



Congratulations



Ben Nott, Greville Patterson

Recent competitions celebrating the art and technique of filmmaking have helped establish the ARRIFLEX D-20 as one of the most versatile tools for productions of all ranges.

THE COMPANY

Cinematographer Ben Nott, ACS not only won the Gold Medal prize of the Australian Cinematographers Society (ACS) for Best Cinematography (Tele-Features, TV Drama & Mini-Series), but also this year's Outstanding Achievement Awards of the American Society of Cinematographers in the category of movie/miniseries/pilot category for his work on *THE COMPANY*, shot on the ARRIFLEX D-20. Nott's other credits include *NIGHTMARES AND DREAMSCAPES: FROM THE STORIES OF STEPHEN KING*, *COUNTER STRIKE* and *CODE RED*. He was previously nominated for the ASC Award in 2005 for the horror miniseries *SALEM'S LOT*, for which he won the Cinematographer of the Year Award from the ACS.



Michael Zimbrich (1st AD), Ben Nott (DoP), Michael Carella (A Cam OP), Michael Salomon (Director), (f.l.t.r.)

"From the outset the D-20 was a very smooth transition because there's a very film camera feel to the system. It has the same familiar form as other film cameras in the ARRI family. Secondly, it was lovely to have an optical viewfinder. I've worked with other digital cameras subsequent and I have to say looking at an electronic image through a viewfinder does not compare to the optical finder offered by the D-20. I commend ARRI on the development of a system that is very familiar to people who've shot film their whole careers," said Nott.

PHOTOS: JAN THUIS

CAPTAIN ABU RAED

For *CAPTAIN ABU RAED*, an emotional story about the human condition, the ARRIFLEX D-20 rendered appropriate visuals that led to the Sundance Film Festival World Cinema Audience Award: Dramatic. Directed by Amin Matalqa and shot by Reinhardt Peschke, *CAPTAIN ABU RAED* is the first feature film to come out of Jordan in 50 years. The production tells the story of an aging airport janitor who is mistaken for an airline pilot by a



group of poor neighborhood children and whose fantastical stories offer hope for a sad, sometimes unchangeable, reality. With a lack of laboratories in the Middle East, the filmmakers chose to keep control of the footage in their own hands by capturing with the ARRIFLEX D-20.

"We wanted a really nice, pristine, appealing, look with the least amount of grain. I was worried about not having a lab in the Middle East and concerned with customs handling film shipments every day, so we opted to shoot with the D-20," notes Peschke. "I really liked the camera, especially the viewfinder system. Since we had so many children in the film, I thought we could have longer takes and get better performances. The D-20 was a great choice for a camera and the whole experience was very rewarding."

PHOTOS: LAITH AL MAJALI



Creating a digital camera that produces cinematic images is no trivial undertaking. It takes leading edge technology, a strong research & development team and continued feedback from the field. Based on input from the many cinematographers, camera assistants and rental houses who have worked closely with our film style digital camera in recent years, we have taken a close look at all parts of the image creation chain and have re-designed the image processing software. Combined with various internal hardware changes and optimized sensor timing, the ARRIFLEX D-21 emerges as the most cinematic digital camera. All existing D-20 cameras will of course be upgraded to D-21 status.

Image Quality

Probably the most important change is the improvement to the D-21 image quality. While the D-20 had already been no slouch in this department (see the article on Ben Nott winning the ACS and ASC awards for best cinematography shooting with the D-20), the D-21 images have an improved color saturation and increased sharpness. A higher MTF was achieved by re-writing the image reconstruction (debayering) algorithm and by carefully fine tuning the interaction between the optical low pass filter and the

ARRIFLEX D-21

An Upgrade to the ARRI Film Style Digital Camera

Based on extensive feedback collected over the last three years, we have undertaken a major upgrade of our film style digital camera. While retaining the same housing and the same sensor as the D-20, the ARRIFLEX D-21 shows significant improvements to the image quality, simpler operation and new accessories. Further new options include the ARRIRAW T-Link transport method for raw data and the use of anamorphic lenses.

down sampling algorithm. A cleaner signal path, improved internal power management, the automatic correction of defect pixels through Defect Pixel Correction (see DPC sidebar) and the elimination of various artifacts have led to improved low light performance. Color management Look Up Tables (LUTs) for 100, 200, 250, 320, 400, 500, 640 & 800 ISO equivalent are now available, in addition to Log C and Log F.

