The “Esmeralda” Stage: An Analytical Test Laboratory for Image Acquisition

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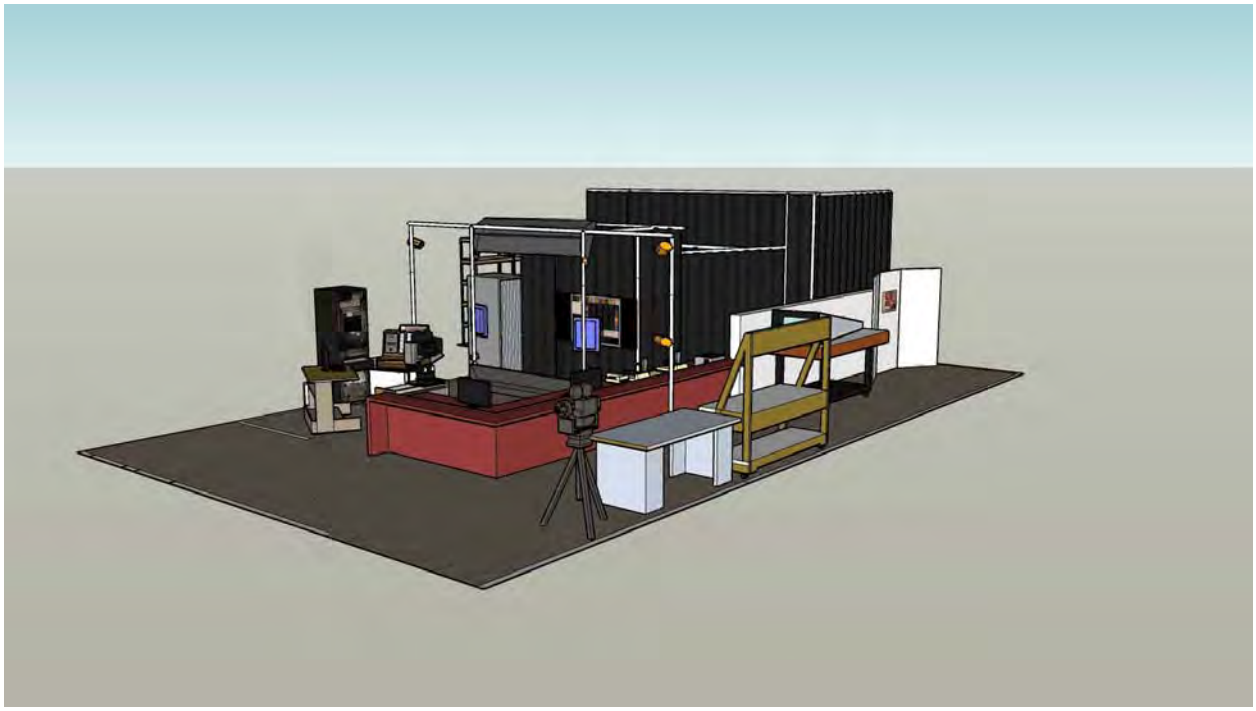
Renaissance Hollywood Hotel, Hollywood, California
Thursday, October 30, 2008
Session: Image Acquisition
Session Chair: Bill Hogan

Thank you, Mr. Chairman.



Visual 02: Slowly rotating SketchUp overview of the Esmeralda stage

The “Esmeralda” stage is a laboratory which provides a highly controlled, repeatable means to assess the efficacy of many components of the cinematographic image acquisition process: photochemical and digital camera systems, filmstocks, lighting apparatus, filters, etc.

Visual 03: Annotated Esmeralda frame

The stage is based on the Laboratory Aim Density (LAD) frame created by the late John Pytlak of Eastman Kodak, a “de facto” industry standard process control image.

Visual 04: Matte painting stage illustration by Clarence Slifer (1912 - 1993)

It is further modeled on a multi-plane matte painting stage such as this one, providing the ability to image large scale flat test targets e.g. Macbeth, D.S.C., ISO and three dimensional targets, including color difference traveling matte backings, as well as motion controlled targets for imaging motion streak and blur.

Development of the stage was begun more than twenty years ago, and it played an important role in the High Speed Emulsion Stress Syndrome project recently recognized with an Academy Award.

