

A USER'S GUIDE TO ASPECT RATIO CONVERSION

One of the most confusing, yet critically important, production issues facing television program producers and broadcasters is aspect ratio. Though the technical tools to change aspect ratio are advanced and simple to use, the creative choices facing producers are not. Many variables, ranging from program genre to the cultural tastes of viewers come into play when making tough decisions on picture shape for digital television systems.

In its continuing series of discussions of real world DTV transition issues, Snell & Wilcox has assembled four of its top engineers for a look at some of the choices producers and broadcasters face as they prepare their programming for both conventional (4:3) and widescreen (16:9) viewing.

The participants are **David Lyon**, technical director; **Phil Haines**, vice president of post production; **Peter Wilson**, head of HDTV; and **Prinyar Boon**, principal engineer.

1. Let's start at the beginning. In shooting original footage for a new drama production, what's important if we want the show to play well on both 4:3 and 16:9 television sets?

Lyon: Try to make sure your master tape has got as much information as possible on it. Look at the history. You don't need to invent it. Go back to feature film production. In filmmaking the entire frame is shot so there is more in that image than they intend to put out on the final print or video release.

In the simplest case – with today's modern cameras – if you shoot in 16:9 and use the technique of protecting the sides, you can later take the center out of that image without a significant degree of loss. This way you've always got the extra information to use in a 16:9 release.

You can't shoot and protect over the top of the image. Video cameras that can do it just don't exist. But you can at least try and use the model to make sure you have as much information as possible. I think if you are going to release 16:9 the only sensible choice is to shoot 16:9.

Of course decisions of final aspect ratio can be made after the fact in post production. For example, if you want to show the 16:9 image in a letterbox on a 4:3 display you can do that after the event. If you wish to take the center out of that 16:9 image, you can also do that after the event. At least the information is there for you to play with.

Wilson: It's now common to shoot 16:9 but confine the action to a 14:9 shoot and protect graticule, which gives you some leeway to convert to either 16:9 or 4:3. This 14:9 area is really masking, not a new aspect ratio. It's a compromise. This is now a trend in the UK and Germany. Another alternative common in Europe is Super 16mm film, which is a 15:9 aspect ratio. This works very well.

Boon: The fall-back position is to shoot 4:3 using a 14:9 shoot and protect graticule. Although this can result in wasted space at the top and bottom of the image, an aspect ratio converter can be used to 'tighten' the shot.

2. In Europe, where most of the 16:9 sets have been deployed, what have viewers accepted and what have they not accepted?

Boon: The decision to transmit the letterbox format has proven highly controversial in some countries. It has taken five years for it to be accepted in the UK. Viewer complaints have proven this is not a trivial exercise.

Haines: These black spaces bordering the picture can also be used effectively. Some people are adding text and other visual effects to the black bands.

3. So what's the complaint? Viewers don't like having a box around the picture?

Boon: Something like "I paid for my television and I want to see a full picture", though it might be okay for films.

Haines: You have to sit closer to the TV set to see all the detail.

4. Are these complaints diminishing now?

Boon: Yes, it's a learning curve.

5. OK, so we can follow a motion picture model for drama production. What about live sports and news coverage – areas where there are no real pre-existing models to borrow from? Let's start with sports. What issues of aspect ratio are unresolved here?

Haines: There are significant issues with sports. So much so that it comes down to a new way of shooting sporting events. Take a situation where a basketball player goes up to slam dunk and it's typically a tight shot. It can also be really tight in 16:9, but there's going to be a lot more information packed into the image. You've got to determine what the viewer's mind can take in.

The net will have to be framed for 4:3. If framed for 16:9 it might not appear on a 4:3 screen. When you go to the movies and the film is in a very wide screen format like CinemaScope, your eyes don't pan across the screen. You cut to various parts of the huge image. Your eyes move around, looking left, right, here and there. There's actually a hole in the center where you may not see anything. In widescreen interviews, the same thing happens: room for two heads in 16:9 that will have to be cut for 4:3.

In widescreen sports, the camera operator may follow the central action, but the viewer may be looking at all the other information in the frame. There are details and action we never noticed before. You must deal with this extra information. The creative decision is how much additional information you deliver to the viewer. We don't fully know yet how to do this.

Boon: News and sports will always be full screen – you don't tend to use letterbox for these genres.

Lyon: I expect one change in sports coverage will be the use of wider, looser shots. If you put HDTV into the sports scenario, you have a more complex situation. If you had a big HD display in a home, you could do very good sports coverage with a single fixed camera. However, that would be completely inadequate with a 10inch set in the kitchen.

