

IEEE 45th Annual Broadcast Symposium
A Look Back, A Look Forward
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A Look Back

I have been one of the privileged few. I have been immersed in the HDTV or digital TV issue for more than fifteen years. Perhaps I should have said I am one of the cursed!

But, because I have been involved for so long, I thought I would spend a few minutes reminiscing about “the good old days.” I think it can be helpful to look back, because often we can see the way forward by looking back.

SMPTE Study Group on HDTV

The first significant effort on HDTV, at least in the United States, was in SMPTE. A Study Group was formed about 1977 to investigate HDTV. Don Fink was the chairman. Don had distinguished himself in a number of ways. Perhaps most notable was that he served as the editor of the black and white NTSC proceedings in 1940 and then as Vice-Chairman of the color NTSC proceedings in the early 1950’s.

Don was the author/editor of the two NTSC books, “Television Standards and Practices” published in 1943 and “Color Television Standards” published in 1955.

Joining Don Fink on the SMPTE Study Group were a couple other people that are very well known to us in this room, Charlie Rhodes and Ren McMann. So, when I say I am one of the privileged few that have been involved for a long time, I am not alone by any means. Indeed, some have been even more fortunate than I!

I did not serve on the Study Group, but I was the chairman of the parent group when the final report was published in the SMPTE Journal. That was, I believe, in February and March of 1980. Other members of the Study Group were Blair Benson, Gerow Brill, Robert Castrignano, Peter Comandini, William Good, Kozo Hayashi, Robert Lovick, Kenneth More, Fred van Roessel, Kurt Wallace, and Raymond Wilmotte.

Some of the conclusions of the Study Group were that there should be approximately 1,100 lines per frame, 30 frames per second interlaced two-to-one for video applications, or 24 frames per second progressive scan for film applications; that the aspect ratio should be not less than 5:3; and that luminance and chrominance should be kept separate.

NHK Demonstration of HDTV

The first look that many engineers had of HDTV was at the SMPTE Winter Television Conference in San Francisco in February 1981. NHK provided a demonstration of the 1125/60 system they had been working on.

By the way, that conference was significant in another, somewhat relevant, manner. That was when a big test was run at KPIX using 13.5 MHz sampling for digital components. That work eventually led to the CCIR 601 standard. But, that's another story.

Shortly after the SMPTE Conference, the equipment went to New York for more demonstrations. I can remember seeing the demonstration in the Plaza Hotel; I missed the SMPTE conference that year.

Formation of ATSC

By this time, it was becoming clear that something was going to happen with HDTV, and it was mandatory that the industry become involved. It was also clear that the standards issues were broader than any one standards organization. As a result, the IEEE, SMPTE, EIA, NAB, and NCTA in 1983 formed the Advanced Television Systems Committee, the ATSC, to serve as an over-sight committee.

It seems strange, to me at least, that I would end up serving as the ATSC Executive Director after I was involved in setting up ATSC — I was the Chairman of the SMPTE Standards Committee at the time. I can remember reviewing the ATSC Charter through various revisions.

It also shows the foresight of those organizations in establishing ATSC because ATSC did end-up documenting the “Digital Television Standard”.

1125/60 Standard

Things really began to heat up about 1985. The United States, Canada, and Japan were pushing the CCIR to adopt the 1125/60 system as a world-wide production standard. I wish to stress the word “production”. The US, Canada, and Japan were not looking at this as a broadcasting standard. Others, however, especially some Europeans, were very concerned that that was just what was happening, though. And they certainly did not want a 60 Hz broadcasting standard!

Dubrovnik

It all came to a head at the CCIR Plenary Assembly in Dubrovnik in 1986. Dubrovnik, the old walled, now bombed, city. About two weeks after Chernobyl! And about 500 miles downwind! Was that a warning? The CCIR vote on 1125/60 as a world-wide production standard was terrible, maybe 1,000 to 3! Perhaps I exaggerate. It sure didn't seem so at the time, though.

Looking at it on the bright side, though, perhaps some good came of it. Maybe a lot of good. It caused engineers around the world to start taking a very serious look at HDTV broadcasting.

Eureka 95

Shortly after Dubrovnik, the Europeans proceeded to set up a program called Eureka 95, or EU95. At the time, the Eureka programs were described by French President Mitterand as being the European answer to the American Star-Wars program. American military research had pay-offs to commercial businesses. Mitterand wanted to do commercial research directly, and have it benefit European businesses just as the American military research benefited American commercial businesses.

