Digital Stills and Movie Camera

Technical Case Study

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1. Executive summary

The scope of the project is in three parts. First testing out the technical aspects of the new DSMC introduced autumn 2008 by Nikon and Canon. The second part is a case study where a DSMC camera is used to produce a full documentary. The third part is to find out how DSMC cameras will influence the profession of photojournalists and videographers in multimedia companies. Findings from this first study suggests that the technical performance of the Canon 5d is at the level of professional video-cameras, but there are some issues concerning user interface and lack of manual controls. However, new firmware updates and new DSMC models makes it applicable tool for journalist, photographers and videographers in the industry. The second and third case study will research how the practical workflow, pros and cons will decide whether this product will become a success or not and how it might change the industry.

2. Problem statement

Throughout the last decade the traditional newspapers have evolved into multimedia companies presenting the news in all available mediums (TV, radio, net, mobile devices etc, etc). At the same time the subscribers has declined. People do not want to pay for news anymore. This has led to hard rationalizations in the different editorial offices and the leaders have tried to find new ways to make the journalists and photographers work more efficiently. Normally in a media-house there have been dedicated photographers and videographers. But now we see a convergence between the two. New technology can make this convergence more rapid and successful.

The autumn 2008 Nikon became the first camera manufacturer to introduce video capabilities in HD as an option on their DSRL (Digital Single Reflex System) D90. Just month later Canon introduced their model D5 markII with similar options. As of march 2009 already two more models have been announced the Panasonic Lumix DMC-GH1 and Canon EOS 500D.

3. Alternatives

The alternative to the DSMC strategy is to use traditional video cameras with the extra burden this would give. Until now this has often been a task for two different people; videographers and photographers. Now, however this work is no longer divided in many editorial offices because the pressure of rationalization. Another alternative used mainly among journalists is to use a cell-phone with stills and movie functionality. This workflow has its limitations especially concerning the technical quality of the footage and lack of manual/creative possibilities.

4. Analysis

This case study has focused on a thorough test of one model the Canon D5 MarkII and compared it with digital video-cameras that normally would do the job for a photo journalist when it comes to filming. The tests are done in a user driven manner rather than a strictly technical one. Qualitative result based on the use, and of the perceived outcome, but also on technical information gathered through the tests. The tests are done by second grade bachelor student in television and multimedia under supervision of university teachers.

Technical specification
First let us look on the Techspec for the two models Nikon D90 and Canon D5 markII

Canon D5 MarkII **Nikon D90**

Max resolution	5616 x 3744	Max resolution	4288 x 2848
Low resolution	4080 x 2720, 2784 x 1856, 5616 x 3744, 3861 x 2574, 2784 x 1856	Low resolution	3216 x 2136, 2144 x 1424
Image ratio w:h	3:2	Image ratio w:h	3:2
Effective pixels	21.0 million	Effective pixels	12.3 million
Sensor photo detectors	22.0 million	Sensor photo detectors	12.9 million
Sensor size	36 x 24 mm (8.64 cm²)	Sensor size	23.6 x 15.8 mm (3.72 cm²)
Pixel density	2.4 MP/cm²	Pixel density	3.3 MP/cm²
Sensor type	CMOS	Sensor type	CMOS
Sensor manufacturer	Canon	Sensor manufacturer	Unknown
ISO rating	100 - 6400 in 1/3 stops, plus 50, 12800, 25600 as option	ISO rating	Auto, 200 - 3200 (plus 6400 with boost)
Zoom wide (W)		Zoom wide (W)	
Zoom tele (T)		Zoom tele (T)	
Digital zoom	No	Digital zoom	No
Image stabilization	No	Image stabilization	No
Auto Focus	TTL-SIR-CT, 9 focus points	Auto Focus	Nikon Multi-CAM1000
Manual Focus	Yes	Manual Focus	Yes
Normal focus range		Normal focus range	
Macro focus range		Macro focus range	
White balance override	8 positions & manual preset	White balance override	12 positions, 5 manual preset and Kelvin
Aperture range		Aperture range	
Min shutter	30 sec	Min shutter	30 sec
Max shutter	1/8000 sec	Max shutter	1/4000 sec
Built-in Flash	No	Built-in Flash	Yes, pop-up
Flash range		Flash range	17 m
External flash	Yes, hot-shoe & sync	External flash	Yes, hot-shoe
Flash modes	External	Flash modes	Front curtain, Rear curtain, Red-Eye, Slow, Red-Eye Slow
Exposure compensation	-2 to +2 EV in 1/3 EV or 1/2 EV steps	Exposure compensation	-5 to +5 EV in 1/2 or 1/3 EV steps
Metering	35 area eval, center	Metering	3D Matrix metering II,

