For Digital Cinema Society

"Discovering the HVX200" - A chronicle of how we came to adopt the Panasonic HVX200 into the workflow of the USA Network series 'The 4400'.

by Chris Oben - (Digital Imaging Technician - IATSE 669)
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Tony Westman CSC is an award winning Director of Photography with credits including: The Sentinel, Muppets 'Wizard of Oz', Dead Like Me, and The 4400. Tony is an Academy Award Nominee and an active member of the Academy of Television Arts and Sciences Emmy adjudication committee.

Chris Oben is an acclaimed Digital Imaging Technician / On-set Colourist with credits including MGM's 'Dead Like Me', USA Network's 'Dead Zone' and 'The 4400'

In 2005 Tony and Chris collaborated to develop the Magic Lantern HD Framestore™ system which enables full HD resolution playback on-set. (see www.chrisoben.com)

HDCam vs. HDV vs. DV vs. DVCProHD

In March of this year, our series 'The 4400' returned for its 3rd season of production. Since its beginning, the series has been shot on high definition cameras. The original 6 episodes were shot with two Thomson Vipers, while the second two seasons have been shot using multiple Panavised Sony F900/3's. It was at the beginning of the season last year that we tested the freshly delivered Sony HDV- Z-1U prosumer HDV camera. As is typical of these kinds of tests we lined up the F900 and the Z-1U side by side and compared the results under various lighting conditions. We looked at contrast and exposure, motion artifacting and overall image resolution and reproduction. At that time we concluded that the Z-1U, although delivering images with very good 1080i resolution, did not meet our strict standards for motion and compression artifacting particularly in 24 frame 'Cinetone' mode. The Z-1U performed poorly in low light conditions and defaulted to an auto mode, which 'gained up' the image at the expense of signal noise. In addition we felt that the ergonomics of the camera (iris, focus and zoom controls.) were not suited for the rigors of a production environment.

Enter Panasonic.

Along with the Sony Z-1U we tested the Panasonic DVX100A. There was of course no comparison in image quality between the Standard Definition 1/3" CCD's of the DVX and the High Definition 2/3" CCD's of the F900. However, we did like the low light sensitivity and the look of the 24PA 2:3:3:2 pulldown when transferred to HDCam via a Teranex standards converter at Rainmaker in Vancouver. Additionally, the intuitive ergonomics of the DVX100a gave us confidence that the camera could be used in POV situations where an actor would be given a camera to operate. The results of these shots can be seen in episode 8 of the second season of 'The 4400.'

This season brought a new round of tests. Just in time for prep in late February, the first Panasonic HVX200 ‘P2’ cameras became available in Canada. Our original testing unit was provided by John Killeen of Commercial Electronics in Vancouver.

The first tests involved examining all of the various formats and frame rates that the HVX offers. We were only interested in the HD formats and therefore the P2 recording media was used in all cases. For these tests we asked IATSE 669 first assistant John Seale Jr., 2nd AC Tasos Menztelopolous and Steadi-Cam operator Robin Forst to run through the formats and frame rates under available daylight conditions with a walking subject.
Using the P2 recording media, they were able to capture about 10 minutes of footage before the cards were full. Each 4G card holds approximately 4 minutes of 1080 footage.

The camera was brought back to the HD workstation where I transferred the P2 data into the Magic Lantern HD Framestore™ system with the camera in ‘1394 Host Mode’ via Firewire. The framestore system was developed by Tony Westman and myself and uses a Dual 2Ghz Macintosh G5 as its host.

Once the cards were successfully transferred and re-formatted (in camera) we asked John, Tasos and Robin to try a further test, this time in a studio situation in a controlled environment. The crew was working on a scene, which was quite contrasty with a black male actor and a Caucasian female actress. The lighting contrast of the scene was carefully controlled with sufficient fill-light to meet the director and D.P.’s needs. This was clearly a situation where our main camera, the Panavised Sony F900/3 excels. Using the SONY MSU-950 at the engineering workstation we have full control over the black, gamma and the knee portions of the HD signal as well as the colorimetry. We decided to try the HVX on a rehearsal of the scene. The camera was set to the default Scene File 1 factory settings with the recording mode set to 1080 24PA. Robin recorded a wide and a tight two shot.

Once the dramatic footage was "on the chip" it was once again ingested into the Framestore G5.

