Ask most insiders where the Moving Pictures Expert Group came from; who thought of it, when, and under what circumstances; how its MPEG-1 and MPEG-2 standards for digitizing and compressing audio and video imagery became so hugely influential and widely applied; and why the whole MPEG standards-setting process has succeeded where many similar efforts failed— and all roads tend to lead back to an office at a television research laboratory in Turin, Italy, occupied by Leonardo Chiariglione.

The laboratory, where he directs research on video services, is the Centro Studi e Laboratori Telecomunicazioni SpA (CSELT). Founded in the 1960s as part of the national telecommunications company then called STET, the lab is probably most closely comparable to Bell Communications Research in the United States. CSELT in fact has long collaborated with Bellcore on projects, while a long-term cooperation agreement with AT&T Corp. has just been concluded by STET, which is currently in the throes of privatization and has been renamed Telecom Italia [see "Italy—the 'Wild West' of the hertzian domain"].

And who is Chiariglione? A native of the Piedmont, in northern Italy, he grew up in a village near Turin, speaking one of the local dialects as his first language. He still lives near Turin with his wife and three children. Yet, most unusually for a Westerner in any field, he went far afield to Japan to do his doctoral dissertation.

Just about as unusually (at least by U.S. standards), his education was entirely classical and humanistic until he embarked on the study of electronics and communications research, first at Turin’s excellent polytechnic and then at the University of Tokyo. Well-grounded in classical Greek and Latin, he now can speak not only Japanese but a handful of other modern languages well enough to carry on arduous technical negotiations in them. At technical meetings, colleagues say, he knows everybody’s name and can speak to many in their own languages. In fact, said one acquaintance, “he is a man who can talk just about as knowledgeably about natural language syntax as about discrete cosine transform (DCT) compression systems.”

In a statement he issued last year, on the occasion of MPEG’s being honored with an Emmy by the U.S. television broadcasting academy, Chiariglione recalled being at a U.S. office in Turin as a teenager and seeing a poster of President John F. Kennedy addressing “the citizens of the world.” Later he was disillusioned to discover (or so he says now) that these world citizens adhered to differing television standards, and later still, as a participant in standards groups, was disappointed yet again by the members’ obdurate inability to adopt global standards for video material. So he set about putting things to rights. People have the same eyes and ears everywhere, he likes to say, and so they deserve to have uniform audiovisual standards.

ACKNOWLEDGMENTS

This is the first of two articles covering fields of electrotechnology in which Italian individuals and organizations have been making outstanding contributions. In this endeavor, the magazine has benefited greatly from assistance and advice provided by the Italian Trade Commission, New York City, and by Alessandro Gandelli, professor of electrical engineer-
Whatever hindsight or hyperbole there may be in all that, nobody denies that Chiariglione is a man of vision, who states his views forcefully, repeatedly, and bluntly. Of those who know him and the motion pictures group best, most agree that he “has to be called the father of MPEG.” But some of those who worked with him from the very beginning stress that MPEG has been a collective effort to which several leading individuals made important contributions, and that its success was due largely to all that “horsepower,” as one of them put it.

Personal feelings certainly color people’s replies when they are asked to pin down Chiariglione’s contribution to the group. One long-time collaborator attributed the man’s success to his “big ego,” another to his “peculiar personality.” Yet for all that, there is an unfailing consistency in the particulars (and his longtime collaborators are not slow to think of particulars): Chiariglione has been “a tireless force in knocking heads together” and is “very effective at getting people to stay focused”; he is “very strong-minded and opinionated” and “steps on a lot of toes but is indisputably brilliant”; he has a “strong Italian temperament,” that is, he is proud, and not unwilling to whip people into shape when he feels his views are being given short shrift; and, above all else, he is a man of honor who, “once he promises something, will stop at nothing to deliver it.”