	weighted, partial, spot
Aperture priority	Yes
Shutter priority	Yes

	Center weighted, Spot
Aperture priority	Yes
Shutter priority	Yes

Continuous Drive	Yes, 3.9 fps max 78 JPEG, 13 RAW
Movie Clips	Yes, 1920 x1080 @ 30fps, up to 12 min, 640 x 480 @ 30fps up to 24 min
Remote control	Yes, N3 connector
Self-timer	Yes, 2 or 10 sec
Timelapse recording	Yes, by cable and PC
Orientation sensor	Yes
Storage types	Compact Flash (Type I or II), UDMA, Microdrive
Storage included	None
Uncompressed format	Yes, RAW, sRAW1, sRAW2
Quality Levels	Fine, Normal
Viewfinder	Optical (Pentaprism, 98% coverage, 0.71x magnification)
LCD	3 "
LCD Dots	920,000
Live View	Yes
USB	USB 2.0 (480Mbit/sec)
HDMI	Yes
Wireless	No
Environmentally sealed	No
Battery	Canon Li-Ion LP-E6 & CR1616
Weight (inc. batteries)	850 g (30 oz)
Dimensions	152 x 114 x 75 mm (6 x 4.5 x 3 in)
Notes	Live View with Manual and Auto-Focus

Continuous Drive	Yes, 4.5 fps(CH) or 1-4 fps(CL)
Movie Clips	Yes 1280x720
Remote control	Yes, Optional (ML-L3 or MC-DC2)
Self-timer	Yes, 2, 5, 10 or 20 sec
Timelapse recording	Yes, by USB cable and PC
Orientation sensor	Yes
Storage types	SD/SDHC card
Storage included	None
Uncompressed format	Yes, RAW
Quality Levels	Fine, Normal, Basic
Viewfinder	Optical (Pentaprism, 96% coverage, 0.96x magnification)
LCD	3 "
LCD Dots	920,000
Live View	Yes
USB	USB 2.0 (480Mbit/sec)
HDMI	Yes
Wireless	No
Environmentally sealed	No
Battery	Nikon EN-EL3e Lithium-Ion battery
Weight (inc. batteries)	703 g (24.8 oz)
Dimensions	132 x 103 x 77 mm (5.2 x 4.1 x 3 in)

There are lots of differences between the two but here we will only focus on the video performance and possibilities. There are three main differences when it comes two the movie mode. The first being the pixel resolution, the second being the compression method and third being the bit-rate on the video (the level of compression).

Canon has a full HD image 1920*1080 whereas Nikon has 1280*720. This should favour Canon but it can also become a drawback since a 1080 image needs more data info to be compressed. Canon uses H.264 compression method with inter/intra-frame compression whereas Nikon uses the older motion jpeg with only intra-frame compression.

The third factor is maybe the hardest to find out because neither Canon nor Nikon specify the bit-rate for the movies and thereby clarify the level of compression. The equations here are based on information and practical tests. Canon D5 lies around 40Mbits/s including 16 bit PCM sound. Nikon on has CBR up to 24 Mbits/s including sound.

These 3 factors all imply that, on paper, Canon 5d mkII is the best choice. It is also the most expensive camera of the two and maybe the camera that could take up the competition with prosumer videocameras. That is why we in the practical test have focused on the Canon model.

