American Society of Cinematographers Technology Committee Report

By Curtis Clark, ASC; Michael Goi, ASC; David Reisner; Dave Stump, ASC; Richard Edlund, ASC; Al Barton; Lori McCreary, PGA; Lou Levinson; Joshua Pines; Gary Demos; Jim Fancher; Jim Houston; Glenn Kennel; Grover Crisp; Garrett Smith; Stephanie Argy; Lenny Lipton; David Morin; Ron Frankel

Chair: Curtis Clark, ASC
Vice-Chair: Richard Edlund, ASC
Vice-Chair: Steven Poster, ASC
Secretary: David Reisner

Introduction

ASC Technology Committee Chair: Curtis Clark, ASC

For the past several months, the central project for our ASC Technology Committee has been the Camera Assessment Series (CAS) conducted jointly by the American Society of Cinematographers, the Producers Guild of America and Revelations Entertainment. The group selected seven digital motion picture cameras and compared each of them to a film reference—the benchmark standard for theatrical motion picture quality. CAS was designed to explore performance characteristics of the seven cameras within a commonly used hybrid film/digital 2K post workflow designed for theatrical motion picture releasing on print film and digital cinema (DCP) to determine how compatibly these digital motion picture cameras would fit in that workflow without having to go through proprietary post facility image transform machinations.

For the better part of this year, the enormous scope of this ambitious all-volunteer project has demanded continuous attention, starting with initial planning and preproduction through shooting and then through Digital Intermediate (DI) post finishing for seven digital motion picture cameras and one film camera.

Four scenes from the shoot have been selected for the final version of the presentation: a day exterior; a day interior; a dusk/night interior; and an extreme high tonal contrast interior using a bare light bulb as a single light source. All scenes were shot on standing sets used for the TV series "Desperate Housewives."

While there are many ways that these cameras can be used and integrated into productions, the Camera Assessment Series was designed to test the cameras within a commonly used hybrid film/digital post workflow finish designed for theatrical motion picture release on print film and digital cinema (DCP). Needless to say, many people were eager to suggest alternate approaches based on their varied experiences with custom workflow post finishing procedures. Filmmakers develop highly personal and frequently conflicting perspectives on digital camera image quality that correspond with their varied results. To get a manageable handle on the digital cameras' image performance we realized it was necessary to eliminate the "wild card" variability of multiple workflows by selecting a commonly deployed "neutral" DI workflow finish for all the cameras.

As far as we know, this is the first time that anyone has done a photographic performance assessment of the seven participating digital motion picture cameras using a commonly deployed DPX file-based film-centric digital intermediate workflow finish. Our target imaging reference was film because "film look" has been the defining photographic benchmark from the inception of cinema. Most of the digital motion picture cameras selected for CAS have implemented a log-encoding option for their image capture in their attempt to move beyond the confines of HD Rec.709 to more closely emulate the performance characteristics of a film negative within DI post finishing. Consequently, we wanted to assess how log-encoded images from these digital motion picture cameras fit in that hybrid film/digital post workflow, without necessarily having to go through proprietary "secret sauce" post facility contortions to make them fit into that workflow. The DI pipeline was 2K because we wanted this assessment to be representative of the majority of current DI post finishing. (NB: the 35mm film references were scanned at 4K on a Spirit Data Cine and converted to 2K.)

A primary discovery made at the start of the DI post process was that all the log-encoded digital camera images required an Input Device Transform (IDT) to adjust the gamma slopes of their respective log curves to be more compatible with Cineon print density, thereby enabling the non-destructive use of a film print emulation LUT for color grading intended for film out. The ASC Color Decision List (CDL) Power function proved to be an effective IDT. As a result of this experience, some digital camera manufactures have started to create IDT LUTs to provide this essential function for their respective cameras.

Having gained invaluable knowledge and experience via CAS about the performance of the current crop of "mainstream" digital motion picture cameras, we now have a better understanding of the challenges that filmmakers face in maximizing the imaging potential of these cameras within various post workflow options.

In addition to the ASC Technology Committee Subcommittee reports included in this SMPTE progress report, our ASC Technology Steering Committee has recently reviewed and agreed on our agenda for the coming year. The pressing issues concerning workflow color management and the need for unambiguous transforms between log, video "linear"(gamma), and scene referenced linear encoded images have been intensified by the rapid adoption rate of digital motion picture cameras for both feature and TV production. As a consequence, the ASC Technology Committee will be focusing attention on the Academy of Motion Picture Arts and Sciences (AMPAS) Science and Technology Council's Academy Color Encoding Specification (ACES) within its Image Interchange Framework (IIF) as defined by their proposal.

ASC President's Report

ASC President: Michael Goi, ASC

This is shaping up to be a really great year. Not just in terms of the accomplishments of the ASC Technology Committee in the area of the CAS with the Producers Guild of America (PGA) and Revelations Entertainment, or our partnership with the Art Directors Guild and the Visual Effects Society on the Subcommittee for Previsualization, but in terms of how these endeavors, and more, are opening dialogue between artists and technology gurus.

I'm not a technology guru. You can write a formula on a blackboard in front of me and you may as well be writing in ancient Sanskrit. But I know enough to see where this is all heading. I saw the enthusiasm with which the participating camera manufacturers in the CAS viewed the results and immediately came to realize the potential for the next generation of their systems, what they could include or refine to make their cameras more serviceable to the artists who use them.

In Fritz Lang's 1927 film Metropolis, the message is that the hand and the heart must work together in order for progress to occur; each is meaningless without the other. And working together to resolve our mutual dilemmas can only result in a stronger industry. It is one of the foundations of why SMPTE was formed and goes straight to the heart of the three words on the shield of the ASC: Loyalty, Progress, Artistry.

I look forward to what the rest of the year will bring. I have a feeling that we're on the verge of an unprecedented level of cooperation and coordination of our efforts toward the end of making our industry better—our crafts better. And I am proud to be a part of this industry at this moment in its history.

Secretary's Comment

ASC Technology Committee Secretary: David Reisner

Since the beginning of the new century we have been seeing major changes and shifts in the way movies are designed (previs), shot (new film stocks, and digital motion picture cameras), post-produced (faster, high-resolution film scanning, pervasive DI mastering, visual effects (VFX), and work coordinated between multiple facilities), delivered (film prints and digital cinema DCPs), and exhibited (film and digital projection, HD displays in the home). As we accommodate to those changes and learn how to use these new technologies as part of our art and engineering, our processes have had to change, adapt, and evolve. Happily, with those changes come opportunities, and sometimes requirements, for improvement. And happily, as an industry we seem ready to make some of those improvements.