Boon: Widescreen will also require the use of new camera angles with some sports, and these may not be appropriate for the 4:3 service. The implication is you may need both a 4:3 and a 16:9 shot for certain events.

6. How is the camera operator or director viewing monitors out in a truck supposed to make judgements about widescreen shots?

Lyon: That's a tricky one. You have to describe this whole enterprise as transitional. The 4:3 and 16:9 systems are effectively incompatible. The kind of very wide shots that work in HD are quite incompatible with small screen 4:3 displays. Since this is transitional, we are trying to get a little bit of the best of both worlds. You must decide on a shot-by-shot basis. You might end up seeing 16:9 HD shots interspersed with much tighter shots showing details of action for the 4:3 viewers. But it won't be ideal in either environment. Some wide shots will be too wide for the 4:3 viewer and some of the close up shots might be oppressively close for someone with a large HDTV display or projection system.

In other words there is a big versus small screen dimension to the widescreen debate that is more of a problem in countries that are going widescreen HD as opposed to widescreen SD. The ultimate big screen problem will be material shot for TV displayed in a digital cinema.

7. What's unresolved with the aspect ratio of news programming?

Wilson: First of all, tapes come in from a variety of sources and in a variety of aspect ratios. All these sources must be assimilated into a single broadcast.

Haines: Then there's the issue of presentation. How do you best present additional information in the larger screen size? The presentation possibilities in widescreen television are extraordinary. There's an opportunity for young directors today because there's so much more information you can get in.

Boon: Probably the biggest overall issue is the need to simulcast 4:3 and 16:9 and deal with the impact on a television service. How do you handle these formats? There is no best way. It's an operational issue. A practical problem is logo insertion and on-screen graphics, with different positions required for each service. The small broadcaster is going to have to make some fairly harsh compromises in the way they present the material over their two channels. I think the one to be hit hardest will be the 4:3 service. If you are presenting a brand new 16:9 service, I think the natural tendency is most of your thinking will go into that presentation. This is akin to what we have seen in Europe.

It is possible to take a 16:9 service and present it to the 4:3 viewer if you make some compromises, such as presenting it in semi-letterbox or 14:9 format. In that case you will generally get away with most things without any great problem. These viewers will see a little bit of black on the top and bottom of the screen but it will be very minimal. The 16:9 image will be normal. I expect this is the compromise most will reach. I think the alternative - to present a full letterbox image - is rather too severe for the complete gamut of 4:3 sets.

Haines: What we do know is that the world is clearly going 16:9. Anyone that compares 16:9 with 4:3 clearly sees the difference. There will be many complications in the transition from 4:3 to 16:9, but there's little doubt about the end result.

8. Should decisions on aspect ratio be made by the program producer or the broadcaster?

Wilson: There are some producers who might not mind leaving the decision to others, while there will be some producers who feel incredibly strongly that they retain full control.

9. OK, so I'm a producer and I want my program to look its best in all markets. Where do I begin?

Lyon: There are some simple scenarios. Take the continental Europe scenario where letterbox is reasonably acceptable. If you shot material that is 16:9 and present it as letterbox, you know the entire scene is visible to the viewer. Provided you are reasonably happy the way it is presented on a TV set, nothing has been done to that image in an editorial sense as to how it's presented to the viewer.

A scenario that has been popular in the UK, though it is now waning a little, is taking a 4:3 portion out completely with pan and scan. This obviously requires more editorial input. This becomes a creative decision. That pan and scan process becomes a significant part of what's essentially the camera motion.

There is in the UK already a trend developing. Losing the sides of the 16:9 image and just taking the middle is a little severe. One thing increasingly talked about these days is 14:9. The aspect ratio on the tape is no different. All it really means is what you are presenting to the viewer is a compromise. With 14:9, you get a bit of black at the top and bottom of the screen and you lose a bit of picture at the sides. If you note that most domestic television sets are fairly heavily overscanned, then putting a little bit of black at the top and bottom really doesn't do much.

10. In the area of standards conversion, we learned there are preferences for the visual look of programs in different parts of the world. Are there cultural implications to determining aspect ratio?

Wilson: There's a great example of that in Europe. The French have a very proud tradition in the country's cinema. If you go to any major city in France, you can watch any film in its original form. You

can see Star Wars there in English. The French embrace the pure art of the cinema. They demand the original versions of films rather than something that's been dubbed. This preference carries over to the visual content on television. For the last 20 to 30 years in France, feature films have always run in letterbox format. The French prefer this. In the UK, on the other hand, viewers have always wanted the full screen picture and the BBC has spent millions of dollars on pan and scanning for every movie. The UK couldn't be more different on this issue than France.

