

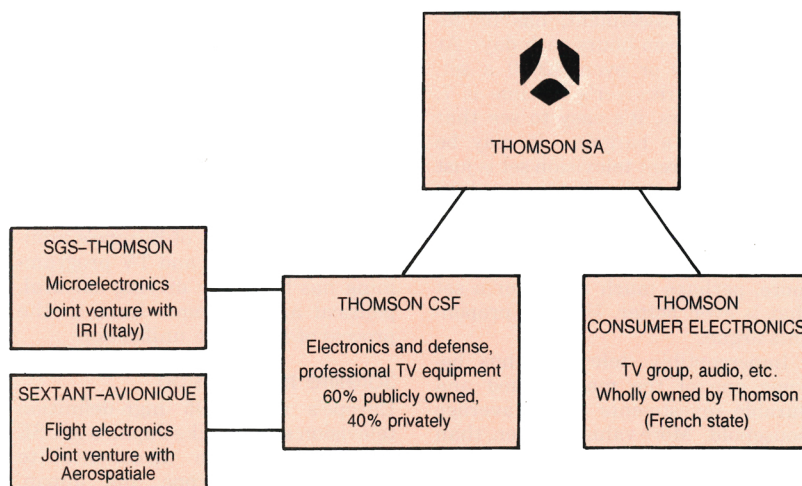
## PLANS FOR HDTV FACE VAGARIES OF MARKET, REGULATION AND LEADERSHIP

Thomas Stanley, the senior technical official at the Federal Communications Commission, is an impish young man with a very nimble mind who sits in a large corner office in Washington surrounded by mountains of reports, chewing on unlit cigars. He spends his days ruminating about all the interests that have a stake in FCC rule-making regarding HDTV—the broadcasting and cable television industries, the consumer electronics manufacturers, the entertainment programmers, makers of videodiscs and optical fiber, and of course, the American consumer and voter. He also thinks, of course, about all the technical specifications of all the advanced-television systems under development in the United States, Europe and Japan (see *PHYSICS TODAY*, March, page 57) and all the ways the various components of those systems are evolving, day to day.

At the end of such days, when he goes home, Stanley says, "I might tell my wife that soon she will be paying several thousand dollars to buy a new television because it will be rectangular and have a somewhat sharper image. And she is likely to say, 'Are you crazy?'"

Why indeed would we pay two or three thousand dollars for a better television? The standard line in the industry is that a rectangular screen will provide a more satisfying field of vision and that the larger and sharper picture will enable viewers to observe images in a much more detailed and interesting way. "High-definition television gives you a lot more choices," a Princeton student commented after seeing a demonstration at the David Sarnoff Research Laboratory in Princeton, New Jersey.

The more rectangular screen, in addition to yielding a better field of vision, will be approximately the same shape as a typical movie screen, permitting viewers to watch current films in their true form on VCRs. Until the early 1950s, films were made in a squarer format about the



**The largest TV manufacturer in the US** is France. Thomson Consumer Electronics, wholly owned by the French government, is the second largest TV manufacturer in Europe and the fourth largest in the world, and its stated intention is to be the world leader by 1995. It benefits from its connection with Thomson CSF, which does military electronics.

same as that of current TV. Therefore one reason why, say, a Tracy-Hepburn movie looks better on your current VCR than, say, one with Cher or Sylvester Stallone, is that when you watch the Tracy-Hepburn film, you're seeing the whole film; when you watch *Rocky XXVII*, you're seeing only the central part of the images, with the sides lopped off.

When one talks to people who have seen HDTV demonstrations, the striking thing is that most of them seem to come away a lot more impressed than they expected to be. Thus, when *PHYSICS TODAY* staffer Jean Kumagai visited Sony's Media World in Tokyo last summer and saw first a regular TV film done in the European PAL format, and then an HDTV film done in Japan's MUSE, she reported back that the experience was really something to write home about.

Yet a lot depends on the conditions

under which demonstrations are made, and not everybody who has seen such demos is bowled over. For example, an individual who is in the business of marketing film cassettes internationally for Columbia Pictures reports that she is quite unimpressed by HDTV. The rectangular screen and sharper images will *not*, she thinks, be enough by themselves to persuade consumers to spend a couple of thousand dollars more for their television sets. (An employee of Sony, she prefers not to be identified.)

