

41 *IEEE Signal Processing Magazine*, January 1995, p. 44.

in South America).[42] Four of the ICASSPs listed above took place or will take place outside the U.S., and the other major SPS conference, ICIP, went outside the U.S. in 1996 and will do so again in 1999 and in 2000. In 1994 the Hong Kong Section organized a major international conference on speech, imageprocessing, and neural networks.

In another move to strengthen its presence outside the United States, the Society reached agreement in 1996 with the Ibero-American Scientific and Technical Education Consortium (ISTEC) so that members of each organization could gain access to the conferences and publications of the other at advantageous rates.[43]

The Society did not neglect its U.S. profile. For example, in 1995 it organized a dinner in Washington, DC for several dozen government leaders, where Tariq Durrani made a presentation about the importance of signal processing in the modern economy. Another example was the 1997 IEEE Media Briefing, entitled "Signal Processing: Shaping Technologies for a New Century". For this event Durrani organized an international program that showed the breadth of technologies dependent upon signal processing.[44]

The 50th anniversary of the Society in 1998 is being celebrated in a number of ways. An Anniversary Ad Hoc Committee was formed, with Yu Hen Hu as Chair. Under his direction, each of the Society's technical committees arranged for the writing of retrospective and prospective views of its technical area, and these were published serially in *Signal Processing Magazine* beginning in July 1997. (See Figure 3.) The

Figure 3. This is the first page of the first of nine articles on the occasion of the Society's 50th anniversary.

42 *IEEE Transactions on Signal Processing*, vol. 45 (1997), no. 1.
43 *IEEE Signal Processing Magazine*, July 1996, p. 24.
44 *IEEE Signal Processing Magazine*, January 1998, pp. 8-12.

IEEE History Center was commissioned to conduct a series of oral-history interviews with signal-processing pioneers, to prepare edited transcripts of these interviews, and to write a booklet on the history of the Society for distribution at ICASSP 98 and ICIP 98[45]. A birthday celebration was organized for these two conferences.

In one of the anniversary article Leonardo Chiariglione wrote "Signal processing has been one of the success stories of the last 50 years, both in terms of the way academic understanding of the discipline has been furthered and in terms of scientific results that have been converted into products that have changed the way we live." An important reason for the success of the field of signal processing has been the publications, conferences, workshops, and other activities of the IEEE Signal Processing Society. The 50th anniversary of that society is an apt occasion to review and celebrate its achievements.

SPS Past President Don Johnson has called signal processing the "stealth technology." All of your friends know what "computing" is: they can touch their PCs and, with CD-ROMs and floppies, they can even touch the once-elusive software. They all know what "communications" is: it used to mean THE PHONE COMPANY, but now includes sizzling words like 'wireless' and cool tangibles like cell phones. But how many of your friends know what signal processing is? It's a key part of innumerable visible accomplishments, ranging from stunning Mars images to voice dialing (albeit audible rather than visible) and from ultrasound images to DVD. However, it often seems that only the people who actually work in signal processing think about who we are and what we do.

Leah H. Jamieson, Signal Processing Magazine, January 1998, p. 8.

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45 In conjunction with the work commissioned by the Society, the History Center conducted additional oral-history interviews, researched the history of the Society and the history of the technical area, and presented this research in two monographs, the one in hand and Frederik Nebeker's *Signal Processing: The Emergence of a Discipline, 1948-1998* (New Brunswick, NJ: IEEE History Center, 1998). In addition, the History Center prepared a small exhibit, for the IEEE Conference Center in Piscataway, New Jersey, on fifty years of signal processing.

46 *IEEE Signal Processing Magazine,* July 1997, p. 33.