The preliminary workflow was as follows:

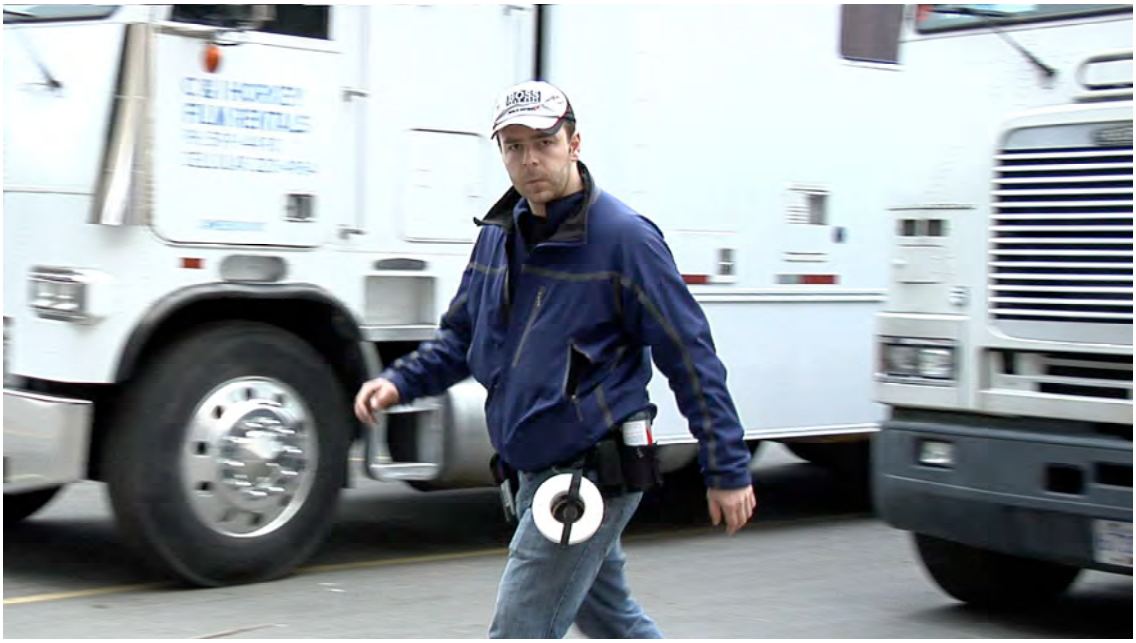
1. Transfer P2 .mxf (Material Exchange Format) files directly from the camera to the G5 hard drive via firewire. This took about 4 mins (approx. real-time)
2. Import P2 footage from hard drive into FCP 5.04 (2 mins 48 secs - approx. 65% real time)
3. Assemble 1080 24PA clips onto timeline set up as DVCProHD 1080i60 with an 'Editing Timebase' of 29.97.
4. Assemble 720PN footage on DVCProHD 720p60 timeline with an 'Editing Timebase' of 29.97
5. Playback to 23" Sony BVM-D24E 23" HD (Multiformat) CRT Monitor via an HD SDI output from the Framestore G5

It was at this point that we were able to see the P2 footage on our HD monitor and make some qualitative assessments. The original footage was shot with available light in an uncontrolled

outdoor environment. We wondered how much this would challenge the HVX200's ability to handle extreme contrast. i.e. would it hold detail in a hot sky while maintaining proper exposure on skin tones? We were also looking for resolution and compression issues as well as motion artifacting problems.

First Assessment:

HVX 200 - Preliminary motion tests



HVX200 - Preliminary motion tests

First we looked at the footage shot in available daylight. Initially Tony was not impressed by the images we saw. They were washed out, desaturated and slightly overexposed. We decided to overlook the contrast and exposure issues for the time being and instead concentrated on how the HVX captured subjects in motion. After closely examining the footage at various shutter speeds and frame rates it was apparent that the HVX200 / DVCProHD output resolution of 1080 lines gave adequate vertical resolution and produced an image that had no dramatic resolution, compression or motion artifacts. There was no discernible evidence of aliasing or quantizing.

We then looked at the footage shot in the dramatic, low-light, studio scene. Here we were immediately impressed. The images shot at preset tungsten white balance were already looking quite good without any specific adjustments other than exposure. Both color and contrast were acceptably reproduced and came quite close to matching images shot simultaneously with the - F900.