Beyond its image quality, the D-21 is distinguished by its operational flexibility. The D-21's unique construction allows different output signals to be generated, accommodating diverse production needs and workflows. In HD Mode, HD output options include Lin or Log, 4:2:2 YCbCr or 4:4:4 RGB and Normal or Extended Range. Alternatively or simultaneously, the D-21 can output the raw Bayer data. In Data Mode, the full resolution of the entire D-21

sensor can be utilized, delivering a larger image than that of HD, offering numerous benefits (see D-21 Raw Data Main Features) for productions.

ARRIRAW

Great strides have been made towards a feasible method for recording raw data. The 12 bit ARRIRAW format contains the raw Bayer data and can be used up to 30fps. Connecting the D-21 to a suitable recorder is as easy as using two BNC cables, thanks to the ARRIRAW T-Link method, which packs the ARRIRAW data into a standard dual link HD-SDI stream (see ARRIRAW T-Link). Close cooperation with manufacturers of data recorders ensures a method of recording and previewing image data. ARRI software tools that are currently in beta testing can process the ARRIRAW files through advanced image reconstruction (debayering) algorithms. The ARRI software can out-



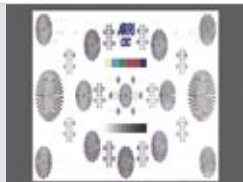
The D-21 can provide various HD formats and raw data at the same time through its flexible output options



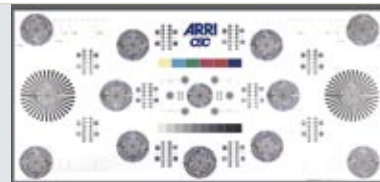
put either an HD image or a 2k data file. The 2k data files are as easy to grade as data files scanned from film, since a special color conversion matrix and LUTs in the ARRI software create data files of the same pixel raster and film-like colorimetry as film scans.

Anamorphic Filming

Since the raw data format transports all pixels of the 4:3 aspect ratio D-21 sensor, the D-21 is the only digital camera that allows the use of standard anamorphic lenses, expanding the creative choices of directors and cinematographers who choose to work with digital images.



The D-21 sensor has a 4:3 aspect ratio, allowing the use of any anamorphic lens. Here is the original 4:3 (= 1.33:1) image from the D-21, shooting a test chart at ARRI CSC with an Optimo 24-290 and an anamorphic rear-adapter



By stretching the image in postproduction, a 2.66:1 image is obtained. The proper 2.39:1 aspect ratio can now be achieved by cropping the sides

Easy Operation and Updates

Through suggestions from the field we have further simplified the controls of the D-21. Even though the D-20 has already been praised for its simple operation, we know how high the pressure on the set can be,

and how crucial a simple menu with easy to understand commands is. The D-21's frame rate can now be set only once on the Video Menu, and the Video Menu structure has been simplified for faster and safer operation. For remote situations, it is possible

Defect Pixel Correction (DPC)

While modern image sensors are veritable miracles of technology, the very fact that they crowd millions of tiny picture elements (pixels) into the smallest possible space creates also some defect pixels. Careful quality control during the manufacturing process ensures that most pixels are performing just fine, but some pixels provide no signal, some too much signal and others a signal with too much noise. Moreover, it is difficult to determine when a given pixel will decide to go bad. This is an issue affecting all digital cameras, and while it has been dealt with in the D-20 through a manual method for creating a defect pixel map, it has been greatly improved through a fully automatic defect pixel detection and correction system (DPC) in the D-21.