4.1. Methods of study

We divided the students into 6 groups with the following different tasks:

Group 1.
Test of Canon EOS 5 D Mark 2.
The camera has only automatics sound control. Can using the mixer or wireless mic optimize sound? (Check the optimal level in relation to the compression / clipping, the use of external sound recordings, etc.)

Group 2.
The camera has only 30 frames per. seconds. How can one get the best results when converting to 25 frames per second (PAL). Find out what works best: After FX, Final Cut and Avid.

Group 3.
Test of Canon Eos 5D Mark 2 vs Panasonic HVX 200.
Shoot in HD (720P25) for HVX200 camera and 5D, which shows how the difference between bitrate and compression turns out.

Group 4
Test of Canon Eos 5D Mark 2 vs Panasonic HVX 200.
Do your shooting under difficult lighting conditions (dark items office el.) Examine the noise and light sensitivity in both cameras. Your admission is also to look well-lit location and examine the same. Check also contrast and resolution. (Use the 720P 25 for 200 camera).

Group 5.
Test of AVC HD and HDV. (VJ camera 10 has AVC HD to 5D, the Sony VJ can record in HDV on the tape.) Locate the advantages and disadvantages of the two formats, both quality brass and workflow

Group 6
Find the optimum workflow for EOS 5 D. (Premier, Avid and FCP).
Final master in PAL and HD

The students worked about 2 weeks and did a presentation for each other in the classroom as well as making a written report with test clip examples. These reports are directly translated from Norwegian to English

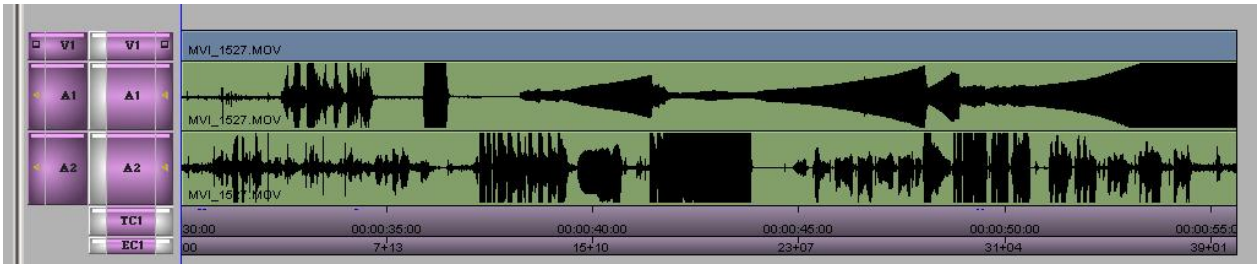
4.2 Group 1. Sound

Canon 5D Mark II and external microphones

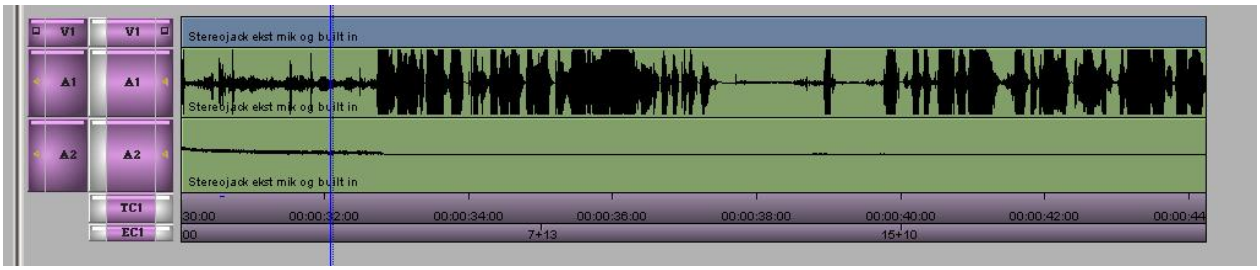
Using mono plug: Takes up only one channel, the other one is only noise.

Stereo Jack - two external mics

- Indicates that the compressor is on the channel and not on seperate tracks
- Look on the audio file. Channel one has a steady test signal 6 db in
- Result is that the test signal is compressed if the other channel has high input.