As we shall see, it has evolved to include a plethora of capabilities, including monochrometer spectral sensitivity, motion control, motion artifact assessment and more.

Visual 05: Pickford Center exterior

Since 2004, the stage has been housed at the Academy's Pickford Center for Motion Picture Studies which, among other things, houses the Academy's extensive film archives.

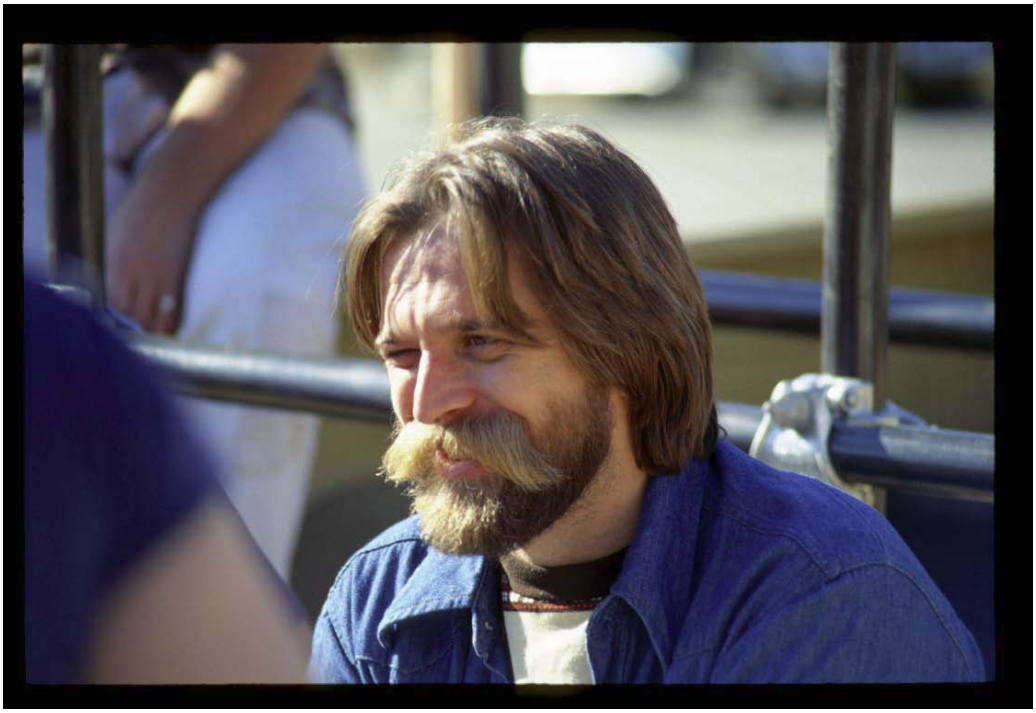
Visual 06: *AMPAS Science and Technology Council Logo*

It is made broadly available to the motion picture community by arrangement with the Academy Science and Technology Council. The lab, unique in the industry for the past twenty years, provides a not for profit, consistent, repeatable test facility and is operated in various programs under the auspices of the Academy Council, the Visual Effects Society, the ASC and this paper's authors.

This illustrates one of the essential functions of non-profit honorary professional societies such as this one. Our societies share a common goal of fostering the pursuit of excellence in our art form, and they collectively form a matrix that binds our professional and industrial community together and without which there would be chaos

Let's take a moment to review how this lab came about and then we'll take a tour of it.