The detailed functionality is complex, but the basic concept works like this: the D-21 constantly checks each pixel in each frame against a reference field of surrounding pixels to identify defect pixels. It does this based on the fact that even small image details

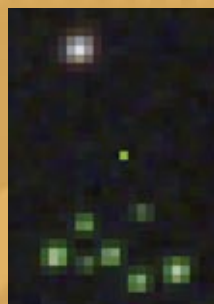
will bleed a tiny amount into surrounding pixels (see images). If a defect pixel is identified, the D-21 uses a special algorithm to replace it. At 60fps, the D-21 evaluates a staggering 42 million pixels per frame, that works out to 2.5 billion pixels each second. Amazingly, the whole analysis and correction procedure works in real time. Thanks to the processing power of the D-21's FPGAs (Field Programmable Gate Arrays, essentially re-programmable computer chips), the DPC adds no delay to the image processing pipeline.

Because the DPC catches and replaces not only dead and defect pixels, but also pixels that exhibit visibly more noise than their neighbors, the D-21 gains the added benefit of a very subtle noise reduction in the dark parts of the image. As the DPC works automatically on each pixel of each frame as soon as the camera is turned on, there is no more human intervention necessary.

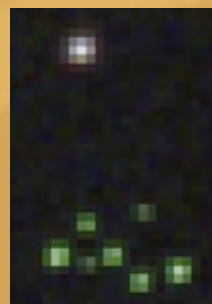
Here is a 200 x 150 pixel excerpt from a D-21 image. The camera was looking at a black piece of cardboard with tiny holes, some with red, green and blue gels, placed before a light box to create an image with very small and detailed image content. The purpose of these images is to illustrate the DPC process. The actual DPC is being performed on the raw Bayer data, and thus difficult to show.

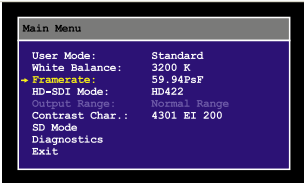


A further zoom in reveals a (simulated) bad pixel that has turned completely green. It is easy to see here that even pixel-sized details of image content look distinctly different from a defect pixel.

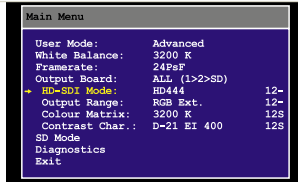


The DPC has identified the bad pixel and replaced it with a new pixel. While a simple averaging of surrounding pixels had been tried originally, that turned out to be not completely invisible and tended to "smear" the image content. So a specialized algorithm had to be created to ensure that the newly calculated pixel blends perfectly into its surroundings.





The D-21 Video Menu in standard mode. A cleaned up menu structure makes operation of the D-21 on the set safer and faster



The D-21 Video Menu in advanced mode

Locking the left side display will now also lock the jogwheel in the back



to control the camera from a laptop via an Ethernet connection. The LOCK sliding switch on the camera left side display will now lock the buttons on that display, as well as the jogwheel on the back to avoid accidental operation.

Software updates can now be achieved through a simple Windows program, and are being distributed through the same method already successfully used for ARRI film cameras.