So, Chiariglione combines vision with the technical wherewithal to figure out what is needed and the interpersonal skills to pursue his ends effectively. But he also has the will, force of character, and political savvy—not to say a Machiavellian streak—to make what he wants to happen, happen.

Once upon a time . . .

Chiariglione became seriously interested in television only after joining CSELT in the early ’70s. He had completed a theoretical dissertation in Japan on stochastic processes in telecommunications, and was assigned by CSELT to TV research. Disappointed in the mid-1980s by the failure of the International Radio Consultative Committee (CCIR) to adopt a single world standard for high-definition television (HDTV), Chiariglione convened the world’s first international workshop on the topic in 1986. He also began casting about for a venue in which more uniform standards for audiovisual material could be pursued.

He found it in March 1987, when he happened to attend a meeting of the Joint Photographic Experts Group (JPEG). This Joint Picture (Coding) Experts Group had been set up under the auspices of the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) to formulate a standard for storage of still pictures.

Chiariglione was impressed by what could be done by a group of experts who were not in thrall to any one industry. So he approached JPEG chairman Hiroshi Yasuda, who had been a fellow doctoral student at the University of Tokyo, and suggested a successor group, to grapple with standards for the digital coding of moving images. Chiariglione pointed out that JPEG's impact, however useful, would be dwarfed by the effects of similar standards for moving pictures.

This was a bold move. ISO’s charter called for its groups to set standards for information processing and storage media, but gave it no mandate to set standards for transmission, broadcasting, or telecommunications. What ISO did offer, though, was the opportunity to pursue uniform standards for digital coding of moving pictures without becoming captive to conservative interests in the video, broadcasting, telecommunications, or consumer electronics industries. Chiariglione readily persuaded Yasuda to support the creation of MPEG (and ever since, Yasuda has been Chiariglione’s so-called ISO boss, the person responsible for MPEG one level up). Formally, MPEG was constituted in 1988 and became the Joint ISO/IEC Technical Committee on Information Technology (JTC 1), Subcommittee 29, Working Group 11. In 1990 it was charged with developing standards for the coded representation of moving pictures, associated audio, and their combination when used for storage and retrieval on digital storage media.

Chiariglione was in effect bypassing the normal video standards committees, in order to give his experts a free hand. But did he know what he was up to? “He knew--he’s a very smart man,” said Cliff Reader. (Reader, until recently associate director of strategic planning at Samsung Semiconductor Inc., San Jose, Calif., and now detailed to the new Samsung company, CagEnt Technologies, in Santa Clara, has been one of the most influential MPEG participants.)

Just what is MPEG?

In 1988, when the first group of a dozen or so experts met to set an agenda, the starting point for MPEG was the possibility of reading Compact Disks (CDs) with moving pictures at rates of around 1.4 Mb/s. By most accounts, Philips Electronics NV of the Netherlands had a large stake in promoting the technology and therefore gave MPEG some of its initial impetus; but yet
The company was also a conservative player, and took some time to be persuaded of the approach adopted in MPEG-1. Ultimately, that approach prevailed, establishing a technology that soon took off in Asia, above all in the People's Republic of China. Powerful individuals in important industries, especially in Japan, took notice. (In 1996, when JPEG and MPEG were honored with their Emmy, two million MPEG-1 videodisk decoders were sold in China, with double that figure expected this year.)

The group’s intent was to put disinterested technology ahead of commercial concerns. But “Although MPEG started out as an anticipatory standard,” as Joan Mitchell, William Pennebaker, Chad Fogg, and Didier LeGall observe in a recent book [see Books, and hit your browser’s BACK button to return here], “its acceptance [was] so rapid that in many cases the applications have been ahead of the approval process. For example, even before the standard was approved, software, multimedia boards, and chips implementing MPEG-1 were already available.”

In MPEG lore, only two out of the 20 or 30 people who attended the first two MPEG meetings attended both. Yet within a few years MPEG meetings were attracting about 150 experts representing close to 100 companies in consumer electronics, computers, broadcasting, and telecommunications. From a tiny experts’ group intent on representing no single interest, MPEG had become the digital coding group that represented every interest.