The ASC-PGA Camera Assessment Series (CAS), conducted collectively by the ASC Technology Committee's Camera, Workflow, and Metadata subcommittees and the PGA, is providing one very useful set of images, to aid in selecting the right camera for the right project. CAS also clearly demonstrated some of the problems with current workflows. For a number of years, the Advanced Imaging subcommittee has advocated that post use wide gamut and wide latitude linear light and floating point arithmetic, and with work in the Academy of Motion Picture Arts and Sciences Academy Color Encoding Space (ACES) and the Image Interchange Framework (IIF) we may start to see those become part of the standard post process. Along with that we also require clear definition and use of terms—no more "linear" when we mean "video gamma," what we actually mean by a given use of camera "raw" or "log." The DI subcommittee's ASC CDL makes it possible to move primary color corrections between equipment and facilities for on-set, dailies, and post. Ability to view those intended looks is being supported by work in the Digital Display subcommittee. We are also seeing the beginning of standardized transforms and processes that allow facilities to move away from developing their own "secret sauce" solutions for ingesting camera data and other operations and focus all their energies on supporting the artistry of their clients.

As indicated by the ASC-ADG-VES collaboration in the Previs Joint Committee, new capabilities like previs add yet another reason why movies can be made more efficiently and economically if filmmaking teams are assembled early, involving key creative collaborators (director, cinematographer, production designer, visual effects (VFX) supervisor) as much as possible in pre-production, and establishing good communication early on. Involving post-production in making decisions for on-set data and metadata management helps ensure the smoothest transfer from production to post-production, and often allows them to overlap. End-to-end testing—scene to screen (digital, film, or home), including any necessary trips to VFX—is still the best way to ensure that everything will work as planned, increasing the prospect that the best image can be delivered to the audience. Keeping cinematographers, art directors, colorists, post-production, and VFX involved from conception to mastering provides the best possible communication and realization of the intended look and allows us to deliver our best work to the audience.

Camera Assessment Series

Co-chair: Curtis Clark, ASC; Co-chair: Dave Stump, ASC; Co-chair: Al Barton; Co-chair: Lori McCreary, PGA Secretary David Reisner

Camera Subcommittee Chair: Dave Stump, ASC; Vice-chair: Richard Edlund, ASC

Workflow Subcommittee Co-chair: Al Barton; Co-chair: Gary Morse; Secretary: David Reisner

For the past several years, the ASC Technology Committee, particularly the Workflow and Camera subcommittees, have been discussing, designing and planning a CAS, to better understand the characteristics of the popular digital cameras intended for use in feature motion pictures (see ASC Technology Committee Progress Reports for 2006, 2007, 2008). In addition to the continued enhancement of the cameras and introduction of new models, a major issue has been that some manufacturers consider a particu-

lar workflow "native" or ideal for their camera. Running a serious multicamera evaluation is a large task, and managing different workflows using volunteer resources and efforts was beyond what could be reliably achieved.

Digital camera development has reached the point where cameras are being built and tailored for use in theatrical motion picture production, as opposed to primarily TV. And more pictures are being shot digitally. At the end of last year, Sony Pictures Entertainment (and subsidiaries) was shooting about 20% of its pictures digitally. (Nearly 100% of studio level feature motion pictures are now being completed via DI.) There was increasing industry interest, as well as a growing need for the Camera Assessment Series—especially for an assessment of digital cameras used for feature motion picture production.

The PGA and Revelations Entertainment have been involved with the ASC in CAS planning for some time and with the creation of the PGA Motion Picture Technology Committee (MPTC), chaired by Lori McCreary, PGA, and the MPTC's desire to be able to present CAS results at their Produced By conference in June 2009; CAS planning acquired the added impetus of a hard deadline.

We realized that CAS data management and post-production would be much more readily managed with a single workflow. For feature motion picture production, with either film or digital origination, the 10-bit DPX Cineon print density workflow is a de facto industry standard—by far the mostly widely used and supported. We decided to proceed with the Camera Assessment Series, running all cameras through the same 10-bit DPX Cineon print density workflow and using the film print look as the reference and target for all the cameras. While it is true that any particular camera may be able to produce excellent images using a different workflow, this approach best shows the practical ability to use images from a particular digital camera with other camera equipment (both film and digital) in producing today's motion picture releases.

Ultimately, in January 2009 we shot a film reference and seven digital cameras for two days on the "Desperate Housewives" standing sets (Wisteria Lane) on Universal's back lot, with about 250 crew, cast, and manufacturers' representatives, in five location teams and eight camera teams. Each location team was anchored by an ASC cinematographer and each camera team was anchored by a manufacturer-approved cinematographer and appropriate crew. The film camera was an Arri 435 with 5207, 5217, and 5219 stock—Walter Lindenlaub, ASC. The digital cameras were the Sony F23—Stephen Lighthill, ASC, and Peter Anderson, ASC; Sony F35—Kramer Morgenthau, ASC, and Sam Nicholson; Panasonic AJ-HPX3700—Roberto Schaeffer, ASC; Arri D-21—Bill Bennett, ASC; Panavision Genesis—Shelly Johnson, ASC; RED One—Nancy Schreiber, ASC; and Thomson Viper—Marty Ollstein. The locations were Jaws Lake—Curtis Clark, ASC, and Dave Stump, ASC; Night Interior—Michael Goi, ASC; Picket Fence—Steven Fierberg, ASC; House Exterior—Richard Edlund, ASC; Garage Interior and Blue/Greenscreen—Bob Primes, ASC; Day Interior—Matthew Leonetti, ASC; Wisteria Park—John Toll, ASC.

Each camera shot eight scenes, five of which were used in the final CAS presentation—Day Interior, Night Interior, an extreme High tonal Contrast Interior using a bare light bulb as a single light source, and an early-morning Day Exterior with flame and water elements.

Photo by David Reisner

250 crew and cast setting up eight teams in five locations on Wisteria Lane.

Photo by David Reisner

Eight camera teams shooting Jaws Lake just after dawn.

Day Interior. Location DP Matthew Leonetti, ASC.

Night Interior. Location DP Michael Goi, ASC.

Extreme High tonal Contrast Interior using a bare light bulb as a single light source. Location DP Bob Primes, ASC.

Early morning Day Exterior with flame and water elements. Location DPs Curtis Clark, ASC, and Dave Stump, ASC.

