Migrating to HDTV

Boris Sedacca attended a two-day training course, Understanding HDTV Technology, at the NFT, London South Bank last November. This highly practical course has been developed for TV Industry Professionals facing the challenge of migration to HDTV.

The presenters (from left): Peter Wilson, Alan Roberts, John Watkinson and Stuart Sommerville.

HDTV has been a long time coming, from the psycho-visual experiments by NHK in the 1970s, through the format wars of the 1980's and the IT/TV battles of the late 1990s.

The first practical equipment appeared in 1985 and this was deployed in Japan with some pioneers in Europe and the USA. The equipment was mainly analogue but in fact already used quite a lot of digital processing in the cameras and recorders.

The politics also hotted up around this time and European manufacturers successfully parted the EU from many millions of ECU's (predecessor to the Euro) to develop an all-European system.

MUSE and HD MAC

So now we had both rival 50Hz and 60Hz HDTV production and transmission systems. The Japanese had MUSE (multiple subnyquist sampling encoding) and the Europeans had HD MAC (Multiplexed Analogue Components) for Transmission.

The European lobby made much of the fact that all the receivers would need to be changed if the Japanese system won. They omitted to say that this was also the case if the European system won.

For production equipment the pinnacle of performance was achieved in the late 80s with large format CCD cameras and uncompressed digital recorders.

The early 90s was a cooling off period though with some useful standardisation work including the much lauded common image format which used the same 1920 x 1080 Image format for both 50Hz and 60Hz.

Influential senators

The end of the 90s was when influential senators remembered that the Broadcasters had successfully quarantined spectrum for HDTV Broadcasting and put pressure on them to make it so.

The Broadcasters at this time were preoccupied with the threat of multi-channel using compression over cable and satellite. They then coined the phrase DTV (Digital TV) and tried to deflect the politicians.

Enter also at this time software vendors who could just about process Standard definition in real time and did not understand the broadcast interlace system.

High School Allegiances

Using political influence and calling in High School Allegiances they managed to initially dilute the DTV offering to NTSC Progressive scan. The broadcasters now seeing a threat from another direction then switched back into an HDTV agenda.

The outcome of all this was the infamous ATSC (Advanced Television System Committee) table 3 with around 30 different broadcasting formats.
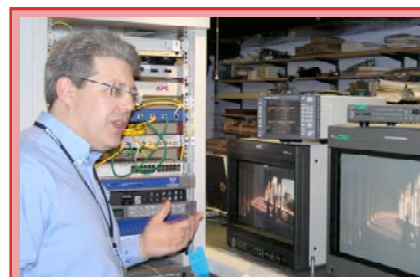
Stuart Sommerville

Head of Purbrook UK digital Product Design Consultant, Stuart worked for Plessey Radio Communications after university. He then moved on to Snell & Wilcox where he worked for 16 years before forming his own bespoke design company, Numedia Technology.

Stuart worked in many product areas in Snell including DEFT (Digital Electronic Film Transfer) which was created to sort out the infamous Dallas Problem when US networks went to electronic post. More recently Stuart's team engineered the first HD Compression Pre-processors and the Archangel Restoration engine. Stuart was a key member of the EU Presto Project.
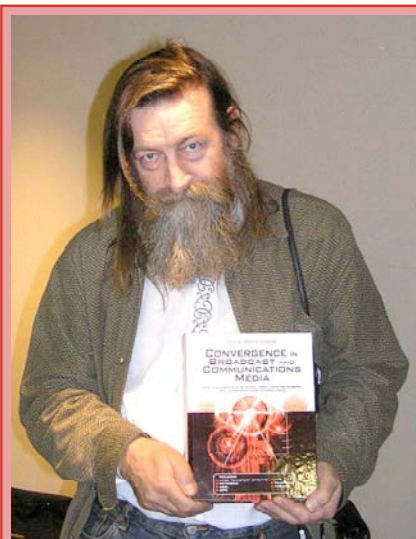
The eventual result was a split between Broadcasters with some supporting the normally interlace Common Image Format of 1920 x 1080 for both production and transmission, and others supporting the 1280 x 720 progressive format much loved by the IT community. Progressive eats double the bandwidth but was easier to process by the novice software writers of the time.

Mainstream HDTV

With luck in Europe the target for mainstream HDTV will be both the common image format (1920 x 1080) and progressive scan. Luckily the NTSC Progressive Format also known as 480P has passed away.

Behind this story the professional equipment vendors were trying hard to make equipment better, lighter and cheaper. This resulted in a significant degradation of picture quality over the costly but superior equipment of the late 1980's.