MPEG-2 and television

As first conceived, MPEG-2 was to standardize the digital coding of interlaced TV pictures (in which a field made up of every other scan line is followed by another field consisting of the remaining scan lines). The coding was to occur at about 10 Mb/s, and standard digital television was the main goal. Then MPEG-3 was to formulate coding standards for pictures at 40 Mb/s, with a view to HDTV. By now, with everybody aboard, it hardly mattered that the group was sailing far from its mandate and the ISO charter.

By the time MPEG-2’s work on digital TV coding was complete, the group had met in many of the world’s chief cities—London, Paris, Berlin, Brussels, Osaka, Singapore, Seoul—as well as in the capitals of telecommunications and consumer electronics research, such as Livingston, N.J. (AT&T, Lucent Technologies, and Bellcore); Eindhoven, the Netherlands (Philips Electronics NV); Tarrytown, N.Y. (IBM Corp.); and, of course, Turin (CSELT and RAI—the Radiotelevisione Italiana Research Center). With the appearance of cable representatives at the end of 1992, every relevant industry group was on board, and within a couple of years of that, about 250 experts were showing up for every meeting.

Milestones in the evolution of the MPEG-2 standard included:

- A basic decision to allow motion compensation only at the level of macroblocks (four 8-by-8 blocks of luminance samples, plus two 8-by-8 blocks of chrominance samples), which was taken at Santa Clara, Calif., in September 1980.
- Formation of a test model ad hoc group, at Haifa, Israel, in March 1992.
- Formulation in July 1992 of a revised test model at Angra dos Reis, Brazil (with basic agreements reached on nonscalable aspects and scalable extensions).
- Adoption of the "main profile" for digital TV coding [again, see Defining Terms] in April 1993 at Sydney, where it also was decided that MPEG-2 decoders should be able to handle MPEG-1 bit-streams.

The most important decision of all was reached at Haifa and Angra dos Reis in 1992, when the head of the U.S. delegation, Reader, pointed out to the others that in formulating a successful coding profile for standard digital television, they seemed to have taken care of HDTV as well. By general acclamation it was agreed to fold MPEG-3 into MPEG-2 (hence, the otherwise mysterious jump from MPEG-2 to MPEG-4).

Within a year of its freezing the main TV coding profile at Sydney, MPEG won a major moral victory in the United States, when the Advisory Committee on Advanced Television Service recommended adopting the emergent MPEG-2 system as the core of its proposed Grand Alliance standard for HDTV. Apparently, in the advisory committee’s competition, AT&T came in with “this huge thing incorporating all relevant research,” said Chris Adams of the C-Cube Microsystems Inc. subsidiary DiviCom, Milpitas, Calif. (a company that won a technical Emmy for the first video encoding chip). But the AT&T system also was the most expensive proposed.

On the other hand, while work from MPEG may have been less exciting and "incorporated fewer innovative ideas," it won out because it was simpler and cheaper; said Adams, who, as a staff member of Hewlett-Packard Co., Santa Clara, Calif., detailed to the advisory committee, was involved in evaluating the relative costs of the various systems.

MPEG prevailed not only over the souped-up AT&T system, but also over the digital TV system invented by Woo Paik of General Instrument Corp., Chicago, and the progressive-scan variant promoted by Jae Lim and the Massachusetts Institute of Technology, in Cambridge. (Paik and Lim had been fellow graduate students at MIT.)

As Barry Haskell, a leading expert on digital picture coding at AT&T Laboratories, Florham Park, N.J., describes the
bake-off: “Most of the Grand Alliance members were also MPEG participants. So what better way to evaluate the parts of the proposed MPEG system than to run them through the advisory committee’s process? Some survived, some did not, and the result was MPEG-2. The Main Profile/High Level System with interlaced and progressive formats is basically the U.S. HDTV standard.”