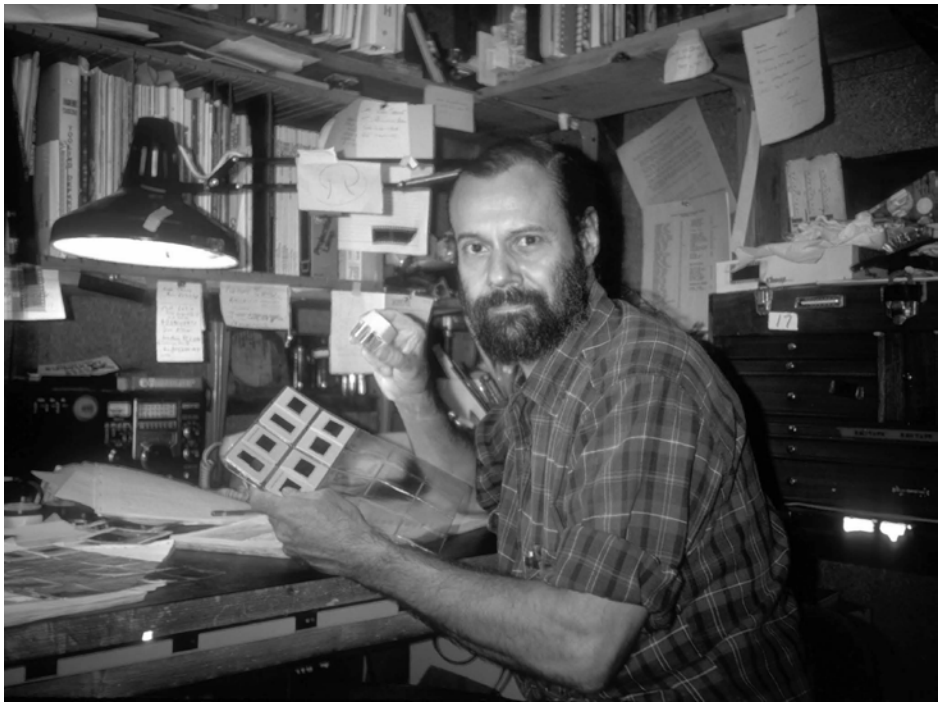
Apogee Productions was formed by John Dykstra in 1978 shortly after the production of the motion picture Star Wars.



Visual 07: *John Dyktstra*

It was comprised of many of the original Industrial Light and Magic crew, including myself, and located in the same building where the watershed visual effects for that film were created.

Visual 08: *ILM/Apogee building*



Visual 09: *Jon in his office at Apogee*

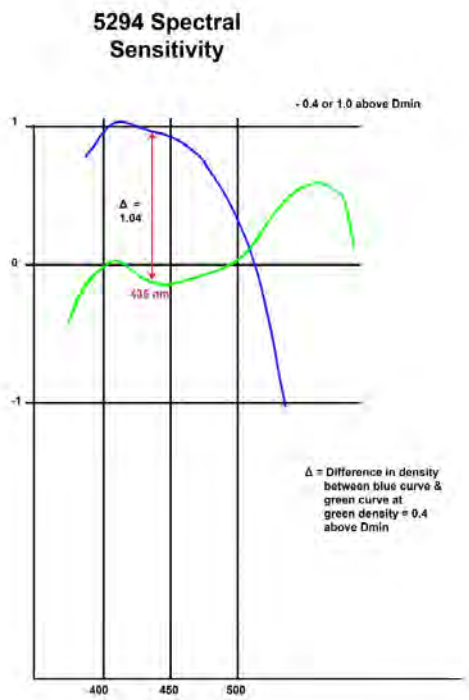
In 1983 Apogee decided to establish a Research and Development Department, rather than conduct research on an ad hoc basis as had been the industry norm, and I became its Director.

Had I known what I was in for I might have thought twice about the decision.