Anyway, the outcome of EU95 was HD-MAC. Now dead.

What lesson can be learned from that? Does a government driven technical standard spell doom? Perhaps. Perhaps, also, the entire approach was wrong. It was a force fit. Take a new standard in its infancy, in this case C-MAC or D-MAC or D2-MAC, try to design a future enhanced standard compatible with it, in this case HD-MAC, and then make compromises in both the infant standard and the future standard, and what do you have? A mess, I think.

Eventually HD-MAC was overtaken by events. In this case, digital TV. But, I am getting ahead of myself.

NAB-MSTV Demonstration

Broadcasters in the US also began to look at HDTV terrestrial broadcasting. In early 1987, the NAB and MSTV, with the assistance of NHK, ran a demonstration in Washington, DC. They used the 8.4 MHz bandwidth (baseband) satellite version of MUSE, vestigial sideband amplitude modulation, and two contiguous channels, 58 and 59 if I remember correctly. The transmit site was in the northwest of DC. WWHD-TV it was called. There were two receiving sites, one at the FCC and one on the Hill. And guess what? It worked.

Then the broadcasters really began to worry. The FCC was on the verge of re-assigning some broadcast TV spectrum to mobile radio. Just when HDTV might really happen. And the broadcasters would be stuck. It looked like they would need two contiguous channels for HDTV, those things the FCC was going to give away! Before you could blink, some 55 broadcasters filed a petition with the FCC requesting that the FCC initiate a Notice of Inquiry. The big question they posed was what would happen to broadcasting when the alternative media began transmitting HDTV and the terrestrial broadcasters could only broadcast NTSC.

NOI, Advisory Committee

And that's just what the FCC did. During the summer of 1987, the FCC began its proceeding, now eight years old and counting. In that first NOI, the FCC said it would establish an Advisory Committee. That did happen late in 1987. As I am sure you all know, the Advisory Committee was organized into three subcommittees, thirteen working parties, and two advisory groups. Hundreds of people have labored thousands of hours, few of them being paid it do it!

Let me point out a significant difference between the EU95 program and the Advisory Committee program. EU95 was government driven, what we call "industrial policy". The Advisory Committee has been industry driven. I have assumed from the beginning that the FCC would adopt what the Advisory Committee recommended — if that was an industry consensus!

The Advisory Committee went to work in a hurry. The plan was to finish the job in the two years that the Advisory Committee was authorized. Right!

The competitive phase of the Advisory Committee work was well underway.

Within months, the proposals for how to do advanced television were coming out of the walls. Altogether there were twenty-some proposals. Everybody recognized now that it had to be done in the 6 MHz channel. It just didn't compute to have to use two channels. There were three types of approaches that were taken.

One approach was to have an enhancement to NTSC that would increase the resolution while maintaining the 6 MHz channel and provide signals to both old NTSC sets and new advanced television sets.

A second approach was to keep NTSC in one channel and broadcast an augmentation signal in a second channel. NTSC sets would continue to operate as before. Advanced television sets would pick up both signals and make a higher definition picture.

The third approach was considered by many to be evil. Invent a non-compatible signal format! What, and make everybody's 80 year old mother have to throw away her TV set?

Simulcast

Evil, that is, until Zenith proposed such a solution in 1988. Zenith made it legitimate. MIT had been proposing such a solution, but they didn't get much attention.

Suddenly people began to realize that it wasn't such a bad idea. The enhanced NTSC approach had limited improvement possibilities. And, you had to live with the inefficiencies of NTSC, forever!

The augmentation approach required a second channel. And, it also kept NTSC forever. At least it could deliver a high definition signal, though.

Then it dawned on folks. If it takes two channels, why not use one of them to deliver a new non-receiver-compatible signal and keep NTSC on the old channel. And let it die of its own weight, whenever that is.

Once the consensus began to form on this approach, the FCC decided to make it official. That's what I was saying before about the approach we were taking in the US. Once the industry has decided what to do, the FCC says OK, and then it's a done deed.

The number of surviving proposals declined radically. Down to about half a dozen. The Advisory Committee volunteers took their jobs seriously. They took real hard looks at the proposals. The ones that were full of hot air just floated away.

The private sector fully supported the Advisory Committee. For example, broadcasters formed the Advanced Technology Test Center (ATTC) in 1988 to test proposed systems. CableLabs was formed in 1988. One stated purpose of CableLabs was to test proposed systems; indeed, they built a test facility at the ATTC location. The Advanced Television Evaluation Laboratory (ATEL) in Canada offered to perform the subjective assessment tests.