Post-production for the eight cameras proved to be a very large job, and provided almost as many lessons as the camera results. Chair Curtis Clark, ASC's Introduction discusses goals, post-production, and some results. An upcoming *SMPTE Motion Imaging Journal* article will discuss CAS in more detail.

One issue CAS highlighted was problems with metadata. Camera notes and slates frequently did not agree, often requiring time in post to try and determine what take was actually being viewed and at what exposure the take had been shot. A good on-set metadata collection system, or for that matter reliable and careful execution of traditional shot notes, would usefully improve this.

CAS also showed the limitation of digital cameras using 10-bit interfaces. SMPTE has recently (or is about to) published a specification for 12-bit HD-SDI. The 12-bit interface will provide more image information—more tonality, more gradations in color, and more filmic feel.

CAS experience with the Cineon-based workflow strongly suggests that even 12-bit DPX will only be a stop-gap during the transition to a large gamut, high dynamic range workflow with clear handling of transforms from log to linear—very possibly AMPAS' proposed Image Interchange Framework architecture. A future CAS would probably be done with a 4K IIF workflow, continuing to include the ASC CDL to allow interchange and interoperation of basic primary color corrections.

Manufacturers consistently saw a risk to image quality from locally generated transforms from camera log output to Cineon DPX. Observing this issue, several manufacturers have created new reference transforms so that any user of that camera mode can get from camera into post with the highest quality and efficiency.

CAS had great participation from all of the camera manufacturers, many rental houses and suppliers, supporting vendors (like data recorders), as well as an A-list of members of the Hollywood production community. The camera manufacturers participated actively and generously (although the combined time demands of production and post did ultimately impose some practical limitations). Reports are that camera manufacturers may have learned as much about how their cameras are used and what cinematographers actually need as we did about the cameras. And, especially because of the round-robin scheduling of part of the shoot, camera manufacturers had an unusual opportunity to interact with each other.

The ASC and AMPAS' Science and Technology Council are jointly working to process several camera's CAS data using IIF components, with particular attention to the ACES colorimetric encoding specification. This should be an extremely useful test of the IIF approach, both in how it handles look and in giving a good deal of insight into likely issues that would be encountered in commercial productions.

The Camera Assessment Series is providing moviemakers with an opportunity to look deeply at each camera and evaluate appropriate selection for a particular project.

Producers Guild of America Motion Picture Technology Council

Chair: Lori McCreary

The PGA would like to acknowledge the ASC for its vision and outstanding leadership in (and for) our industry.

The ASC and members of the ASC Technology Committee have donated literally thousands of hours of their own time as well as used their professional reputations to influence other industry professionals to donate their time and services.

And it is all for the greater good of the entire industry.

Digital Intermediate Subcommittee

Chair: Lou Levinson; Chair: Joshua Pines; Secretary: David Reisner

The most recent concerns of the DI sub-committee have involved work on two fronts: keeping the ASC CDL moving forward, and providing support for the ASC Technology Committee's major recent achievement—the ambitious Camera Assessment Series.

Earlier this year we reached agreement on the next version of the ASC CDL, which has now been published as v1.2. v1.2 provides the formal definition of the much-sought Saturation function with example code and test images. Saturation basically performs a cross-fade from color to black-and-white, with the RGB color components weighted as found in most Rec. 709 saturation function implementations. v1.2 also includes additional discussion of the ASC CDL's position in a workflow.

To get a copy of the ASC CDL implementation documentation, send an e-mail to asc-cdl @theasc.com. The response will contain instructions.

The ASC CDL also played an un-anticipated but helpful role in the CAS post process. See Curtis Clark's Introduction for discussion of how the ASC CDL Power function was used to bring delivered DPX files closer to Cineon print density.

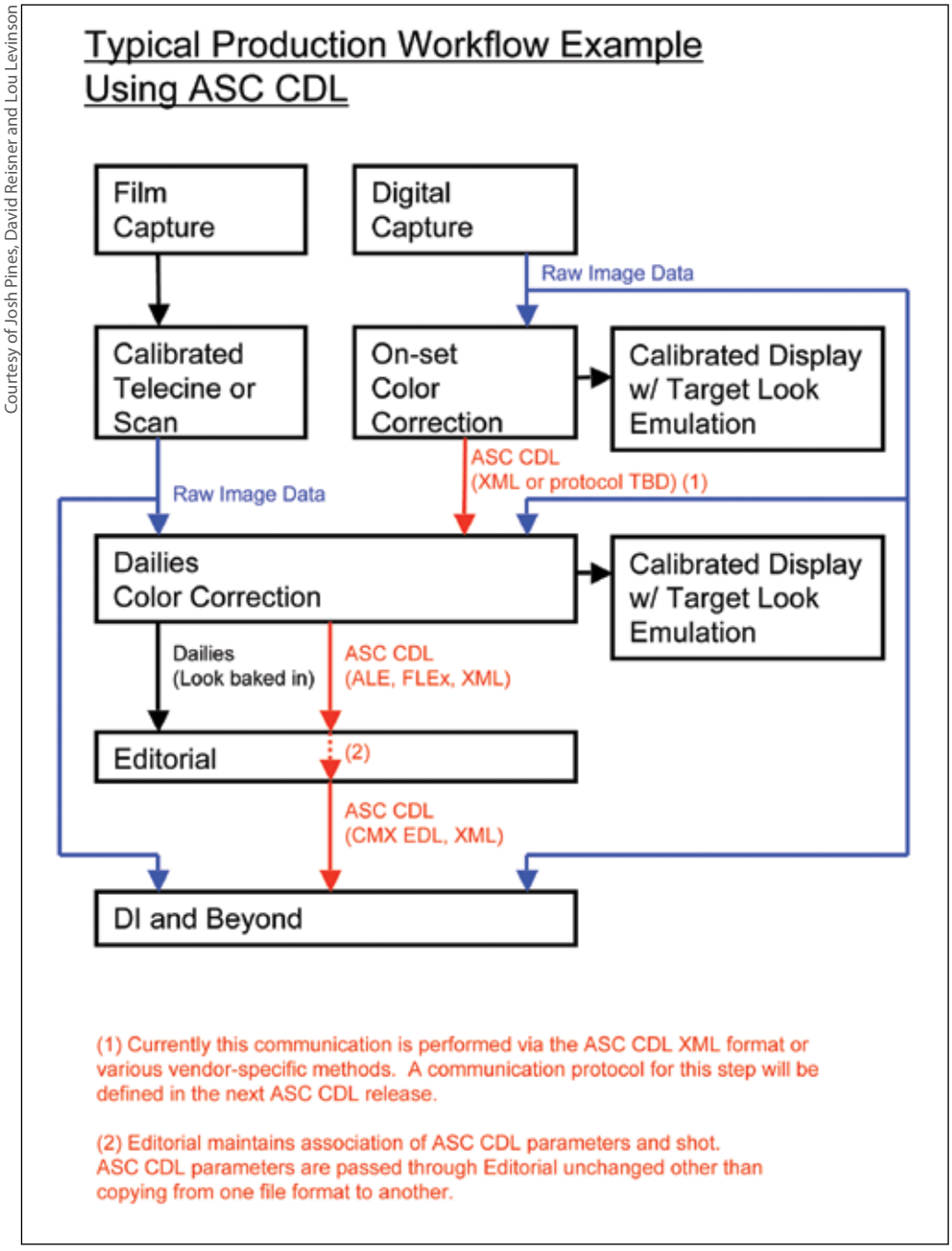
The CAS sub-committee as a whole and through the actions of its members helped plan, execute, and usher the CAS through the post process. There are too many people who we would like to thank for their exceptional time, effort, and commitment, but we would particularly like to thank the people at Laser Pacific who certainly never knew how large a job this would be when they volunteered.