Further to our visual assessment on-set, I output the footage from FCP to HDCam tape and sent it to Rainmaker, our lab in Vancouver. This allowed colour timer Achim Kapitza, and post-production supervisor, Ben Brafman to look at the footage in an on-line suite and make an initial assessment. Their feedback encouraged us to use the HVX200 in 1080 24PA to allow clean extraction of the 2:3:3:2 pull-down inherent in the 1080 acquired footage. The 720P/PN footage could not be qualitatively assessed from HDCam tape.

After this first round of tests we concluded that the HVX200 had potential but that further controlled testing needed to be done in order to ensure that production value was not compromised by the promise of ‘HD in a small package’

The second round of tests:

One of the goals of out tests was to determine how well the HVX 200 footage would integrate into SONY F900 HDCam acquired material. Would it be restricted to 'POV' footage or material with a specific 'look' or could it actually be successfully intercut in an action scene or even a dramatic scene. Our first ‘un-official’ use of the camera would be in an action scene.

In our first episode of ‘The 4400’ Season Three the story calls for a scene where a footrace takes place. Tony felt this would be an ideal opportunity to test the HVX-200 in the field, again in an available light situation. The scene would be shot concurrently with our two Panavised Sony F900’s and the HVX200. The HVX, now affectionately dubbed ‘the P2’, would be used as a ‘chase’ cam.

As the D.P. of numerous MOW’s and series, including ‘Dead Like Me’ and The Muppets’ Wizard of Oz, Tony Westman has long been awaiting a more portable HD camera. Often shots have been compromised due to the shear length and weight of an F900 with a normal matte box and onboard battery. When shooting film Tony regularly uses his ‘Pogo-Cam’ that is essentially a counterweighted post that the operator can literally run with. The ‘Pogo-Cam’ adds a kinetic element unlike Steadicam™ or hand-held. This has been possible with 16mm and even 35mm Eyemo’s but not on HD . . . up until now.

‘On the day’

Most of the scene had been shot except for a running shot and a window shattering special effect shot. During rehearsal for the running shot Tony asked our Steadicam™ operator, Robin Forst, to operate the P2 with the Fig-Rig (a circular camera mount designed by Mike Figgis) The Fig-Rig allowed Robin to hold the camera in positions not possible in handheld configuration. Robin was also able to truly run with the actor at a speed that couldn’t be easily achieved with his Steadicam™ rig and the full sized camera. Exposure was set using 70% zebras on the built in LCD. Optical Image Stabilizing (OIS) was off. Settings were based on the HVX’s factory Scene File 1 with Gamma at HD Norm and Knee at the Med setting. Matrix was NORM.

Once the running footage was ‘on the chip’ Tony decided to operate the P2 as a ‘C’ camera during the special effect shot of glass breaking.

This P2 footage was ingested into the G5 Framestore and output using the following workflow.

1. Transfer .mxf files to G5 via Firewire with HVX200 in 1394 Host Mode
2. Import P2 footage into FCP 5.04
3. Using Cinema Tools – perform reverse telecine to remove 2:3:3:2 pulldown
4. Import new 24 frame clips to FCP
5. Assemble clips in a 24 frame DVCProHD timeline
6. Output to HDCam tape using F500(??????) HDCam deck
7. Export 1080 24P DVCProHD quicktime files
8. Transfer original .mxf data to external harddrive
9. Send external harddrive and HDCam tape to the lab