Stereo Jack - external mic and built in
- Takes up two tracks
- Mute the built in mic completely
- Record level on the remote
- Moderate Noise

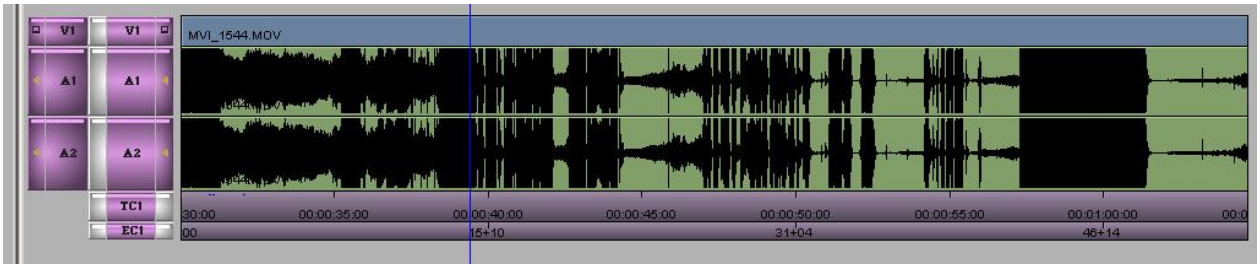


We wonder if the limiter is just on the internal microphone. Because the audio cracks very easily when we connect the external microphones.

Lavaliere (Sennheiser EW500) right in the camera

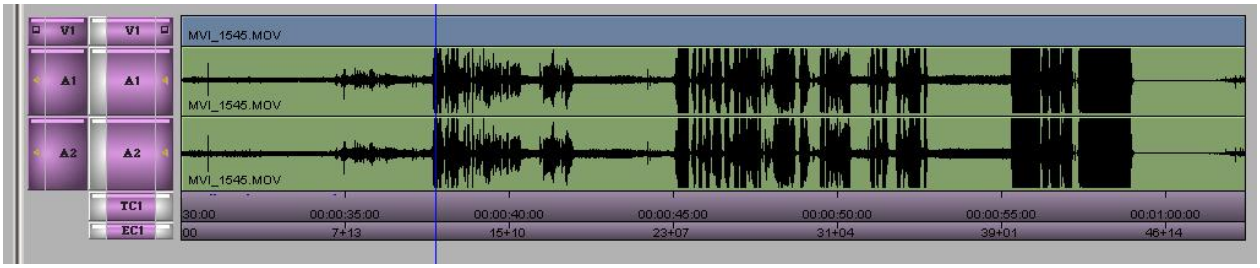
Lavaliere via stereo jack
Level 00

- The use of lavaliere live use a maximum noise reduction on the lavaliere.
- Even at 0 gain the noise is unbearable and the sound cracks continuously



Lavaliere via stereo jack
Level -24

- At the maximum attenuation the level is still too high for the camera, but acceptable
- Cracks are not as easily heard
- Possible to survey the sound from the receiver via headphones.



Conclusion
Very difficult to get a descent sound signal and to control to what extent the camera is limiting and compressing the signal.

4.3 Group 2. Frame-rate conversion

Different approaches:

-Imported clips straight into AVID
-Converted in Sorenson Squeeze
-Converted by rendering from Adobe After Effects
-Converted internally in Adobe After Effects using the frame rate converter (downloaded)
-Interpreted as 25 fps in Adobe premiere and then speeded up

Notions about the clips:
Tested many different types of clips into the AVID and made a sequence of it.
Pinpointed the clip that worked least well, and then we tried to make the fram-rate conversion with different software.
Little movement is fine, and the result is good.
Speed of movement in the picture was also good
Struggled horizontal movements with and without simultaneously pan

Evaluation AVID
Fast and effective, but are struggling with certain movements. Do you have little time and working with the news where the technical aspects may not be the highest priority - then this variant works just fine.