Boon: It should also be noted that letterbox is not just relegated to 4:3 screens. Letterbox is also used for very wide screen cinema releases in 2.35:1 format (CinemaScope) on 16:9. Many DVDs use letterbox on 16:9.

11. Do you have any advice for television stations wanting a safe compromise for setting up an automated aspect ratio converter in a broadcast environment?

Wilson: People seem not to accept black bars on either side of the picture on their new widescreen TV set. Most likely a broadcaster will increase the size of the 4:3 image, which pushes the sides of the picture out. That cuts the heads or the feet of people in the picture. Assuming there are no captions and, since the heads are more important than the feet, you tend to frame it so that you keep more of the heads and lose more of the feet. This is not perfect, but it's the most common compromise when setting up an aspect ratio converter that changes a 4:3 program stream to 16:9.

Boon: No matter what they do, broadcasters operating in a digital environment may not have final control over the pictures they broadcast. Perhaps the most contentious area here is the aspect ratio converter in the viewer's set-top box at home.

Wilson: If you buy a set top box you have to tell it what are the screen dimensions of your television set. In a well thought out system, your set-top box should have the ability to pan and scan the 16:9 picture sent to your 4:3 TV set. Otherwise, you'll probably just end up with a mixture of letterbox and other stuff, including cut outs.

Boon: If the set-top box is not set up properly up, it can severely degrade the resolution of pictures. There are some scenarios here that are quite severe and there's really nothing the broadcaster can do about it.

Lyon: You could imagine a scenario where the broadcaster is sending letterbox. The viewer at home decides to zoom in his television set to expand the height to get a full screen image. If he then walks out of the room and someone else in the family comes in and changes channels to a full height broadcast, a significant part of that program has now disappeared off the top and bottom.

Boon: However, it is the flexibility built into the set top box and the use of 14:9 framing that are the key elements that enable the transition to widescreen to happen.

12: In an ideal world it seems that all these display decisions would be made automatically according to the preferences of the program creator. But, outside of the line 23 standard used within the PAL Plus system, it appears there are no technical standards yet to automate this activity. Is this correct?

Lyon: There are currently lots of opportunities to get aspect ratio wrong. There are proposals for signaling what was originally in the scene and what part of that scene should be shown to the viewer. The line 23 standard was actually developed to control the displays of PAL Plus television.

That information - which is just a vertical active interval control line - has been used in some studio systems in Europe. Because it was designed for the domestic receiver market, however, it's a little bit limited for use by broadcasters.

A fuller standard would be useful and one that's called Video Index is currently before the SMPTE. It provides a more complete description of picture information. In this case, you get numerical values specifying what portion of the image is designed to be seen on the output. My one hesitation about the

Video Index standard is that the video information exists only on the digital interface. That raises the possibility that if you go through a D-to-A converter or through some analog process anywhere in the chain you will lose it. The user needs to bear in mind that the data might get lost in the chain.

13. So even if a producer does all the right things in the post process, it's still very possible that somewhere along the line it will not be handled correctly.

Lyon: That's right.

14. Snell & Wilcox manufactures aspect ratio converters. Some models are standalone, while others are a component of HD upconverters. Can you tell me in simple language how these devices work?

Wilson: Essentially an aspect ratio converter changes the image size. It zooms in or zooms out. But you must consider geometry. You can't just expand 4:3 into 16:9 because circles will become egg-shaped. You must change both axis. What that means is when you expand a 4:3 image to a 16:9 width that the top and bottom expand off the screen and get lost. When you make this size change it either leaves space at the top, bottom or sides, or it chops off bits of the image.

Lyon: In any image you present to a viewer, a circle must always be a circle. If you change the aspect ratio, the average viewer can tell the aspect ratio is wrong. You can tell the buildings or the people are the wrong shape.

What you are actually doing is taking an image in one format and allowing it to be used in another. The aspect ratio converter basically lets us change the shape of a pixel in the picture. It's an engineering tool designed to change the number of horizontal pixels or the number of vertical lines in an image.

Let's take a simple case. We have a 4:3 image that we wish to present on a 16:9 display. My 4:3 image incoming has 720 pixels. If we say my 16:9 output has 720 pixels but it's now a wider screen, then I need to put that incoming 4:3 image into a smaller number of pixels. I need to scale or zoom it the same way a DVE would do in such a way that it occupies less space. You have to dispose of a little bit of information, but you do it in such a way that the image still looks correct.