In particular subsampling lumi-nance and chrominance then compressing it to death confused the format debate by seriously degrading the capabilities of the 1080 I format. Another interesting point was the realisation that Film images in 50 Hz systems were carried as progressive images @ 25P.

This concept went back to the 1960's but was invented as new and promoted heavily as the HD 24P system when the term field dominance morphed into segment dominance. Woe betide anyone who got the domi-nance the wrong way and tried to display motion on a digital projector.

Healthier price tag

So moving on to the middle of the first decade of the 20th Century, several Broadcasters are on air, there is significant religion around the various formats and finally the technology is approaching the performance of the late 80's but with a healthier price tag.

With this background, High Definition and digital Cinema (HDDC) staged its two-day training course. The course was presented by John Watkinson, Peter Wilson, Alan Roberts, and Stuart Sommerville.

By the end of the course, delegates had a better understanding of the origins of HDTV and why certain decisions were made when defining the key parameters. They also better understood the difference between SDTV and HDTV and what issues are critical to reliable performance.

Delegates were given primers in the human visual system and moving image portrayal. They learned about colorimetry and its implications and given primers in HD VTR, switcher and camera systems. They gained practical information on how to build an HD system that works, with infor-mation on new diagnostic systems and metrics for reliable system operation.

Digital cinema is a relatively new phenomenon. It can be broken into two parts, production including post production and distribution/exhibition.
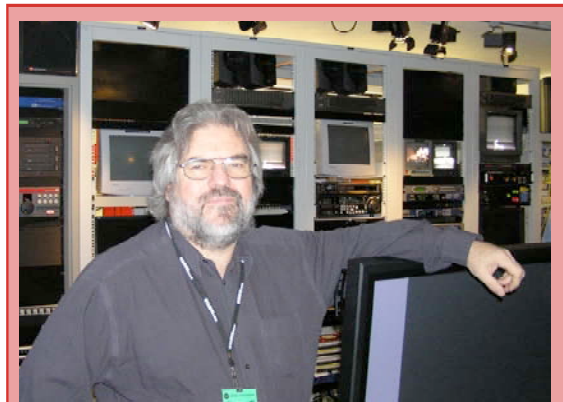
Peter Wilson

Until February 2005, Peter was Snell and Wilcox vice president for Display Processing. He was head-hunted as the manager of Strategic Planning from Sony Broadcast in 1991 where he was senior manager for New Business Development.

He is currently vice-chair of the European digital Cinema Forum and chairman of the technical module. Peter also sits on committees and working groups for the UK Department of Trade and Industry and digital Terrestrial Group.

Peter Wilson is an independent international consultant in the fields of HDTV application and digital Cinema technology. He presents lectures, seminars and training courses worldwide.

He is Co-author of several books, including The EDCF Guide to Digital Cinema Production, Understanding Digital Cinema and The EDCF Guide for Early Adopters. TV Appearances have included South Today current affairs programme, The Money Programme (BBC). He has also had technical articles published in several magazines, including Television's sister publication, Electronics and Wireless World.

He has presented tutorials for the International Broadcasting Convention (IBC), Society of Motion Picture and Television Engineers (SMPTE), British Academy of Film and Television Arts (BAFTA), the Royal Television Society (RTS), the International Association of Broadcasters (IAB), BKSTS (The Moving Image Society) and Fondazione Centro Sperimentale Di Cinematograpia, Milan.

John Watkinson

John Watkinson is an international consultant in audio, video and data recording. He works in advanced applications of electronics to audiovi-sual and avionics systems. He is a Fellow of the AES, a member of the Society of Expert Witnesses, and the British Computer Society and is a chartered information systems practitioner.

He presents lectures, seminars and training courses worldwide. He is the author of many books, including Digital Interface Handbook, The MPEG Handbook, The Art of digital Video, An Introduction to digital Video, Convergence in Broadcast and Communications Media, Television Fundamentals and The Art of the Helicopter.

Production

Whilst there is a trend towards digital camera capture the mainstream movies are still shot on 35mm Film. Pioneers such as George Lucas have shot major features using digital cameras. Where digital technology is really causing a stir is in the effects and post production areas.

Television has had many advanced tools at its disposal for many years. These tools were until recently not good enough for use on major features. The advent of new digital Intermediate tools has changed the situation.

TV commercials used very sophisti-cated secondary colour correction systems with the ability to isolate and

change individual colours in a scene.

Film traditionally used a simple three light process where a skilled operator could match the overall image to the director wishes but could not manipulate colours within the scene.

Special effects have been achieved for some time by scanning the camera negatives at high resolution 2048 x 1556 pixels then storing the images as a file.