Appendix

PRESIDENTS OF THE SOCIETY

IRE Professional Group on Audio: Chairs

1949	Oliver L. Angevine
1949-1951	Leo L. Beranek
1951-1952	Benjamin B. Bauer
1953-1954	Marvin Camras
1954-1955	Vincent Salmon
1955-1956	Winston E. Kock
1956-1957	Daniel W. Martin
1957-1958	Harry F. Olson
1958-1959	Frank H. Slaymaker
1959-1960	Alexander B. Bereskin
1960-1961	Hugh S. Knowles
1961-1962	Cyril M. Harris
1962-1963	Robert W. Benson

IEEE Group on Audio: Chairs

1963-1964	Frank A. Comerci
1964-1965	William M. Ihde

IEEE Group on Audio and Electroacoustics: Chairs

1965-1966	Iden M. Kerney
1966-1967	Donald E. Brinkerhoff
1967-1968	William W. Lang
1969-1970	James L. Flanagan
1971	Reginald A. Kaenel

IEEE Group on Audio and Electroacoustics: Presidents

1972	Reginald A. Kaenel
1973	John V. Bouyoucos

IEEE Group on Acoustics, Speech, and Signal Processing:
Presidents
1974-1975   Lawrence R. Rabiner

IEEE Acoustics, Speech, and Signal Processing Society:
Presidents
1976-1977   Howard D. Helms
1978-1979   Ronald W. Schafer
1980-1981   Charles M. Rader
1982-1983   N. Rex Dixon
1984-1985   Ronald E. Crochiere
1986-1987   Thomas H. Crystal
1988-1989   Delores M. Etter
1990-1991   John G. Ackenhusen

IEEE Signal Processing Society: Presidents
1992-1993   David C. Munson, Jr.
1994-1995   Tariq S. Durrani
1996-1997   Don H. Johnson
1998-1999   Leah H. Jamieson
2000-2001   Panos Papamichalis

Appendix

AWARD WINNERS

Pioneer in Speech Communication Award
(forerunner of Society Award)
1967   Homer W. Dudley
1972   Franklin S. Cooper

Society Award
1975   James L. Flanagan
1976   no recipient
1977   Henry S. McDonald
1978   Hans Wilhelm Schuessler
1979   Alan V. Oppenheim
1980   Lawrence R. Rabiner
1981   James F. Kaiser
1982   Ronald W. Schafer
1983   James W. Cooley
1984   Charles M. Rader
1985   Ben Gold
1986   Kenneth Steiglitz
1987   Thomas W. Parks
1988   John Makhoul
1989   Russell M. Mersereau
1990   Thomas Kailath
1991   Thomas S. Huang
1992   Bishnu S. Atal
1993   Robert M. Gray
1994   C. Sidney Burrus
1995   James H. McClellan
1996   Fumitada Itakura
1997   Frederick Jelinek

Achievement Award

1954	Benjamin B. Bauer
1955	Harry F. Olson
1956	Henry E. Roys
1957	Marvin Camras
1958	Daniel W. Martin
1959	Alexander B. Bereskin and Peter C. Goldmark
1960	William B. Snow
1961	J. Ross Macdonald
1962	John K. Hilliard
1963	Donald F. Eldridge
1964	C. Dennis Mee
1965	Hermon Hosmer Scott

Technical Achievement Award

1967	Daniel R. von Recklinghausen
1968	Murlan S. Corrington
1969	Hugh S. Knowles
1970	William W. Lang
1971	James L. Flanagan
1972	Ben Gold
1973	no recipient
1974	no recipient
1975	Bishnu S. Atal and James W. Cooley
1976	Alan V. Oppenheim and Charles M. Rader
1977	Augustine H. Gray, James F. Kaiser, and John D. Markel
1978	Lawrence R. Rabiner
1979	Ronald W. Schafer
1980	Thomas W. Parks
1981	Kenneth Steiglitz
1982	John Makhoul
1983	Leland B. Jackson
1984	Bede Liu
1985	C. Sidney Burrus
1986	James H. McClellan
1987	Jont B. Allen and Thomas S. Huang
1988	Thomas Kailath
1989	Benjamin Friedlander
1990	Robert W. Broderson
1991	Richard A. Roberts
1992	Sun-Yuan Kung
1993	David G. Messerschmitt and John W. Woods
1994	Thomas P. Barnwell, III, and Louis L. Scharf
1995	Teuvo Kohonen and Sanjit K. Mitra
1996	Murat Kunt and Petre Stoica
1997	Robert M. Gray and Boaz Porat