### The economic case

Speaking with characteristic French irony, Michel Hareng—the physicist-engineer who runs Thomson's HDTV research effort—describes high definition as "a nonsense." "NTSC, SECAM [the US and French color television standards, respectively], whatever—we have a very good picture, and there's no reason to

improve it, really."

Your current television is so good, in fact, and so reliable, you'd have to do something really drastic to break it, observes Erich Spitz, senior vice president for research and development at Thomson. "There's nothing inside anymore; it's just a picture tube and chips. You move three times and it's still working." According to Spitz, the average household keeps its TV for seven years, but a current set's real lifetime is in principle more like 17 years.

The average American household, according to Congress's Office of Technology Assessment, has its television on seven hours each day. At \$300 or \$500 or even \$2000 a set, whether the receiver's lifetime is 7, 17 or 70 years, it's easy to see that television is a bargain. It may be that your current television set is just fine, really. But considering how much you watch that television and how important it has become to you, you ought to be willing to pay even more, perhaps much more, for a set that is even better, HDTV's proponents argue.

Imperceptibly, television has become one of the most valued and durable investments of the average household. More valuable, even, than the family car? "Yes," claims Marcel Annegarn, a physicist at the Philips Research Laboratory in Eindhoven, who is one of Europe's most highly regarded television engineers, "more valuable than the family car."

### Troubling dreams

When the US Advisory Committee on Advanced Television Service completes its job of testing proposed HDTV systems in 1992 and recommends a standard to the FCC, it will be Stanley's job—or his successor's—to tell his boss, the FCC chairman, whether to accept the committee's recommendation or not. One thing bound to bother a person in his position is the story of what happened the last time around, in the early 1950s, when the National Television Systems Committee adopted our current color television system.

Initially the committee awarded the standard to a system proposed by CBS that would have relied on a rotating color wheel—a system derived, conceptually, from an idea patented in 1884 by a German inventor, Paul Nipkow. But within a year RCA's David Sarnoff Research Lab came in with a proposed all-electronic system that was superior, and the committee was in the awkward position of having to say to CBS, in effect: "Oops. Never mind."

As if that were not embarrassing enough, not everybody followed suit. Japan adopted the NTSC color system a year later and introduced it into service in 1960, but the Europeans held off. Partly to improve prospects for their own manufacturers, and partly to provide better constancy of hue, Britain introduced PAL and France SECAM in 1967. While PAL and SECAM are not as vivid as NTSC and often betray a distinct flicker, which is associated with their slower frame rate (50/sec), they do indeed provide much more stable color. Since 1967, European television engineers have liked to refer to NTSC condescendingly as "Never Twice the Same Color."

Building on the success of PAL and SECAM the Europeans have developed conversion techniques that readily transfer program material between the two systems and among the various languages. As a result television has emerged as one of Europe's proudest achievements, and TV programming has become a driving cultural, political and economic force in the process of European unification.

### Satellite transmission

Europe's EUREKA-95 high-definition television system, like Japan's MUSE system, relies on direct-satellite broadcasting. Europe and Japan, which are geographically compact compared with the United States, preferred to go for HDTV systems that bypass the current broadcasting networks altogether. One important reason, in Europe, is that the broadcast spectrum already is almost fully allocated among the various national broadcasters.

Rule makers in the US, also acting primarily with the interests of the broadcast industry in mind, are insisting that proposed HDTV systems be broadcast-compatible as well as compatible with current television sets. (Pressure on the FCC to set HDTV standards came initially from the broadcast industry. The broadcasters did not particularly want HDTV, says Stanley, but gradually they resigned themselves to its coming.)

In bypassing terrestrial broadcasting systems and opting for direct satellite transmission at liberal bandwidths (about 10.5 MHz for Europe's HDTV system), the Japanese and Europeans have made the tasks of information compression and conversion relatively easy for themselves, and maybe easier than really is necessary. "It is almost as though they have decided to solve the problems of AM by inventing FM," says Stanley.

In Stanley's view, the US has set

itself a much tougher task—squeezing 30 MHz worth of information into 6 MHz of bandwidth. (Richard Wiley, the chairman of the FCC's television advisory committee, agrees with Stanley's appraisal.) But it may be that the US is giving itself an unnecessarily challenging assignment. Suppose, observes Stanley, that advances in fiber optics soon permit transmission rates that make broadcasting television not merely unnecessary or superfluous, but positively ludicrous? In that case, the fundamental premise on which rule-making has been based up to now will be void—and much of the research done to date also will be at worst irrelevant or at best of secondary value.