Visual 10: Firefox images from SMPTE paper

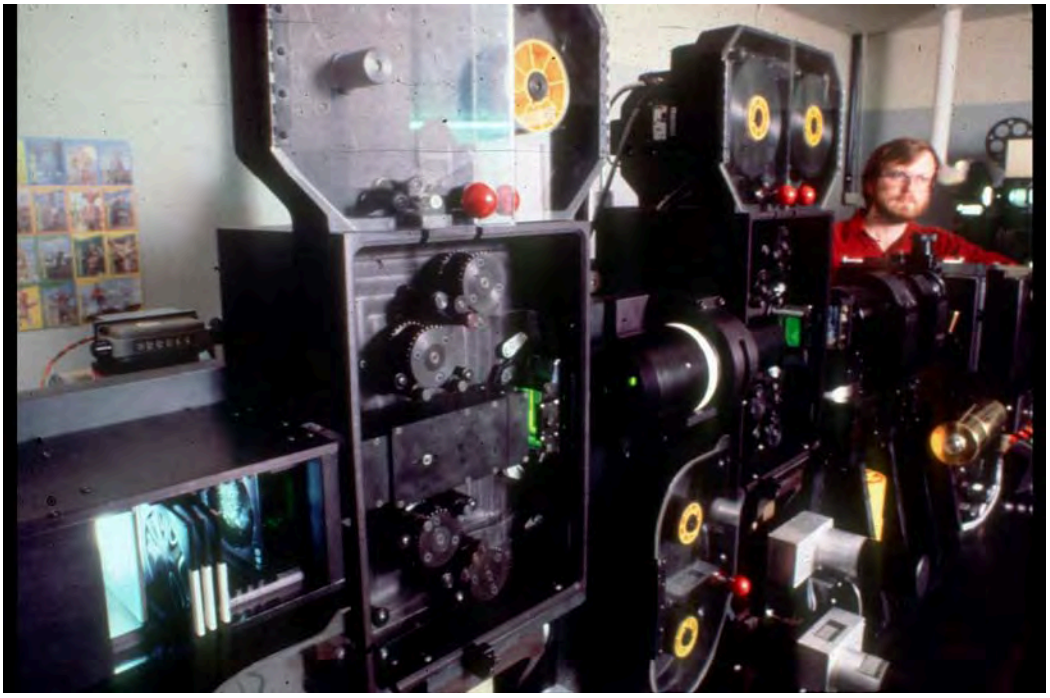
The challenges I'd previously confronted were such brain teasers as how to film shiny black subjects in front of a bluescreen, which was the subject of the first of some twenty SMPTE papers I've presented over the last quarter century.

Visual 11: 5294 Spectral Sensitivity Curves



Almost immediately, the new R&D Department was confronted with a severe challenge. In 1983 Eastman Kodak introduced High Speed Color Negative film 5294. This new stock, while very effective for general motion picture production, was quite disastrous for Bluescreen traveling matte photography due to excessive blue-green crosstalk – in effect, an inability to accurately perceive and render the colour Blue. As Bluescreen composite photography was the core business of Apogee Productions, I was propelled into a crash program to demonstrate to Eastman Kodak the nature of the problem and persuade them to quickly produce a Bluescreen compatible stock.

Resolving this problem would require the ability to conduct very tightly controlled and reliably repeatable film tests from original photography all the way through the optical compositing steps.



Visual 12: Visual Effects Optical Printer representative of the era

The latter was no problem as the Apogee optical department under Roger Dorney was perfectly equipped with very sophisticated optical printers and formidably skilled operators.

The original photography needed to have a comparable level of precision.

Visual 13: Matte stage , Illusion Arts, 1989

Fortunately Apogee's Matte Painting Department, then under the direction of Lou Lichtenfield, was equipped with a superb matte stage including a motion controlled, pin registered matte camera capable of carefully calibrated wedges. Quartz halogen strip lights illuminated matte paintings and there could be three layers of paintings.