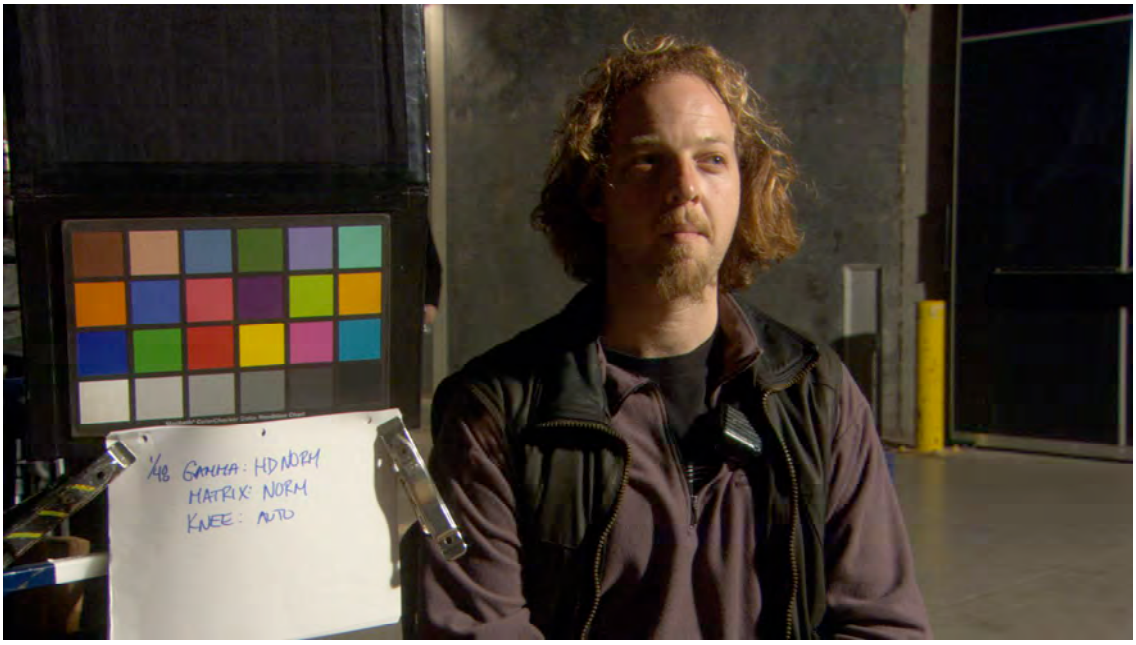
P2 – Running tests

Results:

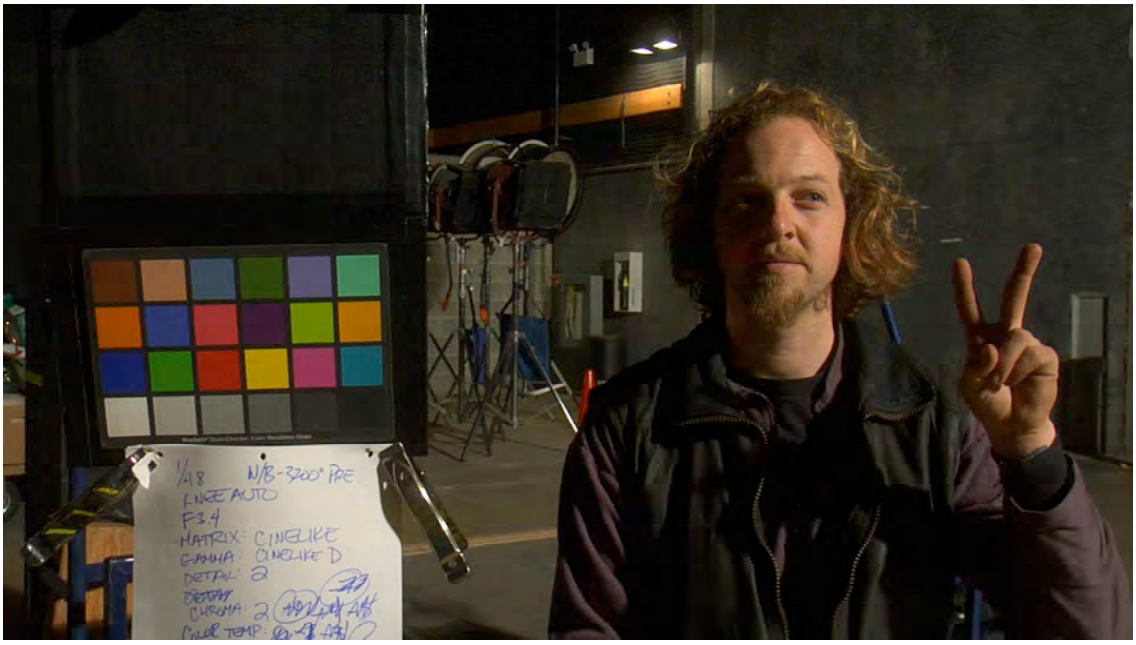
Having the footage in Final Cut allowed me to create a rough edit. The P2 material was intercut with compressed HDCam all on a DVCProHD timeline. The edit looked great. With minor tweaking I was able to bring the P2 footage into line (contrast and brightness) with HDCam. The kinetic energy of the P2 footage definitely added to the intensity of the scene. Even the breaking glass footage, which was a static shot, intercut nicely. When closely scrutinized it was possible to discern the P2 footage from the F900 by looking at the detail in the highlights. The P2 at the default settings did not hold the highlights as well as the F900.