### Tricks of the trade

Whatever transmission and production standards are finally adopted in the US, Europe and Japan, and however much these standards may resemble or differ from one another, the technical problems facing development engineers at all the companies involved in HDTV have seemed essentially similar so far. Every system requires enormously more information to be transmitted and processed for a given television image, and for every system difficult decisions have to be made about what information can be dispensed with, how information can be consolidated and coded, and where and when information is carried and decoded.

One way of coping with the information overload is to discard information that the eye or brain can't register anyway, and so research on visual perception plays an important part in most television development programs. Philips and the University of Eindhoven support an Institute for Perception Research that, according to Annegarn, is a leader along with Japan's NHK and the US's Sarnoff.

Within EUREKA-95, the working group devoted to human perception is chaired by the Centre Commun d'Etudes de Télédiffusion et Télécommunications, located in Rennes, where Thomson maintains one of its important research labs.

Since rapidly moving objects will appear blurred regardless of how finely they are described, a standard approach to reducing information overload is to discard motion detail. A motion compensation algorithm plays a part, for example, in General Instrument's proposed digital system. Another technique, sometimes called conditional replenishment, involves analyzing images digitally so that only those elements in the images that change are transmitted.



Some compensation techniques border on the exotic. When Thomson's Hareng told us in Paris that newborn infants (and aboriginal peoples) resolve visual information equally in all directions, whereas maturing individuals (and civilized peoples) develop sharper resolution in the horizontal and vertical dimensions, and that an algorithm Thomson has developed for HDTV exploits these facts, it sounded to us at first like he was being ironic again. It takes only a little reflection to realize, however, that the ability to put things in accurate perspective is not innate at birth and that putting things into perspective involves favoring some types of visual information over other types.

## Display technology

Both Hareng and Spitz ascended in the ranks of Thomson from laboratories responsible for research on liquid crystals. All the HDTV systems currently in advanced stages of development rely on standard cathode-ray technology, but fitting CRTs to the rectangular formats required by HDTV can be problematic, and it seems unlikely that very large cathode-ray tubes could be devised for the near-term applications anticipated in medicine, business teleconferencing and the military.

Obviously a major advance in liquid-crystal displays such that flat screens of any size and dimensions could be readily produced would revolutionize HDTV. Japan's Sharp has pioneered liquid-crystal display technology (making judicious use of American inventions), and as reported in the previous installment of this story last month, the Ministry of International Trade and Industry supports a seven-year, \$100-million Giant Electronics Project, which is devoted to display technology.

But there also is a lot of skepticism about whether LCDs can be bright enough to serve as television picture elements. Sarnoff's James Carnes seems to think that some other kind of light valve may be the answer in the long run, and Sarnoff has been participating with Texas Instruments in an effort, supported by the defense Advanced Research projects Agency, to develop TI's deformable mirror device as a light valve for high-definition displays. The deformable mirror device is a silicon memory array with a movable aluminum mirror atop each memory cell. Light is modulated through the electromechanical deflection of each mirror, which depends on the charge state of the underlying storage site.

Wayne C. Luplow, the head of

## Japan's HDTV Development Strategy

*Last August PHYSICS TODAY staffer Jean Kumagai paid a visit to Sony's corporate research laboratory in Tokyo and conducted an interview with Toshiro Ozawa, a young engineer in the HD display development group, and Susumu Suzuki, general manager of Consumer High Definition Business Development.*

**PT:** How long has Sony been involved in HDTV research?

**Suzuki:** Since about 1978. NHK [the national broadcasting company] first began R&D on "Future TV" in 1965. In 1978 it first demonstrated HiVision [a prototype of the Japanese HDTV system]. Sony introduced a 1-inch high-definition VCR and a high-definition projector in 1981. The VCR was the first product Sony developed.

**PT:** How many people does Sony have doing HDTV research?

**Ozawa:** There are about 50 engineers in my lab who work specifically on high-definition research. There are others who are nonspecific—they do HD research part of the time.

**PT:** How important is the HDTV project within Sony?

**Suzuki:** It has been given the status of "corporate project." There are maybe less than ten corporate projects, like consumer VCRs or computers. That makes it one of the highest-priority projects at Sony.