Evaluation Sorenson Squeeze
Relatively quick and easy to use if one wants to avoid AVID. But if one work in AVID the direct import is easier since the quality differences is hard to track.When importing to AVID MXF files must be made in addition to the previous conversion. Using one of their AVID codecs, this will go quickly, so it is recommended to use the Avid DNxHD here

Evaluation After Effects
The result is similar as the two above, and render takes a long time. We do not recommend that method for all raw film, unless one knows that one will make further adjustments in After Effects. All in all AE is doing a completely straightforward job. Toiling in the same areas as AVID and Sorenson Squeeze

Evaluatin AE with Andrew Kramers frame rate converter www.videocopilot.net

Does definitely the best job among these four options, and have an opportunity to adjust several settings for your video. But this solution requires that one have a good time for rendering, and one must also learn to know the different settings, and what they do. Overall the best alternative if the quality is most important

Evaluation interpreting as 25 fps
First we encoded the h-264 files from Canon D5 to DNxHD 115 with 709 levels.

We started a 1080p 25fps project in Adobe Premiere Pro CS4, and then imported the DNxHD files in our project. We Interpreted the files as 25p files. The video would then play slower than normal due to the 25 first images will constitute a second.By speeding up the clips to 119.1%, we will achieve the original speed again.

The footage looked very good on both LCD and CRT when the finished film is rendered in DV with 25 frames per second. No artificial signs of the frame-rate conversion. We also rendered out a 1080p h.264 version that looked very good.

4.4 Group 3. Compression

We rigged up the two cameras D5 and HVX200 in the studio to test this.
The set was a news reader, with a TV showing white noise on a dolly behind. The idea was to run the TV in and out of the picture with the white noise, as well as the having the news reader make clear hand and lip movements.

5D records in 1080/30P and have a bitrate of 40Mb / s
On the HVX200, we recorded in 720/50P, and here we have a bitrate of 100Mb / s

Although the idea was good, we were not witness to any substantial differences. We transferred the footage into an AVID project and compared the images there. Zoomed in where we expected to find clear compression blocks and other artefacts but what we found was rather too small to mention.

Another thing we were not fully aware was the contrast area in the 5D, it seems like the 5d have a tendency to make more contrastful images than the HVX 200. So the test images were not identical. But we do not see this as critical to make a fair judgement on the compression

4.5 Group 4. Canon 5D vs. HVX200

To test the different things in the task, we sat down to discuss what kind of things we could take up. We were all agreed that the difficult lighting conditions and large contrasts had to be the core of our test. We first went out late at night and shot both with the 5D and the HVX, but this recording was not so good. That is, factors that we can very easily get in. See "difficult lighting conditions" later in the report. In the dynamic test we wanted to see how much black and white that was cut, so we set up a test poster as well. See the "dynamics" later in the report.

Difficult lighting conditions
We wanted to test the lighting that we can easily come under if we are to create a reportage or the like. We selected sound space 1 and imagined that it was a dark office. In the test with "dark office" we got the problem with the fact that we over exposed images on Canon 5D. It seems that the display is much darker than what the finished picture really is. This is something that we have seen later, when we have used the camera in other conditions.

If the camera thinks it is too dark, set up the aperture automatically. This means that the depth of field area is much smaller, and thus much harder to adjust focus. You can easily see it in this clip, where Kristoffer moves out of focus area.. We used the "focus-helpers" before we started filming, but when we started recording, we could not use it anymore.

Dynamics
In one test, we put 5 lights about 3 meters from the subject (Nicolai who plays guitar) on the one hand, and no light on the other side.

We put the cameras on the spot to get the most light on a smallest possible area. At the same time we put a test poster in the background and exposed by this. The plan was that we then could see if there was cut in black and / or white in the face. We should perhaps exposed for the face and seen how the cut in the black, or not set the spot, so that it had been more light on the test poster. It could be the exposure had been better.

Nevertheless, we see that the 5D cut very much in black. In the shadows there is not rendered any nuances at all. - Everything will be cut. H.264 compression to 5D cut right off, let it not be left anything over 255 or under 0.