“In fact,” Haskell continued, “AT&T [had] contributed a lot of technology to MPEG-2, such as motion-compensated interpolation, interlaced motion compensation, [and so on]. Moreover, none of these technologies existed before MPEG. So MPEG is something more than selecting from off the shelf. The researchers involved actually invented new technology.”

The U.S. advisory committee’s work is frequently portrayed by friend and foe alike as protective of U.S. industrial interests. But Robert K. Graves, chairman of the closely allied Advanced Television Systems Committee, disputed that view. He told IEEE Spectrum that the advisory committee pressed the Grand Alliance to adopt MPEG-2 not only because of its greater efficiency and cost-effectiveness, but expressly “for the sake of world harmonization.” And “when I say that [world television] standards are more the same than different, the first thing I’m thinking of is MPEG video compression,” Graves stated categorically.

Graves worked for AT&T and was involved with its HDTV proposals before joining the advanced TV committee as chairman in 1996. Members of the television advisory committee snickered, he said, when they first heard about MPEG. But they soon saw things differently. "It’s a remarkable process, and it’s all Leonardo Chiariglione’s doing," he said, referring to the procedures enabling numerous experts to collaboratively invent new technology on the fly.

Still, taking stock of the overall results, Graves seems deeply ambivalent. In a letter late last year to The New York Times, he complained that the U.S. broadcast and computer industries were still dickering about interlaced versus progressive display fields, yet “a far less computer-interoperable standard—begun in Europe three years after the technology was invented here in the United States—is sweeping the world, and has even been adopted for two American direct-broadcast satellite services." (Evidently, he was referring to AlphaStar and EchoStar, which rely on digital video broadcasting [DVB]--the digital TV system adopted by the European counterpart to the U.S. television advisory committee, based mainly on MPEG.)

With DVB and MPEG, Graves told Spectrum, “the Europeans have leapfrogged us” and are now “eating our lunch.” But, he said, the Europeans will soon be “looking across the pond and seeing dazzling pictures and [hearing] wrap-around sound”—the Dolby system the Grand Alliance selected in preference to MPEG’s audio component.

The Chiariglione philosophy

Ten years ago, when attempts to devise a world standard for advanced television first failed, and Japan, the United States, and Europe began charting separate courses toward high-definition TV, the casual onlooker might have had the impression that all kinds of important developments would soon take place in video coding. People often talked about matters such as the discrete cosine transform (DCT) and motion compensation as though they were revolutionary concepts that would give rise to one amazing advance after another.

That impression was fortified by General Instrument’s startling mid-1990 announcement that it had found a way to do digital HDTV in a standard broadcast environment. At the same time, since the company was the dominant player in cable set-top boxes and a pioneer in satellite downlinks, its announcement legitimized digital TV rather as IBM legitimized the PC, observes Dragos Ruiu, video strategy manager for Hewlett-Packard.

In hindsight, it is clear that the status of digital coding research was rather different. The main developments had in fact already occurred 10 or 20 years before--DCT coding, for example, already was used by the Pentagon in communications with Vietnam during the late years of the Indochina war. Those coding advances were to be sure closely associated with some individuals and institutions, notably William Pratt (formerly of the University of Southern California, currently chief technical officer for Photon Dynamics, San Jose, Calif.) and K.R. Rao (a professor of electrical engineering at the University of Texas, Arlington, previously at Purdue). But the general nature of the advances was known to academic specialists all over the world.

So it was quite a feat for the small gang of researchers who started MPEG to recognize that digital coding, far from being a nascent science, was a mature or very nearly mature discipline, ripe for transfer from academia to industry—ripe, in short, for standardization.