The computer graphics process then takes the file and integrates it into the CGI shot, or in fact the CGI may be completely synthetic.

The result was recorded back to Film and the negative produced cut into the movie as normal.

The advent of digital Intermediate brings the opportunity to edit and secondary colour grade the whole movie whilst it is in the digital Domain.

The finished file can then be either prepared for digital cinema distribution or written back to negative stock to facilitate film distribution.

A major benefit is the ability to write many negatives of equal quality so improving the quality of the film seen in the cinema.

Distribution

As mentioned above the digital files can be written back to film for traditional distribution. For digital distribution a digital source master is prepared.

This is then encrypted and packaged for delivery by satellite or data tape.

HDDC will run digital Cinema Technology training courses early in 2006 to explain the various technologies specified by the DCI and their practical implications.

www.hddc.co.uk

Alan Roberts

Head of Mugswell UK, consultant in HD imaging specialising in cameras, Alan spent many years at the BBC Research Centre in Kingswood Warren specialising in imaging and colour science. He has authored several BBC white papers including:
WHP034 Colorimetric and resolution requirements of cameras
WHP053 The Film Look: It's not just jerky motion.
WHP085 The "Rel": a perception-based measure of resolution
WHP008 How to recognise video image sources

While at the BBC Alan designed special camera setups for BBC HD co productions. Since retiring Alan has been very busy briefing Directors and Cameramen on HDTV characteristics in production and the best way to capture the images.
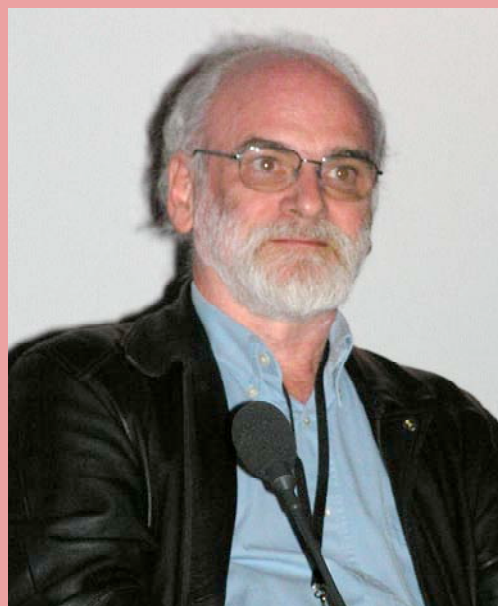
Course Contents

Day One
Introduction
What is your definition of High Definition? Is definition all there is to it? Of course not!
- The things that matter
- Realism v Escapism

The Human Visual System
- The structure of the eye.
- The retina.
- Rods and cones and how they differ.
- Why the eye is not a camera.
- Saccadic motion.
- The pretzel effect.
- Eye tracking and motion perception.
- Persistence of vision.
- Fusion.

Moving Image Portrayal
- Image sampling, spatial and temporal.
- Aperture effect.
- Oversampling and resizing.
- Scanning techniques.
- Motion portrayal and dynamic resolution.
- The optic flow axis.
- Comparison of film, interlaced scanning and progressive scanning.
- Choice of frame rate.
- Where present frame rates came from.
- What frame rates should we use?

Colorimetry
- How we see colour.
- Colour constancy.
- Metamerism and the use of primaries.
- CIE colour space.
- Colour temperature.
- Colour space for transmission and display.
- digital colour space.
- Valid and invalid colours.

Compression for HDTV
- MPEG-2 vs H-264(AVC).

- Spatial and temporal coding.
- Transforms, motion compensation, bi-directional coding, prediction.
- Blocking and concealment.
- Transporting compressed HDTV.
- Packets and PIDs. Timebase recovery & PCR.
- Multiplexing, statistical multiplexing.
- Stuffing.

Day Two
Cameras
- Types of HD camera: prism vs stripe and mask systems.
- Sensor size vs depth of focus.
- Enhanced processing; Gamma, white knee, etc.
- Set up files
- The importance of the correct shutter speed.
- Cameras connections: copper, fibre.
- HDV, "Will it make amateurs of us all?"

Equipment
- Interface standards
- P & PSF
- The 1.5 Gbps HD Serial interface
- Data integrity and CRCs
- Connectors & Cables
- Analogue design issues
- Switchers
- Graphics and CG
- Editing
- SD/HD compatibility and interoperability
- Displays, CRT, PLASMA, LCD

HD recorders
HD recorder block diagram.
- Compression, segmentation, multiplexing, error correction, channel coding, timebase correction.
- Practical HD formats: HD-Cam, HD-Cam SR, HD-D5, D6, HD-DV100, HDV.