Getting the 'look'

We brought the 'P2' back to the studio and in a controlled lighting situation, ran through the various Matrix and Gamma settings looking for the best match to our F900 look in a tungsten environment. This test was performed by comparing captured footage output from Final Cut Pro on the G5 Framestore system to our 23" HD CRT monitor. We achieved our goal using a Black ProMist 1/2 filter a Detail setting of plus 2, Gamma 'Cine-Like D' and Matrix set to 'Cinelike'.



Sony F900/3 – Matrix tests – 'The 4400' Best Boy Lionel Hebert



HVX200 - Matrix tests

Sync sound!

The success of the previous tests led us to believe that the P2 could stand up to the rigors of a sync sound scene. The next episode required dialogue while driving. The SONY F900's are quite cumbersome and long (over 3 feet in length with matte box and on-board battery). This normally means budgeting for the time-consuming use of a process trailer and ultimately shooting the scene from outside the car. Tony and the director of the episode, Morgan Beggs agreed that in the interest of expediency we would shoot the scene from within the car using the P2. Tony's challenge was to expose the interior of a vehicle that was passing in and out of sunlight with various hot or dark backgrounds. Fortunately the car had a sunroof that Tony had covered with Rosco 250 diffusion gel. This had the effect of diffusing the hard overhead light and adding to the ambience of the light level on our actors' faces.

Settings

This time we specifically created a look for the scene rather than using defaults. Based on the results of the Tungsten tests we chose to use the following settings: Detail Plus 2, Gamma 'Cine-Like D' and Matrix set to 'Cinelike'. We performed a white balance prior to shooting which was slightly warmer than preset 5600K.

Operator, Robin Forst, framed the shots from the back seat. An NTSC signal was transmitted to a follow vehicle that allowed Tony and the director to see the action and assess exposure.

Once one side of the scene was on the chip we reviewed the footage directly from the P2 via the Y, Pb, Pr analog component cable. We could tell that the color tone and exposure were great in the sun but that in the shade we were a little underexposed. So armed with this info we

downloaded the footage to the Framestore G5, formatted the cards and set out to shoot the other side of the scene.

Jackie McKenzie – aka Diana Skouris “on the road”

Joel Gretsch aka Tom Baldwin ‘at the wheel’

By this time our lab, Rainmaker, had acquired a Final Cut Pro system and was able to take the .mxf files from the external hard drive without the need for me to reverse telecine the footage on-set. This dramatically reduced the time required to prep the footage for the lab.

Resolution tests:

Our post-production workflow is centered on an HDCam as the on-line format. All material must be transferred to HDCam 1080 23.98PsF before on-line. Since, according to Panasonic, the HVX200's native chip is 960 x 540, and uses software scaling to achieve both 1080 x 1920 and 720 x 1280 we wanted to see if there really is an advantage to shooting 1080 24PA vs. 720 24PN. The actual frame rates are 1080 @ 23.976 and 720 @ 23.976. The resolution test workflow was as follows:

Test goal:

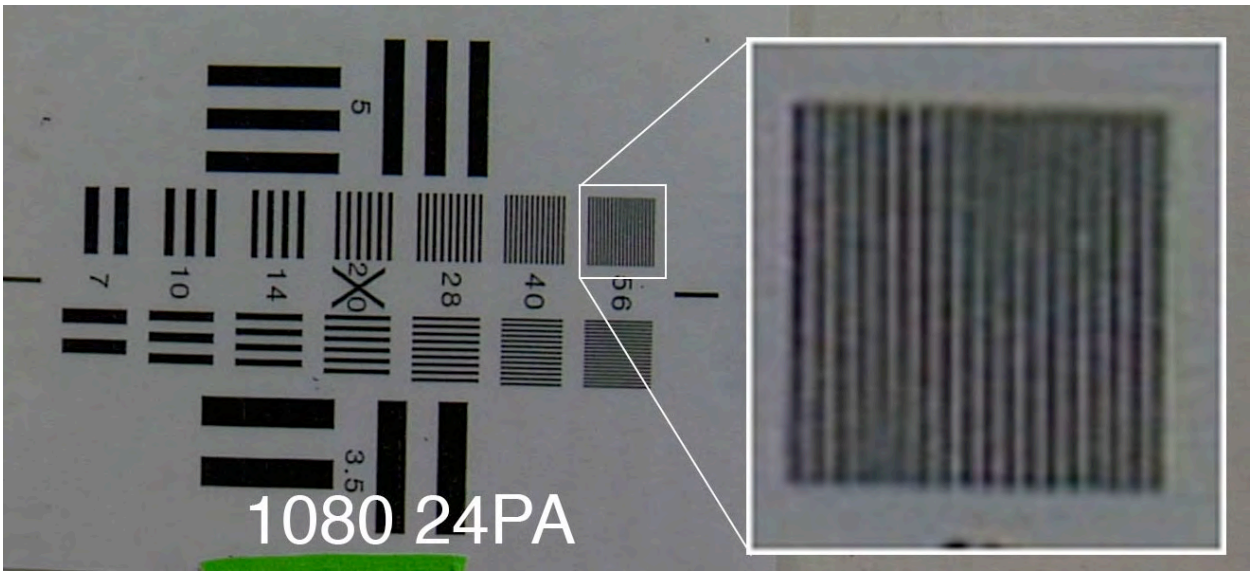
To definitively compare the effective resolution of the HVX200 in 1080 24PA and 720 24PN.
Is 1080 actually higher resolution?
When shooting 720 24PN, is the trade-off of quality for savings in file size worth the loss in quality?

Test workflow:

1. Shoot resolution chart lock-off in 1080 24PA
2. Shoot resolution chart lock-off in 720 24PN

3. Import P2 files to FCP 5.04
4. Locate 1080 24PA (actually 23.98) files in finder
5. Use Cinema Tools 3.0.3 to Batch "Reverse Telecine"
6. Settings as follows:
    i. F1-F2 / Conform to 23.98 / Standard Upper/Lower
7. Import Reverse Telecine material into FCP