**PT:** What is Sony's relationship with NHK?

**Ozawa:** NHK is actually leading the research effort and they set the standards. The companies—Toshiba, Matsushita, Mitsubishi, Sony, Hitachi—make contracts with NHK to use the basic technology and develop applications. NHK holds the patents on the basic technology. Each company develops its own equipment. On the more costly projects, such as LSI chip development, the companies sometimes agree to work together.

**PT:** How does your company work with other Japanese companies?

**Ozawa:** In general there is almost no exchange of information between companies. Of course we have to tell NHK what we are doing because we have a contract with them. For example, I am part of the project to develop a MUSE decoder, which does the data decompression on the receiver end. It is mostly digital signal processing, making use of large-scale integrated chips. In the first stage of the project, making the decoder with discrete [noncustom] ICs, Sony collaborated to make LSI chips. So Sony is making one part of the decoder, Panasonic is

making one part, and Hitachi is making one part, based on information provided by NHK. We are just completing the first-stage decoder, which has about 50 chips and costs about \$14 000. Obviously it is not for ordinary people!

In the second stage, which is to be completed by 1992, our objective is to reduce the number of chips in the decoder from 50 to 10, which will make the price tag look more realistic. At this stage, some companies will do everything by themselves, while others will seek partners.

**PT:** What are your plans for entering the US market?

**Suzuki:** We have no clear strategy to enter the consumer market. We're watching carefully to see which transmission system is selected by the FCC. When the trials are completed, after mid-1993, manufacturers can begin making systems [for the US market]. But the US situation is different from the one in Japan.

**PT:** How did NHK arrive at the 1125-line standard?

**Ozawa:** That is not very simple to answer. I think NHK looked at the two existing standards (525 lines and 625 lines) and decided that 1125 is the easiest to make conversions from. If the number of lines chosen is a simple proportion to existing standards, it is convenient to "down-convert" high-definition software to those standards: 1125 is  $\frac{1}{2}$  of 525 (NTSC) and  $\frac{3}{5}$  of 625 (PAL or SECAM).

Besides, from experiments NHK found that when viewing at a distance of three times picture height, the smallest object that an average person can recognize can be displayed with the resolution that 1100 scanning lines gives you.

**PT:** What kind of products is Sony working on?

**Suzuki:** There are two areas in the high-definition market—consumer and nonconsumer, for applications like medicine, studios, movie theatres, production houses. We're very interested in getting into nonconsumer areas with the 1125 system, and now have a complete lineup of products. We also plan to market to industrial customers, for closed-circuit use.



advanced television development at Zenith, comments as follows on the prospects for LCD displays: "Our feeling here—and I think it's widely shared in the industry—is that if indeed the Japanese (or anybody else) are able to come up with flat-panel displays, it's going to be very hard to compete with the entrenched technology of cathode-ray tubes. They're going to come up with displays, but we doubt that they'll have the same brightness, contrast and color fidelity that people have come to expect, and certainly not at a price that is competitive with CRTs."

### Computing and chips

The guts of every HDTV system will consist of highly specialized chips that do the gargantuan work of coding and decoding picture information. As Congress's Office of Technology Assessment pointed out last year in the opening paragraphs of its 108-page report on high-definition television, "HDTVs must process huge quantities of information at speeds approaching those of today's supercomputers in order to display a real-time, full-color, high-definition video signal. HDTVs are able to do this at relatively low cost through the use of circuitry dedicated to specialized tasks."

"HDTV is driving the state-of-the-art," the OTA report continues, "in a number of technologies that will be important to future generations of computer and communications equipment. These include certain aspects of digital signal processing for real-time video signals; high-performance displays; fast, high-density magnetic and optical data storage; technologies for packaging and interconnecting these electronics; and, as with all high-volume consumer electronics, processes for manufacturing these sophisticated products at affordable costs."

An anomalous aspect of HDTV, worldwide, is that despite the technology's apparent significance for the semiconductor and computer industries, companies in those industries have been slow to involve themselves directly in advanced-TV development. JESSI, Europe's submicron chip effort, which often is described as an adjunct to the EUREKA-95 television program, suffered a reverse last fall with the withdrawal of Philips from the SRAM project (PHYSICS TODAY, November 1990, page 79). In the US, AT&T, Texas Instruments and Motorola seem to be the only major chip manufacturers entering into important agreements with Japanese and American television developers. (TI has an

### Photography and HDTV

Skeptics say that HDTV alone—the wider screen and sharper image—will not be enough to entice consumers to spend much more for television receivers. But added attractions are easy to imagine, and some of them already are on their way, in anticipation of HDTV.