For the future, we anticipate a few more "upgrades" to the ASC CDL, which will improve its usability, and also hopefully start to coordinate its use with the AMPAS' IIF project. The two projects have already shown some commonality of thinking (perhaps in part due to some commonality of participants) in areas such as the correspondence between the ASC CDL v1.01's InputDescription and ViewingDescription metadata and IIF's input and output device interface model.

We also anticipate that the subcommittee will focus more on its namesake and begin to deal with more DI workflow issues, especially in light of the wealth of information gathered through the course of the CAS post.

The DI subcommittee would like to urge all interested parties to consider participating and will try to ensure that subcommittee meeting dates and times are posted on the ASC website with enough advance warning to be useful.

For additional information about the ASC CDL or DI subcommittee, contact Joshua Pines at jzp@technicolor.com, Lou Levinson at Joe.Beats@yahoo.com, or David Reisner at dreisner@d-cinema.us.



Typical Production Workflow Example Using ASC CDL.

Advanced Imaging Subcommittee

Chair: Gary Demos; Vice-chair: Jim Fancher; Vice-chair: Phil Feiner; Secretary: David Reisner

Much of this year's work of the Advanced Imaging subcommittee has been support of the Academy Science and Technology Council's objective Digital Motion Picture Camera Assessment project. The Academy has set-up a special test and measurement oriented stage, called the Esmeralda Easel, at the Academy's Pickford Center for Motion Picture Study. Advanced Imaging has assisted with spectroradiometric measurements on that stage and of displays used in connection with that work as well as assisting in certain technical aspects of camera characterization.

From its early years, the Advanced Imaging subcommittee has been advocating use of high dynamic range, wide gamut image coding systems using scene referred radiometrically linear light and floating point data representation. The Academy's Image Interchange Framework proposes a system of that type. We are working with the Academy to help evaluate and "ring-out" the IIF architecture and its components, initially by taking CAS shooting results from two cameras and running them through an IIF post workflow. We expect that activity will help assess IIF's suitability for practical use, including delivery to film and D-Cinema, as well as provide further understanding of the Camera Assessment Series and the cameras.

The introduction of a true, radiometrically linear light workflow again raises several issues that we have discussed many times—linear light/terminology, and exposure invariance.

In every Progress Report since 2006, Advanced Imaging has raised the issue of terminology and definitions. The industry's incorrect practice of using "linear" to describe what is in reality one or another form of video gamma is getting more common, rather than less. As an industry, our post-production work, and with digital cameras our production work as well, will be much more effective if we describe things carefully and accurately.

Linear light—radiometrically linear light—values are proportional to the photon counts of light in the scene or striking the camera imager or on the display or projector. For example, light meters, spectral radiometers, and chroma meters all use linear light values. But the term "linear" is often misused to describe nonlinear signals containing video gamma.

Gamma, commonly used for video signals, is a nonlinear exponent. Linear light is exponentiated to the power of the inverse of gamma (e.g. 1/2.222) to create the nonlinear video signal. The video signal is converted back into linear light by exponentiating the nonlinear video signal to the power of gamma (e.g. 2.222) usually as part of the monitor or projector. (Note that the DCI digital cinema gamma is 2.6—a "pure" gamma as opposed to video signals which usually have a linear "toe" segment near black.)

Fortunately, all forms of video gamma representation, when precisely specified, can be converted to and from linear light.

Logarithmic representations of linear light include pure logarithmic and quasi-logarithmic representations. An example of a pure logarithmic representation is the log of the linear photon count of light at each pixel. At all luminances, all pure logarithmic representations vary by an equal percentage for an equal step in value. Most digital motion picture cameras offer some form of quasi-logarithmic representation to fit a broader dynamic range into a 10-bit HD-SDI output and to provide coding somewhat in the direction of film printing density.

All forms of logarithmic representation, when precisely specified, can be converted to and from linear light.

Logarithmic Printing Density is the density of a film negative, as used in printing and scanning. It is usually collected by scanning a film negative and using an "encoding function" (as opposed to the "rendering transform" used for output). Cineon and DPX formats most commonly use a density range of 2.048, using 10-bit (1024) units to specify the red, green, and blue densities of film negative.

Because film emulsion characteristics are quite complex and densities will vary from lab processing run to processing run (temperature, state of the chemicals in the film bath, etc.), accurate conversion of logarithmic printing density to linear light is more complicated. Conversion usually requires use of a 3D cross-color look-up table (LUT), or a cross-color matrix/LUT combination, constructed by a combination of engineering and art. 3D cross-color processing is required to encode the interaction between the color primaries. Currently, the construction of these 3D LUTs involves some art and provides some facility-specific "secret sauce," but we believe IIF's well-defined input and output transforms should substantially regularize this practice. Also important, the proposed Academy Printing Density (APD) and Academy Density Exchange (ADX) should provide a common convention for design of density-based film scanners, recorders, and workflows.