That said, a lot of credit also has to go to Chiariglione’s idiosyncratic leadership style and to the special approach to standards-setting that he has formulated in the nine years since convening the first MPEG meeting. The principles of
that approach are that:

- Standards should specify tools and sets of tools that can be relocated across systems--they should not specify whole systems, unique to particular applications.
- Just one tool should be assigned to any given function (though a tool can perform more than one function).
- Standards should be limited to the minimum necessary to get a job done (and, accordingly, should eschew those bells and whistles that companies, industries, and countries try to inject to secure an exclusive position for their products).
- Experts should formulate standards before industries get committed to particular solutions--that is to say, standards should lead the market, not follow it.
- Above all else, standards bodies have to stick to the deadlines they set.

“If a company makes a plan to go to market by a certain date with a certain product that requires a certain technology, and makes the necessary investments for it, the company...is not going to be happy if the standards committee--the supplier [of the technology] vis-à-vis the company--at the due date reports that they are ‘behind schedule.’” Thus wrote Chiariglione in a document currently available on his MPEG Website [To Probe Further]. And while intermediate dates in the MPEG schedules have occasionally slipped, he continued, there has been “no delay in reaching international standard status compared to the planned dates.” Conversely, “the inability of many standards committees to deliver on time has forced companies to take shortcuts, so-called [single] industry standards.”

Chiariglione’s intransigence over deadlines may seem righteous or pedantic. But that is the principle he will stop at nothing to honor.

What all this has meant for digital TV coding standards is that the customer ousted the supplier as the central concern. While almost everybody else was worrying about aspect ratios and numbers of lines, refresh rates, pixel shape, and interface versus progressive scanning, Chiariglione and MPEG were looking at moving picture coding strictly from the user’s perspective. They focused on what they considered the only essential thing: the size of the pipe carrying the bits to the consumer. MPEG succeeded where others failed, Chiariglione told Spectrum, because, for example, the ITUR (the radio division of the International Telecommunication Union) focused on the camera, MPEG on the receiver: in the digital domain, he said, the deciding factor is how many calculations the receiver can perform on a signal.

MPEG does not of course specify everything needed to make a TV set work--and does not do so by express intent--but it has managed to set the standard for digital coding of advanced television pictures. And that standard seems on its way to acceptance in Japan as well as in Europe and the United States, despite grumbling and foot-dragging by Tokyo's officialdom.

So does that mean that the industries represented in MPEG are on the verge of converging? Not at all, said Chiariglione. While content, transport means, and equipment may come together, this does not imply that the computer, broadcasting, cable, satellite, consumer electronics, and telecommunications industries also will or should converge. "The professions of barber, butcher, and cobbler have not moved a single inch to a convergence point through the millennia in spite of all sharing the common 'knife' technology," Chiariglione has written, with the bluntness that makes him somebody not to be messed with at an MPEG meeting.

The Italian connection

When challenged, Chiariglione will sometimes appeal to universal or basic principles in a way that can come across as irritatingly moralistic. For example, the Duck Corp., New York City, has claimed that its TrueMotion software is superior to MPEG-2 for interactive and linear movie playback on platforms equipped with DVD (digital video disk) ROM. Chiariglione’s comment? “A lot of companies try to make a living out of inventing a proprietary video compression algorithm, and I am sympathetic, but I don’t believe they are working for the progress of mankind.”

In moments of triumph, the rhetoric he favors can also be a little much. Accepting MPEG’s Emmy Award last year, he said, “The MPEG-1 and MPEG-2 standards provide a technology that, if not deliberately limited, enables the transfer of combined audio and video information that is end-to-end transparent, so much so that it is even able to mend the 50-year-old 525/60625/50 rift [that is, the lines and refreshment rates for the U.S. vs. European TV systems]. This is because all men are created equal, they are endowed by their Creator with certain inalienable rights, among these life, liberty, communication, and the pursuit of happiness.”