Next year Kodak is scheduled to introduce a system permitting photographers to have images on film transferred electronically to compact disks by a digital process, so that pictures can be viewed on television sets or color computer screens. The disks reportedly will contain 16 times more detail than can be reproduced on current television, and four times more than on HDTV.

The transfer of images would take place at the time film is developed, at a price of about \$20 for the first batch of 24 photographs. Disk players (also capable of reading audio CDs) might sell for around \$500.

The technology will permit amateur photographers to store photos more economically, to randomly access images and to manipulate images on-screen. Potential commercial applications—for example in publishing, banking and insurance—are legion. John P. White, a vice president of Kodak, has pointed out that the disk technology will permit commercial users to maintain much larger photo archives than is currently feasible, providing readier access and assuring perfect preservation of image quality.

Processing equipment and disks will be sold by Kodak, disk writers and the compact disk players for current television by Philips (which co-invented the audio CD), and a special workstation for photo finishers by Sun Microsystems.

agreement with NHK, and Motorola has been negotiating with Toshiba.)

### Who's ahead?

From the US point of view, the race to develop an advanced television system is resolving into a contest among three US-based groups, the European EUREKA-95 group and the Japanese group led by NHK. One of the US groups has a very strong European element (Thomson and Philips), and the Japanese group includes several companies, such as Sony, Hitachi, Toshiba and Mitsubishi, that control—like Thomson and Philips—substantial research and manufacturing operations in North America.

Largely because of its early start in HDTV and its impressive general performance in consumer electronics, semiconductors and computers, Japan is conventionally described as the leader in advanced television research, and Japan plainly intends to be the leader. At Sony, still the number-one name in television, HDTV development is at the top of the corporate agenda. The brochure for the company's Corporate Research Laboratories, which were formed in 1988 to bring all corporate research under one umbrella, characterizes HDTV as "the final major developmental project of this century." To realize HDTV, the brochure says, a digital signal decoder, a CRT and a VCR have to be designed. "The basic research on these three units has been done," the brochure says, "and prototypes are now being made."

One measure of Japan's confidence was Sony's 1989 purchase of Columbia Pictures at a cost of \$3.4 billion, which was echoed late last year in the decision by Matsushita (known in the US for the Panasonic and Technics brand names) to buy MCA for \$6.6 billion. The conventional wisdom is that the driver behind both decisions was HDTV: Sony had concluded that one important reason why the Beta-max format lost out to VHS in the VCR market, despite a decisive early lead, was that not enough films were available on Betamax; accordingly, Sony hopes with the purchase of Columbia—and Matsushita with the purchase of MCA—to build up an archive of films that will be immediately available when HDTV receivers and high-definition VCRs come onto the market.

Despite Japan's formidable position, the Europeans also express a great deal of confidence. For one thing, in contrast to their performance in, say, computers or semiconductors, the Europeans already have had a great deal of success in television. As in Japan, but in contrast to the US situation, the European HDTV effort is the product of careful central planning and strong public support. Last May, Philips and Thomson announced an agreement committing the two companies to spend 20 billion francs—about \$4 billion—on HDTV development over a five-year period. (Philips is to spend 11 billion francs, Thomson 9 billion.)

While the general position of Philips has slipped badly in the last few years because of company-wide business difficulties, Thomson's position seems stronger than ever. Under the leadership of Alain Gomez, the company has acquired major television



manufacturers in Germany, Britain and the United States, thus bringing into its fold important research laboratories, the patents to PAL and NTSC television technologies, and of course large manufacturing facilities.

Thomson Consumer Electronics is a wholly owned subsidiary of the French state and appears to have the full confidence of the current French regime. Admittedly, the government's support cannot be taken entirely for granted. In February a unit of the French Foreign Ministry produced a memorandum questioning the wisdom of the government's commitment to Europe's MAC television system at a time when fully digital systems are being discussed in the US. The memo provoked an indignant response from Thomson's corporate leadership. The company questioned whether an all-digital standard could be met by the end of the 1990s and suggested that the case for an all-digital system depends on the special requirements for terrestrial broadcasting set for the US by the FCC. "I had no idea that there were qualified electronics engineers at the Foreign Ministry," a spokesman for Thomson commented acidly.