In the meantime, an electronics association in the US made a pitch to the government that HDTV was a key technology, that our government should be involved in industrial policy, and that our government should invest a billion dollars or so in semiconductors to help it along. That did not happen.

Digital

Not to be outdone with Zenith having a better idea, General Instrument came up with its own better idea in mid-1990. About one week before the deadline for submitting proposals to the Advisory Committee. GI said they could do what everybody else (well, most everybody else)

thought was impossible. A 100% digital system. Not a hybrid system, but a full 100% digital system.

Within about six months, all system proponents left in the ball game had converted their proposal to a digital system. All but one, NHK.

In Europe, it became clear that the analog HD-MAC program was not the proper direction. Many laboratories began to investigate digital broadcasting privately. Eventually, the HD-MAC program ended and the Digital Video Broadcasting (DVB) group, dominantly a private sector group, was formed to lead the investigations on digital television broadcasting. The DVB emphasis was, and continues to be, standard definition television (SDTV) rather than HDTV.

First Round Testing

Five systems survived long enough to be tested. Oops, six systems. I forgot the enhanced NTSC system that was tested. But, that test report still hasn't been released, as far as I know!

The testing began at ATTC in July 1991. It finished at ATEL in November 1992. Test books were published that must have been a thousand pages each. The Advisory Committee working groups were busy examining the proposed systems and analyzing the test data.

Special Panel

These reports went to a meeting of Advisory Committee leaders, called the Special Panel, in early 1993. The participants in the meeting were the chairs of the multiple Advisory Committee groups plus a few others that were added to ensure that various industries were represented. The meeting lasted three or four days.

At the end, it was agreed that only digital systems should receive further consideration. It was agreed also that none of the four digital systems were clearly superior to the others. So, the Special Panel recommended that various improvements — improvements that the individual proponents had suggested would make their system superior to all others — should be implemented and then test the systems again.

One clear message that came from the test results and discussions at the Special Panel meeting was that digital HDTV broadcasting in a 6 MHz channel was not a fantasy, it was a reality.

This proposal went to the Advisory Committee in February 1993. The Advisory Committee agreed. But, they also suggested (strongly, I might add) that the proponents should pool their resources and make a “Best of the Best” proposal.

Grand Alliance Formation

And they did. Three months later. The Digital HDTV Grand Alliance was formed. And thus began the cooperative phase of the Advisory Committee work.

A new combined proposal was made. The Advisory Committee, through its Technical Subgroup, evaluated the proposal, made some suggestions, which the Grand Alliance took very seriously, and all (well, most all) lived happily ever after.

Some new questions began to surface. With this fantastic technology, is it possible to send data in addition to television programs? Is it possible to send multiple SDTV programs in place of an HDTV program? The Technical Subgroup and Grand Alliance discussed these issues. It was

pointed out that the FCC had made it clear that HDTV was the target. The Technical Subgroup did make sure, however, that data transmission and SDTV were possible within the framework of the system. Eventually, it was agreed that SDTV should not only be possible, but be included specifically in the standard.

Grand Alliance Prototype Testing

Now the Grand Alliance prototype has been tested. The Technical Subgroup is very busy writing up test analysis reports. One of the papers you heard yesterday, from Tom Gurley of ATTC, gave you some information on the test results.

ATSC Standard

Just over three years ago, ATSC proposed to the Advisory Committee that ATSC would standardize the ATV system. The anticipation was that the FCC would treat the ATSC standard similar to the way the Ghost Canceling Standard was handled. In the case of the GCR, ATSC adopted a standard after a long study on what was the best thing to do. Then the FCC said that's their standard, too.

Since this is a technical conference, seems to me I should say something technical. So I will. The ATSC Standard is based on the Grand Alliance proposal. It was adopted in two stages by ATSC. The HDTV portion was adopted in April 1995. A revision to include SDTV video formats was adopted just one week ago today.

Video is bit rate reduced using the MPEG-2 Main Profile syntax. There are three video formats that must be recognized by the system. The two HDTV formats were proposed by the Grand Alliance, 1080 vertical by 1920 horizontal and 720 vertical by 1280 horizontal. Picture rates are 60 Hz, 30 Hz, and 24 Hz. All are progressive scan except for the 1080x1920 at 60 Hz which is interlaced scan. The aspect ratio is 16:9.

The third video format is 480 vertical by 704 horizontal or 640 horizontal. With 704, the aspect ratio can be 4:3 or 16:9. With 640, the aspect ratio is only 4:3. Picture rates can be 60 Hz interlaced scan, or 60, 30, or 24 Hz progressive scan.