In that combination of high principle and aggression so typical of Chiariglione, there is something more than a little Napoleonic--and both, as it happens, grew up in areas where French and Italian cultures both meet. Is this, then, simply another case of an exceptional person bending world history to his will? Or did the French-Italian frontier environment in which Chiariglione grew up and worked produce, by some process of cross-breeding and mutation, MPEG’s seed?

This much can be said. At just the time Chiariglione was conceiving and engendering MPEG, across town, at the
Research Center operated by the national broadcaster RAI, another youngish video coding expert was also being very active. Marzio Barbero was publishing lucid papers and delivering talks at broadcasting conferences around the world on digital compression systems for “contribution quality” video materials—that is, for error-free electronic transfer of studio footage. What Barbero was discussing was the feasibility of compressing a standard 4:2:2 digital TV bit-stream of about 165 Mb/s down to 34 Mb/s, or an HDTV bit-stream of 900 Mb/s to 140 Mb/s or less.

Barbero joined forces with a team led by Silvio Cucchi at what was then the Telettre laboratory. Located in Vimercate, outside Milan, it had started to design and produce DCT compression chips in 1988. Together Barbero and Cucchi produced the first HDTV codec, using intra- and interframe motion-compensation compression and hybrid DCT. They succeeded in time to do a Europe-wide demonstration, during the 1990 World Soccer Cup, of an all-digital, contribution-quality HDTV compression system, proving that sharp digital TV signals could in fact be compressed and transferred among studios and transmitting stations.

In those days, when Japan was still clinging to its proposed analog HDTV system and Europe to its hybrid analog-digital system, they “thought we were crazy to be looking at 34 Mb/s,” observed Cucchi last April. By then the Vimercate lab was part of a complex owned by France’s Alcatel.

About a year after RAI and Telettre’s World Cup coup, Maurizio Ardito of the RAI Turin Research Center told Scientific American, "We are [still] supporting the Eureka [the joint European TV] strategy of MAC. But from a technical viewpoint, we are very sure that the future is digital."

That was 1991. Evidently, whatever the personal connections and criss-crossing influences may have been, Chiariglione was operating in a national environment and a technical culture in which the promise of digital video coding was widely recognized, early on.

Reaping dividends—or not

Not long after the 1990 demo, the work of the Telettre lab was brought to the attention of MPEG-2 by Guido Vannucchi, then its head and already one of Italy’s most prominent and influential electrical engineers. But soon after, Alcatel took over the Vimercate lab, and, not appreciating the "jewel"—Chiariglione’s term—it had acquired, failed to give the video coding group adequate support. Vannucchi resigned, and the lab stopped participating in MPEG, missing—as the father of MPEG sees it—an opportunity to produce an integrated MPEG solution two or three years earlier than in fact happened. "I am after all an Italian citizen," he said, "and so permit me to express disappointment retroactively about the lost chance [for Italy, but also the world]."

As it happened, the remarkably successful joint Franco-Italian chip-manufacturer SGSThomson has been a big MPEG beneficiary: it is the world’s leading producer of MPEG-related ICs and currently supplies close to 70 percent of the world’s MPEG-2 decoder chips. All the same, that was not the result of the Italian connection, said Chiariglione, but rather, of the audiovisual vision that was shared by the leaders of Thomson Multimedia SA, Paris, and France’s Socialist government of the day. Also, he noted, Thomson’s U.S. subsidiary RCA was in need of MPEG chips for a huge order of satellite TV decoders—a million set-top boxes for the Hughes-RCA DirecTV system—and SGS-Thomson Microelectronics got the contract.

MPEG is, of course, a wholly international effort, and other major beneficiaries of involvement in the MPEG process include U.S. companies. As far as MPEG encoder chips are concerned, "we own the market," boasts C-Cube’s Adams. In China, where MPEG-1 CD decoders have taken off like a rocket, the name C-Cube is like having "Intel inside," he claimed.