These blogs describe cut in black.
http://prolost.blogspot.com/2009/01/5d-crushing-news.html

http://cineform.blogspot.com/2009/01/full-dynamic-range-video-from-canon-5d.html

The latter suggests that the Canon cuts on the 30-220. We noted that the crushing part, and if so, it is quite "serious" in a professional context. The first blog says that it is actually hidden information which the editing program cuts. Using the "Apple Color", one can retrieve the lost information in the video. This is information that neither Avid, Final Cut nor Premiere Pro apparently are able to "see." We have not have time to test this, but it is very interesting if it is the case.

Other notes

We recorded in DVCPRO (50Mbit / s) with the HVX 200, and h264 (38Mbit / s) with the Canon 5D.

The reason that the 5D is so bright is because of the image tag. It operates with the full image (35.8 x 23.9mm) while operating with HVX
HVX can record in 4:2:2, while the h.264 profile the canon can only take up the 4:2:0

Canon can record in 12bit RAW format, so it should have much better dynamic range than the HVX, with its 8 bits. But because h264 compression the camera does not use 12 bits in movie mode.

4.6 Group 5. MPEG 2/MPEG 4

This is actually a comparison test between MPEG2 and MPEG 4 compressions methods, but it can be interesting since some videocameras still uses MPEG2. In this case HDV. But the more newly developed AVC HD is based on MPEG-4/H.264 are standard of the new Panasonic Lumix DMC-GH1.

Test of AVC HD and HDV. Locate the advantages and disadvantages of the two formats, both quality-wise and workflow.

Workflow:
In HDV one usually use Tape as recording media. Normally the recording is done in 1440 x 1080i. with interpolation while AVC HD supports native resolution in 1920 x 1080i.

Since it is not the cameras that are the core of the test, but the formats, we are not writing much about the individual cameras. To shoot in HDV you only select the correct settings and then to put in the tape and start filming. Same applies to AVC HD, only that it is hard disk recording. This helps when you get to the transfer process. Since the footage is on the hard drive it is fast to copy files instead of have to capture the video from a deck. It did prove to be a problem though for AVCHD, that few editing programs will accept the format.

Premiere Pro:
AVC HD: CS4 version is needed to be able to run both image and sound. On CS3 the AVCHD will not play the sound, since it does not support the audio portion of the AVC HD format. In addition, we need a powerful computer to work with AVC HD due to the power of MPEG-4 compression.

HDV: format you have to take on the traditional way of capturing. Premiere failed to record the image on the computer screen while this took place and were not getting full communication capabilities with the camera. We had to put on capturing in the program and then start playing from the camera manually.
Working with HDV is relatively easy also on a less powerful machine due to the low bit-stream at only 25 Mbps per second and also less advanced compression coding.

Final Cut:
We attempted to import settings for HDV via Motu box without success. But the program managed to communicate with the camera in a HD resolution, but did not have a picture up. Final Cut did not import AVC HD files.

Avid:
Opened HDV project. It was really the only thing that worked for HDV in Avid. When we were to capture or achieve contact with the camera, we had only the "No Host". It seemed that avid capture failed to communicate with the HDV device. We tried both Mojo and adrenalin directly into the FireWire connector, without success. What we really could do was to export HDV material from Premiere and import this into avid project without having to transcode it.

AVCHD does not work in avid. The way we might have done it was to use a third part converter program so you convert the files from AVCHD to DNXHD. Another possibility is to use a program made by Panasonic. This program allows you to generate a "P2" card files on your PC and then avid is able to import.

As a conclusion one can say that AVCHD is the format that works best as long you have the editing program that supports the format. It is faster and easier to to transfer it to the hard-drive and in many cases safer than a DV tape.

Quality:
Darker colors for HDV than for AVCHD. This despite the fact that colour-sampling in 4:2:0 and bitrate at 25 Mbps is the same for both formats. If you make a digital zoom in the picture, we also see that HDV has considerably more noise. (See Skybilder)
AVCHD has the best image and noise. Why this is the case is not easy to say, but some artefact can also be due to that we used two different models (both by Sony) so it can be a difference also inside the cameras. New chip better electronics and so on.

Conclusion:
AVCHD surpasses HDV in quality.But it is important to investigate whether you editing software support the format or not.