The D-21 Update program provides easy updates with the push of one button

ARRIRAW T-Link

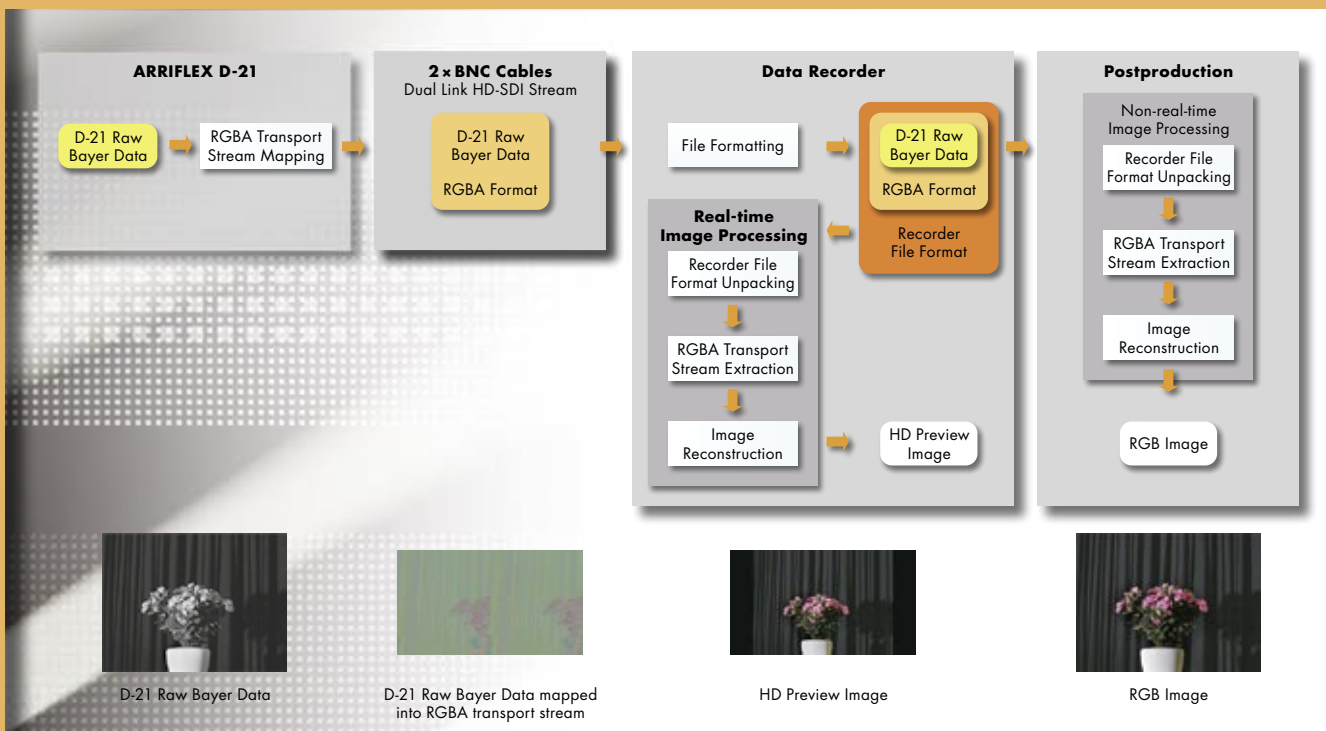
One of the obstacles that has stymied the use of raw data in the past has been the problem of how to get data easily from the camera to a recorder. ARRI engineers have found a way to utilize a standard dual link HD-SDI connection to transport the raw D-21 Bayer data. This new transport method is called "ARRIRAW T-Link" (Transport Link). It allows any recorder capable of recording an uncompressed dual link HD-SDI stream to record raw D-21 Bayer data, greatly simplifying the raw data workflow for manufacturers and users alike.

The properties of the dual link HS-SDI connection are defined in SMPTE 372M. The standard specifies a maximum data rate of 2.97 GB/s, which is enough bandwidth to carry the 12 bit D-21 raw Bayer data. SMPTE 372M also defines a number of standardized source signal formats to be sent through two BNC cables (affectionately known as Link A and Link B).

One of those source signal formats is the RGBA format. RGBA stand for red, green and blue plus an alpha channel, technically called 4:4:4:4 (R'G'B'+A) / 10bit. The ARRIRAW T-Link works by mapping the 12bit raw Bayer data into this RGBA data stream, so that it can

be transported via a dual link HD-SDI connection. Any recorder that is capable of recording a SMPTE 372M compliant RGBA signal and playing it back without compression or further encoding can record this signal. If the signal is recorded by a data recorder, the additional option of a live preview exists. The data recorder can extract the original D-21 raw Bayer data out of the RGBA data stream, and use a real-time image reconstruction (debayering) algorithm to display the 4:3 image as a 1440 x 1080 preview HD image. If anamorphic lenses are used on the D-21 a suitably "de-squeezed" image can be displayed on an HD monitor.