The Advanced Imaging subcommittee has proposed an **Exposure Invariance Test** to quickly and easily informally examine whether a camera's output is truly linear or can be transformed to truly linear. In a linear representation, whether camera output or an intermediate representation like ACES, simple mathematical operations such as doubling or halving values (the mathematical equivalent of going up or down a Stop) should preserve hue and relative exposure within the scene. The middle section of a film's response curve behaves in this way, but the toe and shoulder regions do not—they are not linear.

The Exposure Invariance Test takes images of a chart or scene, starting with something near the camera's maximum exposure, then takes a series of images each with exposure reduced by one stop (either by lens T-stop adjustment, ND filters, or changes in lighting—whichever is most accurate and consistent). Each stop down should reduce the linear code values by half.

The series of images are scaled up to "reference" exposure by multiplying by factors of two. They are then printed and visually compared.

Images taken at lower exposure will exhibit more noise, but if the camera response is otherwise linear, then within the limits of the camera's exposure range, the scaled up images will look very much like the reference image—darks, highlights, tonal scale, hue. Cameras in which the imager does not respond linearly or internal processing or the output representation cannot be mapped to linear will produce a scaled-up image with noticeably different characteristics.

An upcoming *SMPTE Motion Imaging Journal* article will define the Exposure Invariance Test in more detail.

The Advanced Imaging subcommittee has also been measuring some of the CRT-replacements displays that are being introduced. We have measured or are currently measuring the HP Dreamcolor LCD, Sony BVM-L230 LCD, and will be measuring the Sony BVM-L231.

Metadata Subcommittee

Chair: Dave Stump, ASC; Jim Houston

The ASC Metadata subcommittee has continued to participate in efforts to standardize a metadata path from set through post. Metadata Subcommittee chair David Stump, ASC, traveled to Oslo, Norway, to participate in the European Digital Cinema Forum (EDCF) and the European Federation of Cinematographers (IMAGO) effort to establish metadata standards. To help build bridges between Hollywood and Europe, he has enlisted the aid of several IMAGO members, most notably Kommer Kleijn—member of the IMAGO Technology Committee, member of the board for SBC, EDCF, and chair of the SMPTE Digital Cinema Additional Frame Rates Ad Hoc Group—to visit Hollywood to participate in the AMPAS Metadata Symposium held this past June. The subcommittee is in active contact with and supports other new independent metadata initiatives and continues to participate in the committee work at AMPAS.

Through the work of chair Jim Houston, the Academy/ASC Common LUT Format committee, a joint effort of the AMPAS Science and Technology Council and the ASC Technology Committee Metadata subcommittee, continued efforts toward developing a Common LUT format and is working with volunteer developers on a reference implementation. The primary goal of the Common LUT format is to provide a means of attaching metadata to LUTs in a consistent fashion. It uses an XML format as a container for both the human-readable LUT data and input and output descriptors for how the LUT should be used. The format also allows information to be carried for conversion from one color space to another, connected as either input or output of the LUT by providing a format for color conversion matrices. The specification, "A Common

COMMON LUT FORMAT 3D LUT EXAMPLE

Example:

```
<ProcessList xmlns="urn:NATAS:ASC:LUT:v1.0"
  id="LUT12Jul09" name="Prod Lut A">
  <Description> Convert to rec709 from Slog with 3D LUT </
    Description>
  <Description> made for Prod XYZ </Description>
  <InputDescriptor> Sony F23 Slog </InputDescriptor>
  <OutputDescriptor> Sony BVM CRT </OutputDescriptor>
<LUT3D id="LUT120709" name="Slog convert"
  interpolation="trilinear" inBitDepth="10i" outBitDepth="10i" >
<Description> converted to rec709 primaries with D65 white </
  Description>
<Array dim="17 17 17 3">
0 0 0
1 1 1
3 3 3
5 5 5
***lots of other lines****
*********
1023 1023 1023
</Array>
</LUT3D>
</ProcessList>
```

Format for LookUp Tables" v1.01 May 11, 2008, has been distributed to more than 150 interested parties worldwide, including DPs, digital image technicians, software creators, monitor and projector manufacturers, and many major film industry hardware and software companies. There is continued progress on creating an XML reader for the format and several example LUTs have been created for testing implementations. The next phase of the project is to increase awareness of the availability of the format and to make it available within major industry software packages (which often happens only through user feature requests).

For additional information, contact Jim Houston at jim.Houston@mindspring.com.

Digital Display Subcommittee

Co-chair: Glenn Kennel; Co-chair: Alan Hart

The Digital Display Subcommittee has not been active in the past year, other than supporting the planning and execution of the CAS project. In this project, we specified the use of a standard industry DI pipeline, with film print LUTs and calibrated DLP cinema projectors. Deliverables included standard DCP and film prints.

Meanwhile, flat-panel consumer display technology continues to evolve with improvements in performance of plasma and LCD technologies at lower price points. Recent introductions of modulated LED backlights for LCD displays have substantially improved the contrast characteristics. However, we are still missing a widely accepted alternative to the trusted Sony BVM (CRT) reference monitor in post-production. Many facilities have adopted Panasonic plasma displays as a short-term solution.

Dolby showcased its high dynamic range (HDR) display technology at NAB and invited industry experts to look at a prototype reference monitor, calibrated to match a Sony BVM. The Dolby HDR technology uses an LCD flat panel with sophisticated image processing to modulate a LED matrix backlight. Most agreed that the pictures were very impressive, even more so when they turned up the lights and showed that it could still maintain the contrast and picture quality at high ambient light levels that completely washed out the CRT display. Dolby intends to introduce this reference monitor at the end of the year.

For additional information contact Glenn Kennel at gkennel@arri.com or Alan Hart at ahart@mvfinc.com.

Digital Preservation Subcommittee

Co-chair: Grover Crisp; Co-chair: Garrett Smith

Last year, we reported that "The Digital Intermediate workflow processes, which have become predominant in the production and post-production environment continue to present the most challenging issues for preservation. There are several key components to developing conservation programs to preserve the data produced out of the DI workflow: how the data itself should be preserved, developing policies and procedures for long-term storage and retrieval, ensuring there will be no loss or degradation to the data, creating migration plans to newer platforms. These and other issues are key components to preserving the data from digitally-created or mastered motion pictures."

Although the above is still very relevant and there are a number of data preservation initiatives are under way across the industry, concerns about data integrity and reliability have continued to rise in importance for all content owners, whether traditional studio or independent. Also, there still is no consensus within the industry on any specific path for preservation, from either a data integrity or cost perspective. As the industry debates the pros and cons of tape

migration vs. "spinning disks" (and all the variants), another growing concern is how do we proceed in a digital environment with respect to preserving the data for "unknown future needs"—think Director's cut, anniversary edition, ring tones in 2020?