Meritorious Service Award

1970	Robert H. Rose II
1971	no recipient
1972	William Chapman and Frederick Van Veen
1973	Henry S. McDonald
1974	John J. Earshen
1975	William Chapman
1976	Lawrence R. Rabiner Charles F. Teacher
1977	Howard D. Helms
1978	James F. Kaiser
1979	James Cooley and N. Rex Dixon
1980	Harvey Silverman and Charles F. Teacher
1981	Rao Yarlagadda
1982	Maurice Bellanger and Claude Gueguen
1983	Charles Rader
1984	William E. Collins
1985	Ronald E. Crochiere and N. Rex Dixon
1986	Jont B. Allen
1987	Hiroya Fujisaki
1988	Mos Kaveh
1989	John W. Woods
1990	Delores M. Etter
1991	Maureen P. Quirk
1992	John G. Ackenhusen
1993	Thomas H. Crystal
1994	David C. Munson, Jr.
1995	Panos E. Papamichalis
1996	James R. Deller
1997	Alan C. Borik

Appendix

EDITORS OF SOCIETY PUBLICATIONS

Transactions

IRE Transactions on Audio
1954-1955   Daniel W. Martin
1955-1958   Alexander B. Bereskin
1958-1962   Marvin Camras

IEEE Transactions on Audio
1963   Marvin Camras
1963-1965   Peter Tappan
1965   Frederick Van Veen

IEEE Transactions on Audio and Electroacoustics
1966-1971   Frederick Van Veen, Editor-in-Chief
1972-1973   William E. Collins, Editor-in-Chief

IEEE Transactions on Acoustics, Speech, and Signal Processing
1974-1984   William E. Collins, Editor-in-Chief
1988   Monson H. Hayes, Editor-in-Chief

IEEE Transactions on Image Processing
1992-1995   David C. Munson, Jr., Editor-in-Chief
1996-   Alan C. Bovik, Editor-in-Chief

IEEE Transactions on Signal Processing
1991   Pierce Wheeler, Managing Editor
1992-1995   Delores M. Etter, Editor-in-Chief
1996-   Jose M.F. Moura, Editor-in-Chief

IEEE Transactions on Speech and Audio Processing
1992-1996   Dan Kahn, Editor-in-Chief
1997-   Biing-Hwang (Fred) Juang, Editor-in-Chief

Signal Processing Letters
1994-   Ahmed H. Tewfik, Editor-in-Chief

Newsletter

IRE PGA Newsletter
1950-1951   Jordan J. Baruch
1951-1952   Benjamin B. Bauer

IEEE Newsletter on Audio and Electroacoustics
1967   A. Costanzo
1968-1973   Irving Rosenblatt

IEEE Acoustics, Speech, and Signal Processing Newsletter
1974-1975   Irving Rosenblatt
1976-1978   John W. Simms
1979   Charles M. Rader

ASSP: The Newsletter of the IEEE Acoustics, Speech, and Signal Processing Society
1980-1983   Rao Yarlagadda

Magazine

IEEE ASSP Magazine
1984-1985   Nuggehally S. Jayant, Editor
1986-1987   Delores M. Etter, Editor
1989-1990   S. Tom Alexander, Editor-in-Chief
1990   John R. Deller, Jr., Editor-in-Chief

IEEE Signal Processing Magazine
1991-1992   John R. Deller, Jr., Editor-in-Chief
1993   Gregory H. Wakefield, Editor-in-Chief
1994-1996   John R. Deller, Jr., Editor-in-Chief
1997-   Aggelos K. Katsaggelos, Editor-in-Chief

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