8. Create 1080 23.98 DVCProHD sequence
9. Drop 1080 Reverse Telecine footage onto timeline
10. Drop 720 24PN footage onto timeline
11. Select 720 24PN clips on timeline / From 'Modify' menu choose 'Scale To Sequence'
12. (Mathematically 720 fits into 1080 by scaling to 150%)
13. Render all clips
14. Export stills from clip using Quicktime Conversion
15. Export to PSD / Millions of Colors +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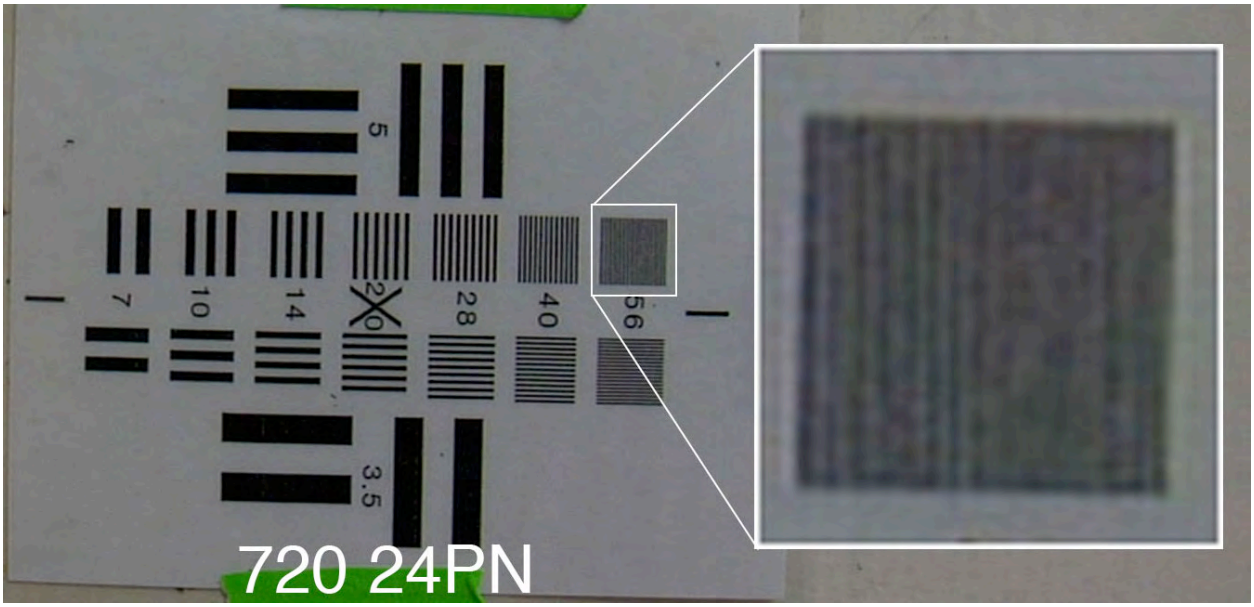
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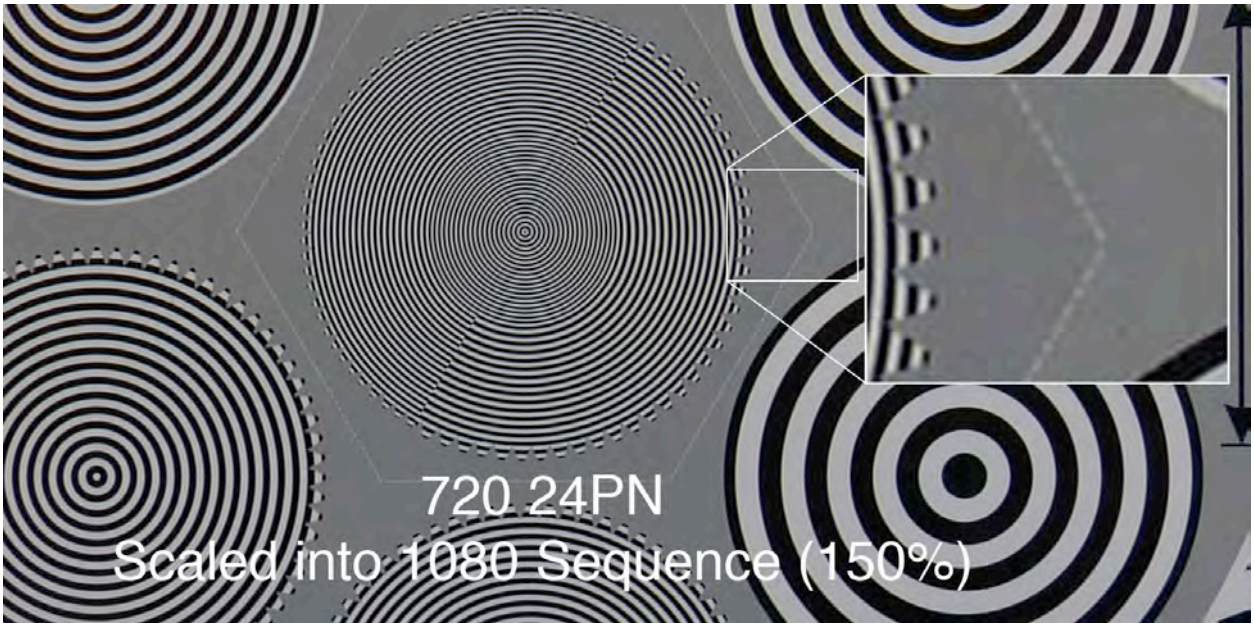