As the industry has come to agree somewhat on the procedures for preserving the "Theatrical Version" via Digital Separation Masters (YCM) and various flavors of data/media migration of the approximately 11,000 ft of the finished film/DI files, one of the key challenges will be what to do with the rest of the footage that was shot? In other words, what do we do with the B-Negative? This will be one of the top areas of discussion in the Preservation community in the near term.

Enlightenment Subcommittee

Chair: Richard Edlund, ASC; Stephanie Argy

The Enlightenment Subcommittee was formed to get the word out to the ASC members and the rest of the world about the great work that the ASC Technology Committee, chaired by Curtis Clark, ASC, is doing. Populated mostly by ASC Associate Members, along with several cinematographers, the committee has had and will continue to have much to do with the specifications, structure, nomenclature, and development of the new digital cinema and its related tools. My invaluable colleague, Stephanie Argy, has written several articles for the American Cinematographer magazine and the ASC website, and with her help we are finally living up to our name.

Building on those articles, the subcommittee is now developing a series of informational videos on various topics. We intend to begin with a trilogy of 10-minute easy-to-understand videos by Lou Levinson—Color Science 101, Reference Display 101, Digital 101—that will review fundamental concepts of color, vision, and image representation, and we will approach other members of the Technology Committee to facilitate the creation of accessible videos on other subjects.

As the subcommittee responsible for gathering and disseminating information, we are very interested in hearing ideas and suggestions, as well as news about projects using technology in innovative ways. SMPTE members who would like to contribute or participate can contact Richard Edlund, edlund@cinenet.net or Stephanie Argy, steph@mentalslapstick.com.

3-D Subcommittee

Co-chair: Lenny Lipton; Co-chair: Peter Anderson, ASC

Since our last report there has been a marked increase in the number of stereoscopic productions released (mostly CG animation) and a reasonably decent increase in stereoscopic projection installations, although disappointment has been expressed by some in the industry since deployment has not met their expectations. This slowdown is directly attributable to the difficulty in financing purchases of projectors. Nonetheless, as of this writing, there are probably close to 4,000 stereoscopic installations worldwide. That means that roughly half of digital projectors are stereoscopically equipped. There is widespread consensus that the stereoscopic cinema is the driving force for the deployment of digital projectors.

The subcommittee plans to greatly increase its membership by inviting experienced stereoscopic cinematographers and other technical experts to join its ranks and to create an agenda. Topics will include a study of camera designs, stereographic methodology, and post-production workflow, and pipeline issues centered on stereo timing and adding visual effects.

Previs Subcommittee

Co-chair: David Morin; Co-chair: Ron Frankel; Secretary: Georgia Scheele

The ASC-ADG-VES Joint Technology Committee on Previsualization (Previs Subcommittee, for short), is an unprecedented joint effort between the ASC, the Art Directors Guild (ADG) and the Visual Effects Society (VES), to discuss and explore the new relationships developing around the field of previsualization.

Previsualization is a collection of processes developed over the past 25 years by a pioneering group of artists-entrepreneurs, to aid in the production of movies. The initial idea behind previsualization was to harness the power of post-production 3D computer animation software to assist with pre-production design and technical planning. Previsualization gained its first stronghold within visual effects, where it was used in tasks such as testing motion control moves or determining the size and placement of blue screens. More recently, previsualization has evolved into a tool to help develop and test story ideas. Sets, locations, props, and 3D representations of the actors are built within the Previs environment, creating an interactive virtual world that can be viewed from any angle and through any lens. The result is a process that combines visual narrative and technical accuracy, allowing the project's creative team to make informed decisions early in the production process. Today, previsualization has grown into a field that increasingly touches every aspect of production and helps foster inter-departmental collaboration.

As was originally planned when it was created, the Previs subcommittee is coming to an end at its 12th meeting on August 13, 2009, and will deliver its final report at the meeting.

The Joint Committee clarified many questions that were unclear to the industry about the previsualization process, and has submitted recommendations that will be carried forward in a new, permanent organization to be announced at the meeting.

Also at the meeting, a new Joint Technology Committee will be formed to explore another aspect of the new digital motion picture production process.

For additional information, contact Chair David Morin, davidmorin@davidmorin.com.

The Authors

Curtis Clark, ASC. Clark's credits include such artful narrative films as *The Draughtsman's Contract, Dominick and Eugene, Alamo Bay, Extremities* and *Talent for the Game*. His extensive commercial cinematography projects have put him on the cutting edge, working for some of the industry's top directors and agencies. Clark currently heads the American Society of Cinematographers (ASC) Technology Committee, which examines and addresses imaging technology issues as they relate to the creation of motion pictures and cinematography. That committee worked closely with Digital Cinema Initiatives (DCI) to produce the ASC-DCI Standard Evaluation Material (StEM) used to evaluate the performance of digital projectors and other elements of digital cinema systems.

Michael Goi, ASC, is the president of the American Society of Cinematographers. His credits include the series "My Name Is Earl," for which he received an Emmy nomination, the original pilot for "Life On Mars," and the feature films *The Christmas Movie, Witness Protection*, and *The Dukes*. He recently wrote and directed the drama *Megan Is Missing*.

Goi is a member of the the Academy of Motion Picture Arts and Sciences (AMPAS), the Academy of Television Arts And Sciences (ATAS), and serves on the National Executive Board of the International Cinematographers Guild.

David Reisner has consulted in entertainment and technology for 25 years. His motion picture work focuses on image quality, color, and workflow for features. He works above-the-line with producers and directors, helping them make the right choices for their shows and below-the-line with cinematographers and post-production. His work emphasizes creative flexibility and best practices in color management, hybrid imaging workflow and DI, mixed gamut monitoring/viewing, production, and delivery environments in digital and hybrid production, post-production, distribution, and exhibition. His work in digital cinema also includes security, testing, interoperability, and standards.

As Secretary of the ASC Technology Committee and DI, Workflow, Advanced Imaging and Camera Assessment Series subcommittees, he has had principal roles in creation of the ASC Color Decision List (ASC CDL), the ASC-PGA Camera Assessment Series, and the ASC-DCI Standard Evaluation Material (StEM) test movie (screen credit—*Test Design and Methodology*). Since 2001 he has been officer of SMPTE digital cinema groups including 21DC-10 and DC28.10 Mastering, 28.8 Projection, KMAH/SKM Security and Key Management, and Test Materials. He has been Secretary and Vice-Chair of the Inter-Society Digital Cinema Forum (ISDCF) where he had a principal role in design and execution of the 3D projection luminance demonstration. He was architect of one of three proposals for DCI's 4K and 2K proof-of-concept systems. Work in other industries has included early technical and business plans for internet-based music and movie distribution, computer hardware and software architecture, and killer whale training.