Thomas Sikora of the Heinrich Hertz Institute, Berlin, current chairman of the MPEG video group, presides (left)—partly like a judge, partly like a professor—at a plenary meeting in Stockholm, 24 July 1997. Many of the remarkably young participants in MPEG (plenary below) are assigned by their companies to serve initially as observers and learners of this unusual standards-setting process.

Both the chief executive officer and the chief technical officer of C-Cube Co. are French. The latter, Didier LeGall, is a former Bellcore researcher and adjunct Columbia University professor who chaired the MPEG video group for seven years. As one of its dozen founders, he helped guide MPEG beyond its mandate into television coding and then, having done that, persuaded the group to adopt a mainstream approach to coding of interlaced pictures for all types of television broadcasting.

Another founder, Cesar Gonzales, senior manager for digital video at IBM, has likewise helped his company prosper as a result of MPEG efforts. According to Gonzales, IBM is now taking the lead in MPEG encoders, with a less expensive and more compact solution for contribution-quality transmission. (IBM’s boasts three chips, versus seven or
eight in the C-Cube version—though C-Cube may soon come to market with a single-chip solution.)

**Looking ahead**

The current effort of the Moving Pictures Experts Group, MPEG-4, is geared to digital coding at low bit-rates and was at first conceived rather vaguely in a multimedia context. Some think the agenda is still vague, in comparison with MPEG-1 and -2. Despite Chiariglione's insistence on tools rather than applications, the fact is that MPEG-1 and -2 had distinct applications in view: video CDs, digital TV, and HDTV. Does MPEG-4 have as clear a goal?

Chiariglione "is a very hard-driving, committed individual [who is going to] deliver something whether it is useful or not," observed one critic, one of the longtime MPEG leaders. When MPEG-4 was launched, said another, it was expected to take off from "the next great algorithm"—which, however, has not materialized, leaving things in a kind of limbo.

Not so, said Chiariglione: he had never looked for an algorithm breakthrough, and anyway, it is obvious where MPEG is headed—coding of moving pictures for the Internet and Web, utilizing new tricks of the trade such as object-oriented coding, which will permit natural and synthetic elements to be combined. And his perspective still has plenty of support from other longtime associates.

The MPEG-4 toolkit will be very important, agreed Reader, who was leader of the MPEG-7 planning group, 1993-95. It will solve a problem that both Web and Virtual Reality Modeling Language (VRML) experts have been wrestling with, he observed—how to store and transmit moving images in real time for Internet applications. In MPEG-1 and -2, Reader said, it's still a matter of taking analog feed, digitizing it, and then feeding it back to an analog receiver; MPEG-4 moves beyond that to fully interoperable display of objects and will ultimately be three-dimensional. The object-based MPEG-4 techniques will enable the user to move around in a scene and pan, to mix and replay, zoom, and so on.

A real disappointment, on the other hand, has been the failure of multimedia, in the sense of interactive video and video-on-demand, to take off. Perhaps related is the failure of the MPEG-1 and MPEG-2 standards to be applied widely outside the video recording and broadcasting industries. Chiariglione himself sometimes refers, a little churlishly, to the "hijacking" of the MPEG-2 standard by a "particular industry" (that is, broadcasting).

But with MPEG-4, argues AT&T's Haskell (another of the founding dozen), the telecom people ought to grow more interested. This is because MPEG-4 will herald applications such as multimedia on the Internet and bandwidth on demand.

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**To probe further**

To get the story from the man himself, see "MPEG and multimedia communications," by Leonardo Chiariglione, at the MPEG Website: [http://drogo.cselt.stet.it/mpeg/](http://drogo.cselt.stet.it/mpeg/). Also of interest, though somewhat dated, is his "Development of multi-industry information technology standards: the MPEG case," International Workshop on HDTV '93, 2628 October 1993, Ottawa, Proceedings: Vol. 1.


Provocative views of the unfolding HDTV drama in the United States can be found in Charles Platt, "The Great HDTV

All photos: Gamma Liaison Network

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