## US and Soviet markets

Together, Thomson and Philips account for about one-third of television manufacturing in the United States, and as members of one of the three consortia competing in the FCC trials, they seem well placed to make big inroads into North America's HDTV market. In addition to that, even though the MAC systems developed for Europe require 12-MHz channels and therefore are not compatible with the 6-MHz simulcast system favored by the FCC, they may turn out to be more readily adaptable to emerging FCC standards than currently expected. NHK is developing variants of MUSE, which normally requires a 9-MHz channel, to compete in the FCC trials, and if MUSE can be adapted, it is not obvious why the same would not be true for the MAC family.

Even if MUSE and MAC cannot be successfully tailored to the standards selected by the FCC, the possibility remains that programs from either system could be transmitted by satellite into the head-end of private cable systems or telephone systems—if the "Baby Bells" are permitted to enter the television business, as is widely expected—for further transmission to homes. No obvious technical barriers stand in the way of direct satellite transmission of MAC and MUSE in the United States. And statements made in recent months by FCC Chair-

man Alfred Sikes suggest that his dreams are troubled by the specter of direct satellite transmission.

The USSR uses the SECAM color television system, and so free convertibility between Soviet and European television already is an accomplished fact. Two years ago, when Mikhail Gorbachev paid a visit to Bonn (the first state visit by a Soviet leader to the Federal Republic of Germany), the notion was hatched at a high level in the German government of making an HDTV news film of his visit. According to Bosch's Dieter Pohl, the coordinator of Germany's work in EUREKA-95, the idea was presented to the HDTV directorate and quickly won approval. The result was the first live HDTV news film ever made, Pohl says.

Obviously the officials planning Europe's future television system have been casting a sharp eye on the potential Soviet market as well as the US market.

## Setbacks and uncertainties

Effectiveness in global politics, as Henry Kissinger has been fond of saying, often is a function of the ability to "create facts." The direct participation of the French state in the European HDTV program helps give that program the capability to pursue a long-term strategy and to engender *faits accomplis* that everybody else in the world then has to adjust to. Yet the EUREKA-95 program has not been immune to glitches and disappointments.

The first high-power satellites designed to carry D2-MAC transmissions (enhanced television, not true HDTV) all suffered technical failures. As a result, there seems now to be some uncertainty as to whether HDTV customers will be able to receive programs using 40-cm dishes as originally intended, or whether they will have to purchase 60-cm dishes instead. The whole strategy of requiring customers to buy dishes is fraught with risk. Will customers be willing to invest in new receivers and dishes in order to receive D2-MAC and HD-MAC transmissions, considering that those transmissions will not be backward compatible with receivers based on PAL and SECAM?

In Britain, whose engineers played an important role in the development of the MAC transmission system (along with Philips, which developed an important algorithm), hopes for the EUREKA-95 system have been set back by Rupert Murdoch's stubborn insistence on continued use of PAL in his Sky Television network, despite a directive by the European Communi-

ty requiring satellite broadcasters to switch over to D2-MAC. British Satellite Broadcasting remained committed to MAC, but late last year it was taken over by Murdoch.

Japan's MUSE system has the advantage of being directly backed by the national broadcaster, NHK, but in Japan too, it will be the customer in the end who decides whether to invest in a dish, a receiver and converters.

—WILLIAM SWEET

## SCHMID SUCCEEDS STRASBERG AS ASA'S EXECUTIVE OFFICER

Charles E. Schmid, an acoustical engineer with over 25 years' experience in the general area of underwater acoustics, has succeeded Murray Strasberg as administrative chief of the Acoustical Society of America. Schmid recently took office as executive director, a newly created position that ASA's executive council authorized with a change in the society's bylaws in November 1990.

Schmid earned his BS at Cornell University (1963), his MS at the University of Connecticut (1968) and his PhD at the University of Washington (1977), all in electrical engineering. He worked for General Dynamics/Electric Boat in Groton, Connecticut, from 1966 to 1968 and for Honeywell Marine Systems in Seattle and Poulsbo, Washington, from 1966 to 1990. He was ASA's Congressional Science and Engineering Fellow in 1985-86.

An expert on underwater acoustics and signal processing, Schmid has done research and design work involving submarine sonars and train-

Charles E. Schmid