Visual 14: Annotated Kodak LAD frame

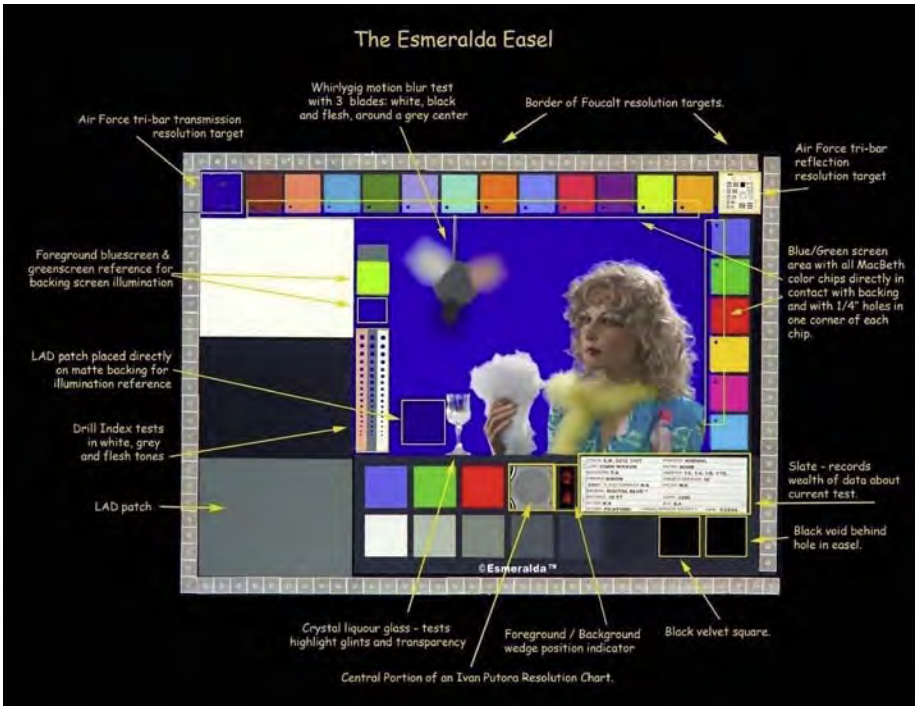
Instead of a painting I constructed a panel based on the Pytlak LAD frame, a paper on which he read to this Society in 1976, entitled, "A Simplified Motion-Picture Laboratory Control Method for improved Color Duplication" The acronym LAD stood for Laboratory Aim Density and the image featured three patches of White, Gray and Black as well as a six step gray scale and Red, Green and Blue patches. It also included a Girl Head seen against a black void.

Visual 15: John Pytlak accepting award

John Pytlak, who was awarded an Academy Technical Achievement Award in 2000 for development of the LAD System, provided me with the specifications for each of the patches in his design.

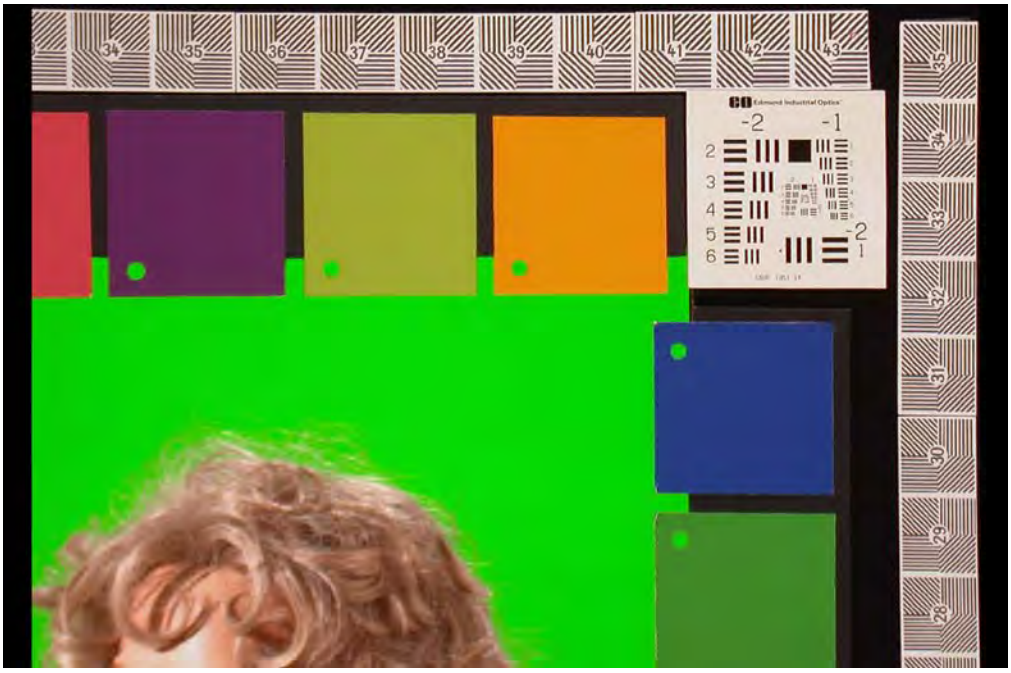
Visual 16: Calvin S. McCamy, creator of the Macbeth chart

For the purpose at hand, however, additional elements were needed. Principal among these is the Macbeth Chart, which, like Pytlak's LAD frame, was created in 1976, by Calvin McCamy, and is equally well established as a "de facto" industry standard.