Both 59.94 and 60.00 Hz rates are to be supported in all formats.

Audio is bit rate reduced using the AC-3 syntax. This was standardized by ATSC last autumn.

Multiplex and transport follow the MPEG-2 syntax.

RF transmission is 8 level VSB with a 16 level VSB high data rate mode for media which can support the higher data rate.

I have described two standards, the AC-3 standard, called ATSC Standard A/52, and the digital TV standard, called ATSC Standard A/53. Both are available for free on the Internet. You can use a Web browser at <http://www.atsc.org> or anonymous ftp at <ftp.atsc.org> in the directory /pub/Standards. ATSC has written a guide to the use of the standard called ATSC Document A/54. It is available also on the Internet. It is a bit out of date at the moment because it doesn't recognize that SDTV formats are included in the standard. We are updating it now, and it will be posted on the Internet on October 4.

A Look Forward

Advisory Committee Final Report

So, that's my look back. Now a look forward. The Advisory Committee's Technical Subgroup is scheduled to meet on Halloween. Gee, I sure hope that's not an omen.

The Advisory Committee is scheduled to meet on November 28. Should it have been Thanksgiving Day? All I can say is that for many of us, that's just what it will be!

FCC Adoption

The Advisory Committee recommendation will go to the FCC later this year. What can it possibly be except the Grand Alliance system according to the ATSC standard?

What will the FCC do? There are several issues they must address. Who gets which channels, when, and how. Do they have to pay something. When do they have to return the NTSC channel. Do they have to broadcast HDTV. Do receivers have to display HDTV transmissions. What are the rules regarding the technical standard.

And the big question. When will the FCC make the final ruling.

No, the big question is whether the consumer will embrace this new technology. And the answer is YES.

Less than ten years after the CD was introduced, the LP was clearly obsolete. I believe that happened for several reasons, but the primary one is because it is digital. The consumer didn't go gaga over digital, though. It's what the new digital format gave them. Lots of advantages. The disk is always perfect. No scratches. It's easy to store. Random access is easy.

I believe we will find that digital TV is much the same. No snow. No ghosts. The picture is always the same as it is in the studio.

What about HDTV? Yes, it will succeed. People want large screens. You heard that from Mr. Teger yesterday at lunch. People want good large-screen pictures, something you don't get with large-screen NTSC. Premium programs — prime time? — will be HDTV.

There is always the question of how you get started, though. What if TV set manufacturers do not build HDTV decoding into the TV set at the beginning. Will broadcasters not broadcast HDTV?

What if broadcasters do not broadcast HDTV at the beginning. Will TV set manufacturers not build HDTV decoding in the TV set?

Perhaps the FCC will require HDTV decoding and/or HDTV broadcasting for some period of time to make sure it does get started.

How Did We Get Where We Are?

Where did we start? With NHK research, SMPTE studies, international discussions. Then national concerns related to technology and strategic direction caused us to look for different solutions in different parts of the world. Europe went the HD-MAC way as a political solution to the technical problem, then made a U-turn.

The US was later starting, but there have been no U-turns. Constant fine-tuning of direction, though. Like the move to simulcast. Then the move to digital. Then the inclusion of SDTV.

The US and Europe are still going in different directions. While the US and Europeans agree on MPEG-2 for video compression, the US insists that the High Level must be supported, Europeans will use only the Main Level. The US will use AC-3 for audio compression, Europe will use MPEG-2 audio. We both plan to use MPEG-2 transport. The US will use VSB, Europe plans to use COFDM.

I can summarize the US approach as follows: Think about it for a long time. Then fight like hell with each other for five or six years. Then work together for two or three years. What else can I say? It works for us!

What Is the End Point?

What will be the long-term effect of the often discussed convergence of TV, telephone, and computers. I continue to believe that there are different applications and equipment will be tuned to applications. Some equipment will work for multiple applications, but I believe it will cost more or it will sacrifice quality in some or all modes. Thus there will continue to be specialized equipment. Again, I think I am echoing what you heard at lunch yesterday.

What about different standards between Europe and America and perhaps Japan? As TV becomes digital, and processing power increases, it will be easier to convert from one standard to another and maintain quality. Does that mean I believe standards are not needed? Not at all. I believe common standards are preferable, but we sure seem to have difficulty in getting to that point. And, we are really making sure the standard fits our way of looking at things.

Have I wasted the last ten plus years? Not at all. I have been one of the privileged few!