Dave Stump, ASC, began his career in film in the late 70s, first as a TV producer for several cable shows and then at ABC where he helped put together a late night TV show called "Completely Off the Wall." He worked on a number of pictures with Clive Donner then worked for Francis Coppola in his camera department at Zoetrope Studios, working on all Zoetrope pictures such as *One from the Heart* until the studio moved to San Francisco. He worked on *The Day After* TV miniseries that won a VFX Emmy Award.

In 1991 Stump started a rental company, Motion Control Rental Services, which grew into the model for Visual Effects rentals in Hollywood. He has worked as DP, VXF DP and VXF supervisor on numerous large motion pictures and television productions and earned another Emmy nomination and an Academy Award for Scientific and Technical Achievement. He is a member of the ASC and chairs the Camera sub-committee of the ASC Technology Committee, helping to shape the future of digital cinematography.

Richard Edlund, ASC, established his reputation winning four Oscars for the visual effects in *Star Wars, The Empire Strikes Back, Raiders of the Lost Ark*, and *Return of the Jedi*, with a nomination for *Poltergeist*. He has received six additional Oscar nominations, three Academy Scientific and Engineering Awards, an Emmy, and two BAFTA Awards.

In 1983, Edlund founded a VFX company called Boss Film Studios, which produced effects for thirty-plus movies, including *Ghostbusters, 2010, Die Hard, Ghost, Poltergeist 2, Cliffhanger, Batman Returns, Alien3, Species, Multiplicity* and *Air Force One*, achieving ten Academy Award nominations. Following Boss, Edlund supervised *Bedazzled, Angels in America, The Stepford Wives*, and *Charlie Wilson's War*.

Edlund is a governor of the Academy and chair of its Scientific & Technical Awards Committee. He was chair of their VFX Branch for its first 11 years. He also serves on the boards of the ASC and the VES. Recently, he was honored with the Academy's A. Bonner Medal of Commendation and the ASC's Presidents Award.

Edlund was a SMPTE member from 1978 to 1990 and was a manager of the San Francisco Section for several years in the early 1980s.

Al Barton has spent 29 years as a technologist in production, post-production, and manufacturing for television and feature films. Most recently, he worked in production/post-production and distribution of feature films for Sony Pictures. He is chair of SMPTE TC 10E Essence and the Mastering working group under 21DC TC. He participates in ISO, ITU, and ISDCF committees as well as the Workflow subcommittee of the ASC Technology Committee. Barton also participates in the AMPAS IIF committees and was a key member of DCI; he helped create the digital cinema specification.

Lori McCreary's career in the film industry began as co-producer on the critically acclaimed film *Bopha!*, which first teamed her with Morgan Freeman. In 1996, the two filmmakers founded Revelations Entertainment with a mission to develop films that enlighten, express heart, and glorify the human experience.

Founder of the PGA Motion Picture Technology Committee, she has maintained an ongoing dialog with filmmakers as a trusted advisor to leading technology manufactures as Hollywood transitions into the digital arena.

McCreary currently sits on the Producers Council of the Producers Guild of America as well as on the Technology Committee of the American Society of Cinematographers.

McCreary just returned from South Africa where she was producing *Invictus*, an adaptation of the John Carlin book "Playing The Enemy: Nelson Mandela and the Game that Made a Nation," which Revelations developed and teamed with Clint Eastwood to direct. Matt Damon will star with Morgan Freeman.

Lou Levinson received an MFA from the School of the Art Institute of Chicago in the spring of 1979, having worked his way through school as a tape operator and colorist. After graduating he joined Columbia Pictures Videocassette services, where he helped to maintain the first flying spot scanner installed in the Midwest. In September of 1980, he was hired as a colorist at Modern VideoFilm, becoming the 13th employee. Thirteen years later, MVF had more than 200 employees, and Levinson left to become colorist at the MCA/MEI Telecine Research Center, working in what was the third HD telecine room on the planet. From 1998 to 2008 Levinson was senior colorist at Post Logic Studios. He is now supervising colorist—mastering at Laser Pacific. A longtime ASC associate member, he has been on the ASC Technology Committee since its inception and is currently chair of the Digital Intermediate subcommittee.

Joshua Pines is vice president of imaging research and development at Technicolor Digital Intermediates, where he is currently in charge of imaging and color science.

Pines joined technicolor after more than ten years at Industrial Light & Magic (ILM), where he supervised the film scanning/recording department from its inception, working extensively with both traditional and digital cinema technologies. Pines started his career teaching film courses at the Cooper Union in New York City after earning a degree in electrical engineering. He began working in visual effects at MAGI in 1982 during its work on *Tron*. He also led the computer graphics division at r/Greenberg Associates, and supervised film effects and film recording at Degraf/Wahrman, before working for ILM. Pines is a member of the AMPAS, an associate member of the ASC, and has credits on numerous feature films.

Gary Demos has spent his career working with the physics of light in motion pictures, together with corresponding mathematical and computational analysis. Demos was integrally involved with the first generation of digitally simulated scenes—CGI—for motion pictures. Demos founded DemoGraFX in 1988, working in integer-DCT-based digital image compression for moving images, and with image-processing and image formats for HD and beyond. Since 2004, he has been working independently on wavelet-based and optimal-filter-based moving image compression. Since July 2008, Demos has also been serving in R&D at Lowry Digital.

Demos has authored dozens of technical papers and is the inventor of numerous patents in digital signal processing, image processing, and moving image compression. Demos received an Academy Scientific and Engineering award along with John Whitney Jr. "For the Practical Simulation of Motion Picture Photography by Means of Computer Generated Images" (1985), shared another for his work in digital film scanning (1995), and shared a Technical Achievement award for work in digital compositing systems (1998). In 2006, Demos received the Academy Gordon E. Sawyer Oscar for lifetime technical achievement.