Visual 17: Annotated Esmeralda Easel

Our set of Macbeth chips is included as a border around an opening in the panel.

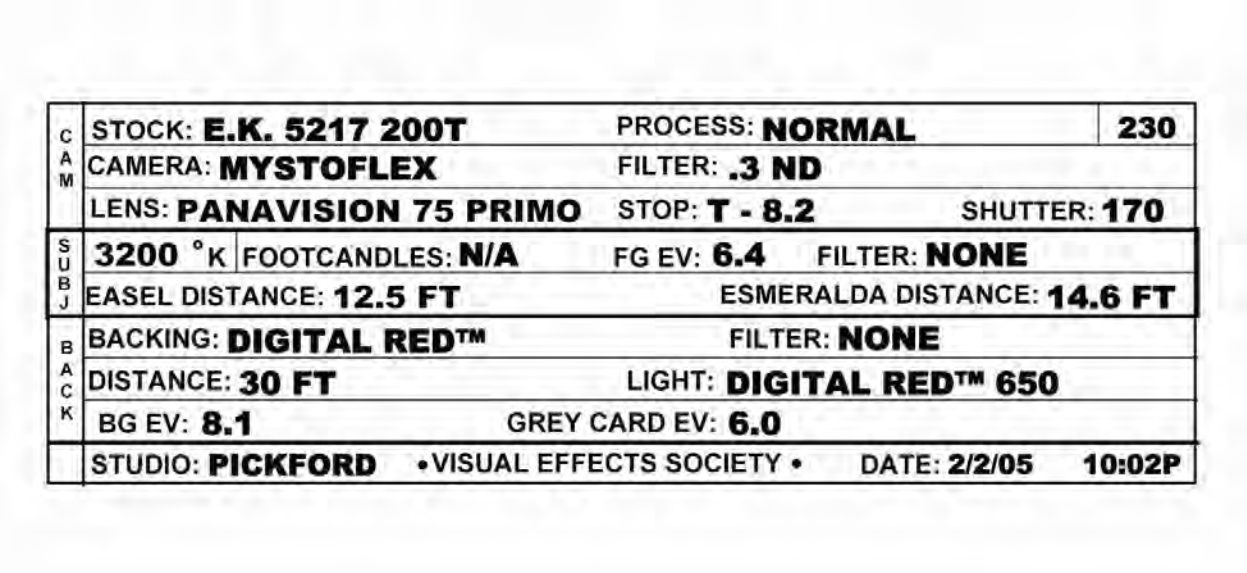


Visual 18: Close up of chips with holes and reflective Air Force resolution chart

Each colour patch is exposed to the background and further contains a quarter inch hole that also reveals the background. This reveals any tendency to generate edge artifacts at the junction of the various colours.

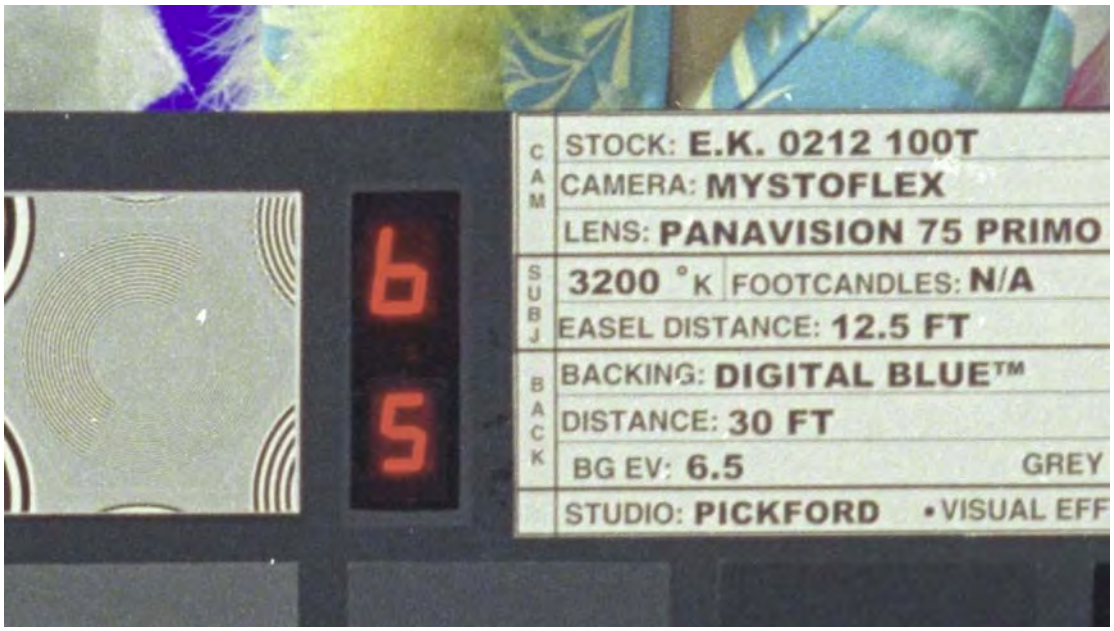
Visual 19: Close-ups of Foucalt and transmission Air force resolution chart