4.7 Group 6. Workflow in different editing software

Tested editing software: Final-cut pro, Premiere pro, avid and Vegas

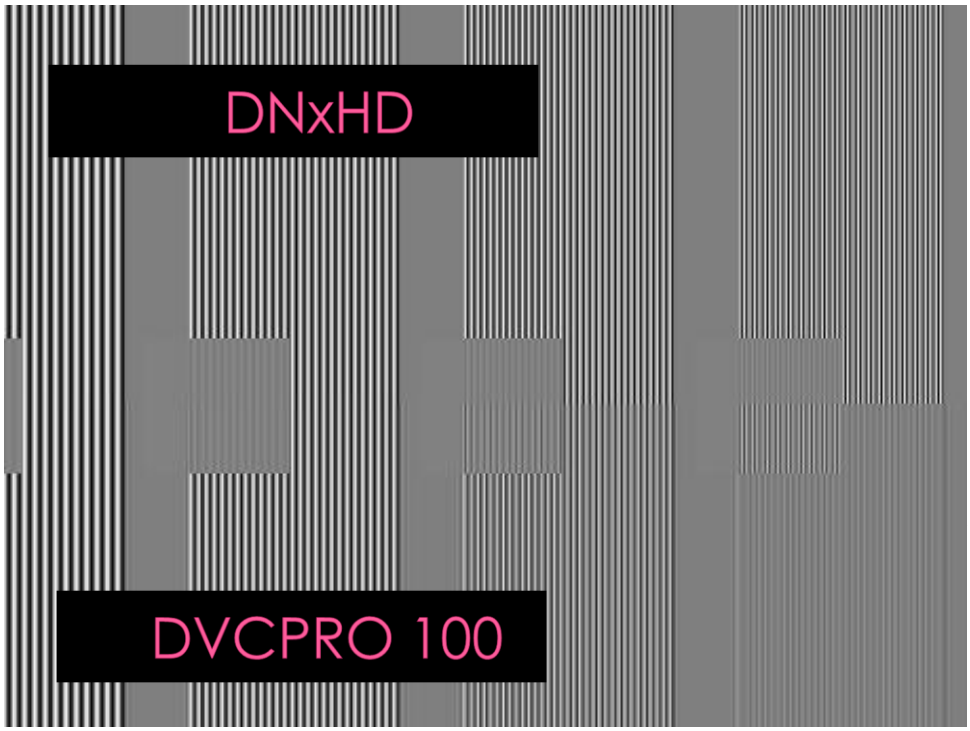
All software supported the Canon 5d 264 codec. But all programs converted the clips into their own native format.

Avid's codec DNxHD was compared with Dvc-pro HD

DNxHD has bitrate of 220,185 and 36 Mb/s (the last one is meant for offline) whereas DVCproHD has only one option 100 Mb/s

Resolution chart for codecs

DNxHD uses full 1920x1080 whereas DVCproHD uses 1440x1080



Result is that sharpness deteriorates after multiple generations of sub-sampling in post production. An advantage to use DNxHD.

Time consumptions on import:

From H.264 => DNxHD
Raw file: 21 sek
Import time: 1 min 28 sec.

Export
From DNxHD => DNxHD (for archiving masters)
Raw file: 21
Export: 2 min 26 sec.

5. Overall conclusion based on all the reports

Canon 5D is already a big success and as a still camera it is obviously a very good camera that proffesionals would have no troubles to work with. As a video camera, however, it is a different cup of tea. As we see it there is at least to big “faults”. One is the exposure controls or actually the lack of it. This is a major issue if one is to use the camera also as a professional video camera. The second issue is the quality of the sound. Even with extra external mics there is too much noise on the soundtrack and it is almost impossible to override or knowing how to deal with the camera’s internal compression and limiter system. Also here it would help a lot with manual controls. A third issue in Europe is that if you wish to produce something for a European broadcaster it is a big problem not to have the possibility to shoot in 25p. Also this should be fixed before canon 5D can be a real DSMC and thus challenge the typical VJ cameras.