A similar process is used in postproduction. The original raw Bayer data is extracted from the RGBA stream, and advanced debayering algorithms are used to reconstruct a pristine image in HD or 2k. Doing this in post has the added advantage that it does not have to be done in real-time, so a significantly better image quality and greater flexibility are possible. Note that throughout the whole process, the image always stays uncompressed, at the highest quality.

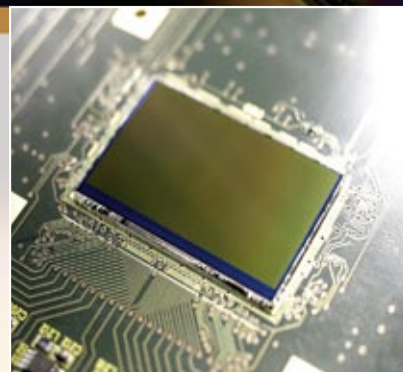
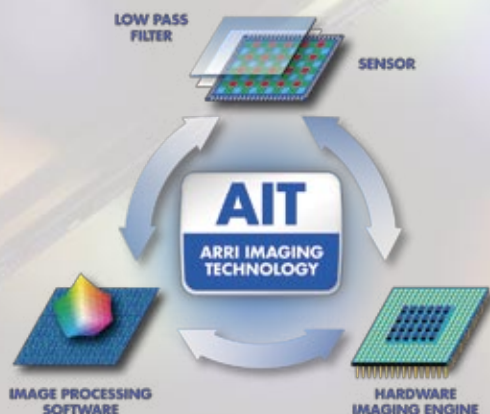


ARRI Imaging Technology

For us as an equipment manufacturer, developing a film camera and developing a digital camera are processes with interesting similarities and differences. While both share elements we are very familiar with, like an optical viewfinder, a mirror shutter, PL mount lenses, similar ergonomics and accessories, there is a basic difference that required the establishment of a whole new

department within ARRI: in a digital camera we are responsible for the actual image creation. The proprietary technology that creates the uniquely beautiful D-21 images has now been given its own name: ARRI Imaging Technology (AIT).

AIT stands for the smart orchestration of a custom designed CMOS sensor, a finely tuned optical low pass filter, a powerful imaging hardware engine and advanced image processing algorithms. Each part of the D-21 is custom developed to perform optimally in a digital motion picture camera, and thus we fully control the D-21's imaging chain down to the smallest detail. This allows an optimization of the whole system far beyond what would be possible with off-the-shelf components. In addition, we are engaged in continuous testing and improvements to all parts and their interaction. Through AIT, the D-21 produces outstanding images with a cinematic look and feel, high dynamic range, high contrast and the most film-like color reproduction of any digital motion picture camera.



The CMOS sensor inside the D-21 was designed and developed specifically for use in ARRI high end motion picture cameras. Its Super 35 size and 4:3 aspect ratio ensures perfect compatibility with the unequalled variety of existing spherical and anamorphic cine lenses

Accessories

A number of new hardware pieces complete the picture. A new shoulder set D-1 has been created specifically for the D-21. Similar to the ARRICAM shoulder set in functionality, the D-1 can accept a quick release plate, which attaches directly to a tripod head. Additional around classes for

the 1.33, 1.78, 1.85 & 2.39 formats will soon be available. D-21 cameras can be equipped with the FEM-2 addition, which provides a built-in radio for wireless lens and camera control. The FEM-2 also contains motor drive electronics, so the ARRI Controlled Lens Motors (CLM) can directly into the camera, avoiding extra boxes. Not least, the SONY SFR-1 allows the remote control of the SONY HDCAM SR field recorder through the D-21's fiber optic Remote Interface SFI-1.