15. What makes the circle stay a circle?

Lyon: The only thing that makes the circle stay a circle is the display. There's a huge opportunity here for confusion. If I take a 4:3 picture and feed that picture to a 16:9 monitor it will fill the entire screen. However, the circles are no longer circular. On the 4:3 monitor they were circles, but the 16:9 display makes them a different shape. The signal has not changed. In order to make it circular on the 16:9 monitor, I have to change the signal. Because the shape of a pixel on those two monitors is different. I actually need to bend the signal to make it look right to the viewer. I'm distorting it so that it appears correctly wherever it's displayed.

16. What distorts the signal?

Lyon: There is a filter in the aspect ratio converter that allows you flexibly to have any numerical ratio between the number of input pixels and the number of output pixels to almost continuous resolution. If I have a number of pixels coming in I can scale it to three quarters of that which effectively squeezes the image. Or I can expand the image horizontally to make it look right in the inverse process of 16:9 to 4:3.

That's very much an engineering detail. We can design, demonstrate and measure them to be very nearly transparent. Effectively, they are not there. The difficult thing is understanding what it is doing to the image as it appears on whatever display it going to be shown on.

I don't say this in a derogatory way, but it can be very difficult to understand what is happening between all the possible permutations of images on these various displays.

17. An aspect ratio converter sounds very much like a DVE...

Lyon: Essentially it is a DVE. The difference is one of technical detail. A DVE nowadays is generally designed to be able to do almost anything. They are very, very flexible in the way they can manipulate an image. In order to do this at viable prices, they generally make some compromises in the way they filter the image.

In the case of an aspect ratio converter, we know what it's going to do. It's going to squeeze or expand horizontally or it's going to squeeze or expand vertically. That's it. It's dedicated to a single job. As a consequence, it's not necessary to make the same level of compromises that you would for a DVE. In fact, it's the opposite. You can specifically target the processing to do the job it's doing well.

18. It seems that high end aspect ratio conversion, along with preprocessing for MPEG encoding, could open up an entirely new area of the post production process. Is this coming?

Lyon: The parallel to that today is the DVD mastering process, where people spend enormous amounts of time on a virtually frame-by-frame optimization. There are many technical opportunities in this area. What we must work with are the interests of the broadcasters and archive owners. They will determine the amount of manual input in these processes as opposed to the amount of automatic input.

Wilson: It depends on the markets. A straight conversion to letterbox would require very little additional creative work. However, if you want to do scene-by-scene pan and scan, this would add a very significant layer of work to the post process. You could program the aspect ratio converter from an edit controller and use the edit list to pan and scan every scene if necessary. This is a major undertaking because, by its very definition, pan and scan alters the director's original vision in making the film.

Haines: I think there will be specialty post houses for handling archives. Most archives are in 4:3. If it's film, you can do a new telecine transfer. If it's tape, you've got to use an aspect ratio converter. At the same time you'd probably use noise reduction and pre-processing as well.

19. What about a sitcom mastered on one-inch tape? How would you handle this in a digital environment?

Haines: Resolution may not be so bad, but noise reduction becomes important. And precision decoding is also very important.

20. So there's room here for a specialized post production suite for handling these functions?

Haines: If I were 20 years younger, I'd go to LA and set up a suite like this. It's not fully realized yet, but it's inevitable.

21. Is it fair to say that this type of work is still a black art?

Haines: Yes, very much. This is only the beginning of a new field.

22. Do you all agree that aspect ratio is the top production issue of the DTV transition?

Haines: Yes! The whole production technique will be different. Wide angle will be used more, and cutting between scenes will require a another sort of timing – later and with shots held longer. Shooting for television will involve more camera movement like film – especially in drama, with tracking cameras as opposed to zoom.

Boon: Not only does the greater amount of information on the screen allow you to linger on the shot for longer, cut positions also change as the cut point for a 4:3 frame will be in a different place to that of the equivalent 16:9 frame.

Lyon: I think it potentially is for an interesting reason. An awful lot of people haven't realized how big a problem it actually is. I say that a bit cautiously because I speak from the viewpoint of a hardware manufacturer. From a hardware point of view, the processing is relatively easy. It's almost a technical detail. Yet, making the hardware has made us aware of how many in the production community are unprepared.

We sometimes hear, "Oh, I've got this program and I want to convert it to something else". The answer is you can't convert it in the same way you can convert an NTSC tape to a PAL tape. I can give you a box that will allow you to bend the picture, but from then on it's a production decision. I think a lot of people are really only recently waking up to it as being a production problem.