Jim Fancher currently develops next-generation technology for Deluxe Digital Media in Burbank, CA. Previously, he was chief science officer at the Thomson Corporate Research facility in Burbank, where he developed cluster computing architectures for image processing, 3D color correction systems, and digital asset management technology. As chief technology officer for Technicolor Creative Services, the post-production arm of Technicolor, he was involved in the development of color management systems, image processing and media asset management. Fancher has been a part of managing Technicolor's world-class Digital Intermediate facility (formerly known as Technique), as well as the deployment of DI processes

to Montreal and New York. Before his engagement at Technicolor, Fancher was chief science officer at Pacific Ocean Post, where he started POP Sound, POP Film, which won two Academy Awards for visual effects, and the POP—Cinram DVD center.

Jim Houston is vice president of Technology and Engineering at Sony Pictures Entertainment and chair of the Academy/ASC Common LUT format committee. He is also chair of the Academy of Motion Pictures Arts and Sciences' Image Interchange Framework committee, a project of the Academy's Science and Technology Council.

Houston has been a member of SMPTE since 1987.

Alan Hart started his television career in 1967 with KCET Channel 28, the PBS station in Los Angeles. He served as Chief engineer from 1975 to 1978. In 1978 he joined RCA and was involved in videodisk technology before joining Modern VideoFilm in 1981 where he serves as executive vice president, engineering, responsible for all technical resources. A member of SMPTE since 1975, Hart served as Chair of the Hollywood Section, two years on the Board of Managers, two terms as National Governor , and is a SMPTE Fellow.

Glenn Kennel is chief technology officer at ARRI, Inc. In this role, he is responsible for technology development, coordinating with product development activities in Munich, supporting customer applications and workflows. ARRI's digital products include the D-21 camera, the Arrilaser and Arriscan DI products, and the new Relativity image processing suite.

Previously, Kennel headed the feature film group at Laser Pacific, worked in product and business development roles with Kodak and Texas Instruments, and has helped to define, develop, and evangelize products and services for digital film post-production, distribution, and exhibition. A SMPTE member since 1980, Kennel chaired the SMPTE DC28.20 Digital Cinema Distribution working group.

Grover Crisp is senior vice president, asset management, film restoration, and digital mastering for Sony Pictures Entertainment (SPE). In this capacity, his department oversees all facets of the restoration, preservation, and mastering program for the Columbia Pictures and TriStar Pictures feature film and television libraries for SPE. He has worked in the motion picture and television industry for more than 25 years, and since 1984 for the Columbia/Sony Pictures Entertainment studios. Crisp is an associate member of the ASC, a member of SMPTE and AMPAS, and has served on the Board of Directors for non-profits, including the Association of Moving Image Archivists (AMIA) and NTVPF. He also co-chairs The Reel Thing Technical Symposium and co-chaired the worldwide Joint Technical Symposium in 2004 and 2007.

Garrett Smith is vice president of production technology for Paramount Pictures. Smith joined Paramount in 1988, where he has been involved with film-to-digital mastering and quality control for the electronic distribution of all Paramount theatrical films. He has also been active in the development of D-Cinema. He is a member of the Academy of Motion Pictures Arts and Sciences' Science and Technology Council, an adjunct associate professor at the University of Southern California (USC) School of Cinematic Arts and an associate member of the ASC, where he is also vice chair of the ASC-Technology Committee Digital Preservation subcommittee. Before Paramount Pictures, he worked in various post-production positions including director, post-production for New World Television; director, post-production for Columbia Pictures filmed television; and Manager, Film Services for CBS Television Network.

Stephanie Argy is a filmmaker and journalist. Her films as a writer/director (in collaboration with her partner Alec Boehm) include the independent feature *The Red Machine* and several award-winning shorts, including *Gandhi at the Bat*, which received an honorable mention from BAFTA, and *Scene*, in which the lead actor won a Scottish BAFTA for his performance in the film. Argy has written extensively on the art, craft, and technology of filmmaking for many periodicals and websites, including *American Cinematographer, Variety, Hollywood Reporter*, and many more. For three years, Argy edited the *Editors Guild Magazine*, published by the union that represents film editors, sound editors, and rerecording mixers. She holds a B.A. in history from UCLA and an M.S. from the Graduate School of Journalism at Columbia University.

Peter Anderson, ASC, is a world-class director of photography, specializing in 3D, feature, large format, special venue, theme park and visual effects films. Among his many entertainment industry affiliations, Anderson is a founding member of the ASC's Technology Committee and a career-long member of SMPTE since 1964.

Lenny Lipton was the founder of StereoGraphics Corp., where he invented the most widely used method for projecting theatrical 3D movies, the ZScreen. He is author of the books *Foundations of the Stereoscopic Cinema* and *Independent Filmmaking*. He has been granted 35 patents and has more than 40 pending. In 1996, he received an award from the Smithsonian for his invention of CrystalEyes, for 20 years the dominant electronic stereoscopic product.

Lipton produced and directed 25 films, including *Let a Thousand Parks Bloom*, which was was included in the exhibition Summer of Love at the Whitney Museum of American Art (2007). While an undergraduate at Cornell he wrote the lyrics of the song *Puff the Magic Dragon*.

Lipton served twice as a cultural liaison for the U.S. State Department to countries in Latin America. He is a SMPTE Fellow.

David Morin earned a B.Sc.A. in computer science from Laval University (Quebec City, Canada) in 1982 and then worked as an artist in traditional media. In 1991, he joined Softimage, where he participated in the early development of 3D software technologies and supported product sales and marketing in various functions worldwide. Morin also opened an office in Santa Monica, CA, where he headed the special projects group as director when Softimage was acquired by Microsoft. He later worked as vice president when the division was sold to Avid Technology. In 2000, Morin joined Manex Entertainment as president of the MVFX division, a VFX house. In 2001, he retired from the industry, and in 2007 returned as an independent consultant. Morin currently represents the Media & Entertainment division of Autodesk, Inc., in the Los Angeles area.

Ron Frankel is president and founder of Proof, Inc., a market-leading previsualization company based in Los Angeles, CA.

After receiving a master's degree in architecture from M.I.T. in 1996, Frankel began his professional career as creative director/previs supervisor at Pixel Liberation Front. There he introduced such directors as David Fincher, Steven Spielberg, and Darren Aronofsky to the use of previsualization in feature film production.

Intrigued by the promise of previsualization as a singular tool for integrating the technical and design processes that underpin filmmaking, Frankel founded Proof, Inc., in 2003. He has been a driving force behind the development of previs beyond its roots in technical planning for VFX to serve directors, cinematographers, and production designers. Proof has contributed to over 40 feature film productions and numerous commercials and music videos.