The SFR-1 can start (REC) and pause (PAUSE) recording of the SONY HDCAM SR field recorder. In addition it can play back a few seconds of the last take (REVW) and shows when the deck is recording (green TALLY LED) or ready to record (blue READY LED)



The D-1 has three quick release plates. It fits into the camera's shoulder. It provides air to the camera's cooling system. A quick release plate can be attached to the bottom of the D-1



The Functional Expansion Module FEM-2 contains motor drivers for lens motors, hardware and software for the Lens Data System as well as a slot for an optional radio. With the Universal Radio Module URM-3 installed, the D-21 and its lens can be easily and quickly controlled by the ARRI Wireless Remote System (WRS)

ARRIFLEX D-21 Main Features

A number of powerful FPGAs (Field Programmable Gate Arrays) constitute the imaging hardware engine inside the D-21. They are a crucial component of ARRI Imaging Technology

Optical Viewfinder

- zero delay
- outside image area
- bright, full color image
- works without power
- fatigue-free viewing

ARRI Imaging Technology (AIT)

- custom designed CMOS sensor
- custom designed, powerful imaging hardware engine
- unique ARRI image processing software
- carefully tuned system integration

Cinematic Image Quality

- AIT creates a cinematic look
- rotating mirror shutter for film-like motion portrayal
- single, Super 35 format sensor for 35 format depth of field
- highest dynamic range of any motion picture CMOS camera
- super sharp, alias-free images through over sampling, finely tuned optical low pass filter & advanced image reconstruction algorithms
- extended color space provides natural, film compatible color reproduction
- consistent match between cameras

35 Format Film Lenses

- industry standard PL mount
- unequalled variety of prime, zoom & specialty lenses
- compatible with spherical and anamorphic lenses (1.33:1 sensor format)

Compatibility with 35 Format Film Accessories & Support Equipment

- ARRI matte boxes, follow focus, wireless remote control
- dollies, cranes, Steadicam, etc.

A True ARRI Camera

- silent running < 20 dBA @ 24 fps, (no fan)
- simple operation
- robust construction
- ergonomic design
- variable speed (slow motion, ramps)

Flexible Output Options: Data and / or HD Modes

- simultaneous data & HD outputs possible
- Data Mode: 4:3 ARRIRAW uncompressed data for film-like 2k workflow
- Data Mode: ARRIRAW T-Link
- HD Mode: 16:9 uncompressed HD output
- HD Mode: Lin or Log, 4:2:2 YCbCr or 4:4:4 RGB, Normal or Extended Range
- Fiber optic option allows cable lengths of up to 500m / 1,600'

Modular Architecture

- sensor, electronics & firmware can be upgraded
- secure investment
- long product cycle

D-21 Raw Data Main Features

Superior Image Quality

- uncompressed, unprocessed 12 bit raw Bayer sensor data (ARRIRAW)
- the output option with the highest dynamic range & lowest noise
- images are "developed" in post with AIT advanced image reconstruction (debayering) algorithms
- decisions regarding color space conversions and look up tables are made in post
- upgraded image reconstruction can be applied to archived raw data for better image quality

Use Full Sensor Resolution for 2k or HD Output

- 2880 x 2160 (4:3) at 24 and 25 fps
- 2880 x 1620 (16:9) at 30 fps
- finer detail and crisper edges
- 2k files have the same pixel raster and film-like colorimetry as 2k scanned data from film
- easy, familiar post workflow
- easy image reposition and cropping

Cinemascope

- anamorphic lenses can be used

Flexible workflow options

- simultaneous data and HD output possible for HD video monitoring & offline editing
- ARRIRAW T-Link: transport ARRIRAW data via dual link HD-SDI
- ingest converted data files to NLE