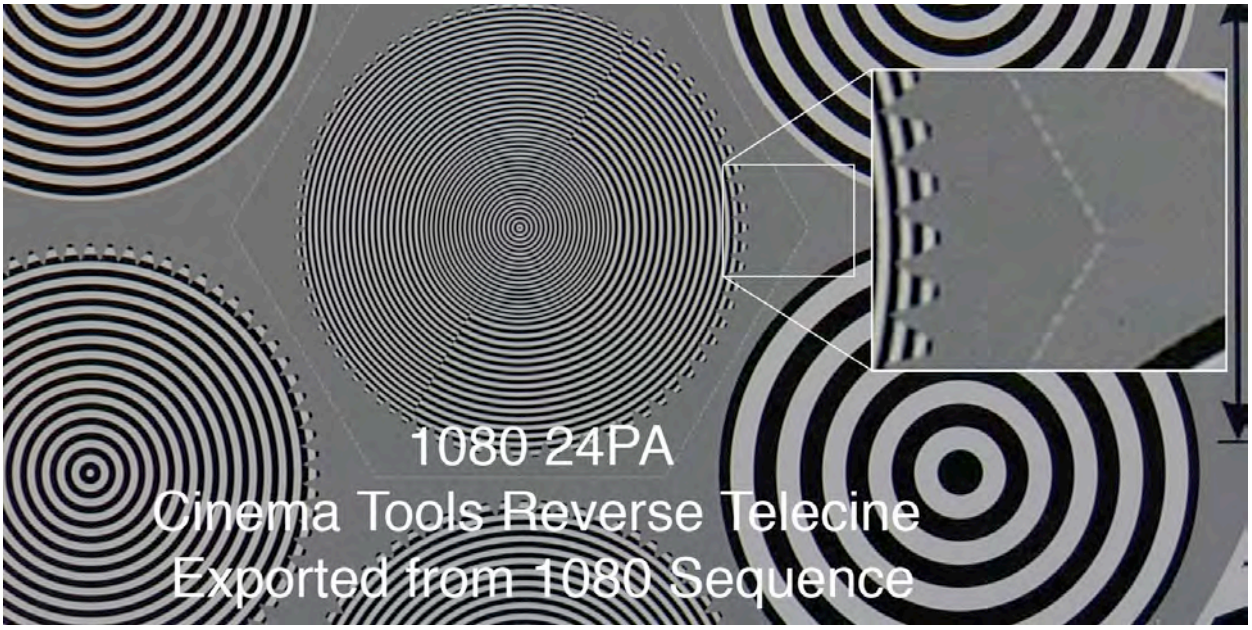

Test Results:

In comparing the test stills, particularly the 'line pair' chart, you can clearly see that shooting with ‘Recording Mode’ 1080 24PA results in higher 1080 resolution than acquiring at 720 24PN and scaling up 150% to 1080. The cost of this extra resolution is that a 4 Gigabyte P2 card holds only 4 mins of material as opposed to nearly 10 minutes when shooting 720

In my opinion, when intercutting HVX200 footage with HDCam, 1080 24PA should be used as the recording mode.

Conclusion:

With the HVX200, Panasonic has found an excellent balance between size and quality. Ergonomically the camera is well designed. The DVCProHD codec stands up to the requirements of broadcast specifications and can be intercut with HDCam acquired footage. The best characteristic of the P2 is its compact size. The most difficult aspects of working with the P2 are the limitations of storage space and the need to download the files and then the risky process of reformatting the disks. The HVX200 has been used at least one day per episode this season and it seems likely that more and more story points will be best captured with this technology.

Pros:
Versatile, lightweight (under 7 pounds with battery and mattebox)
DVCProHD quality is an extremely good acquisition format
Increased creative choices: i.e. handheld from inside a car, 'Actor Action' POV shots.

Cons:
Difficult to monitor without an HD-SDI output
P2 media (.mxf) is still not widely supported by larger post houses
Limited storage space on 4 Gig cards

Addendum:

In response to my inquiry as to why the results of the above test show that 1080 has higher resolution than 720P, Steve Mahrer of Panasonic Broadcast writes:

The HVX200 is a multi-format three chip native HD / SD camera; the imagers used are progressive, 1/3" and 960 x 540 pixels. We use a closely specified half pixel horizontal and vertical spatial offset of the (R ed + Blue) to the Green imagers. Each imager is then fed to its own 14 bit A/D, this is then fed to the camera's DSP "engine"

This new video DSP "engine" parallel processes the CCD content and in the luminance matrix processing area combines the sampled video onto a 1920 x 1080 array. The beauty of this system is that we gain an approximate 30-40% increase in effective luminance resolution from the spatial offsetting over the native imager resolution. This "correlated" image data is then gamma corrected, detail enhanced, matrixed, colour corrected etc as required. The 1920 x 1080 video "array" data is then format converted, sub-sampled and then compressed to whatever recording format is chosen by the user.

In the US HVX200 cameras, the 1080 DVCPRO HD CODEC uses a 1280 x 1080 sampling matrix for the Y signal, the R-Y/B-Y is 640 x 1080. The Y signal derived from the 3 CCDs is thus more than sufficient to saturate the 1080i CODEC and produce a very high quality image.

In 720p we sample at 960 x 720 (Y) and 480 x 720 (R-Y/B-Y), this is why the 1080p looks slightly sharper than the 720p CODEC, yet both are derived from the same CCDs….