There are assorted resolution targets including an outer border of Foucalt targets, an U.S. Air Force Tri Bar reflection target as well as the transmission version backlit by the background source.



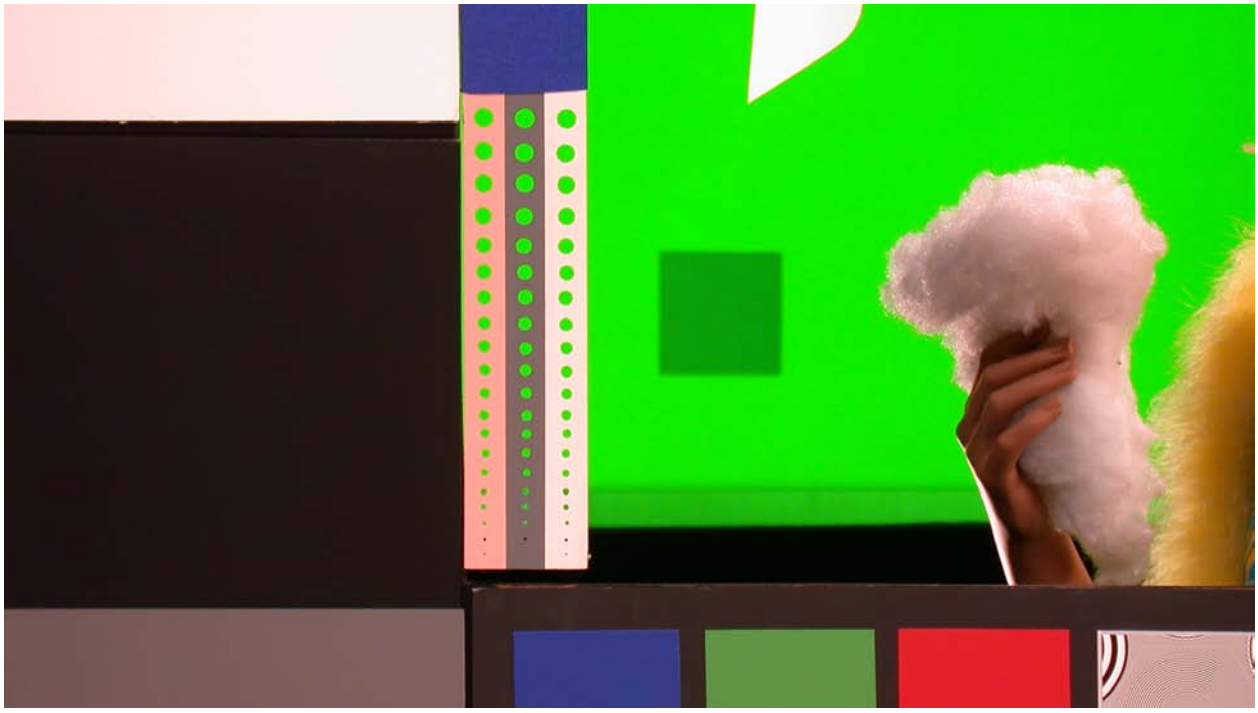
Visual 20: Slate close up

There is provision for a “slate” containing a wealth of information about the image, from camera and lens type to illuminant, filmstock t-stop and so forth.



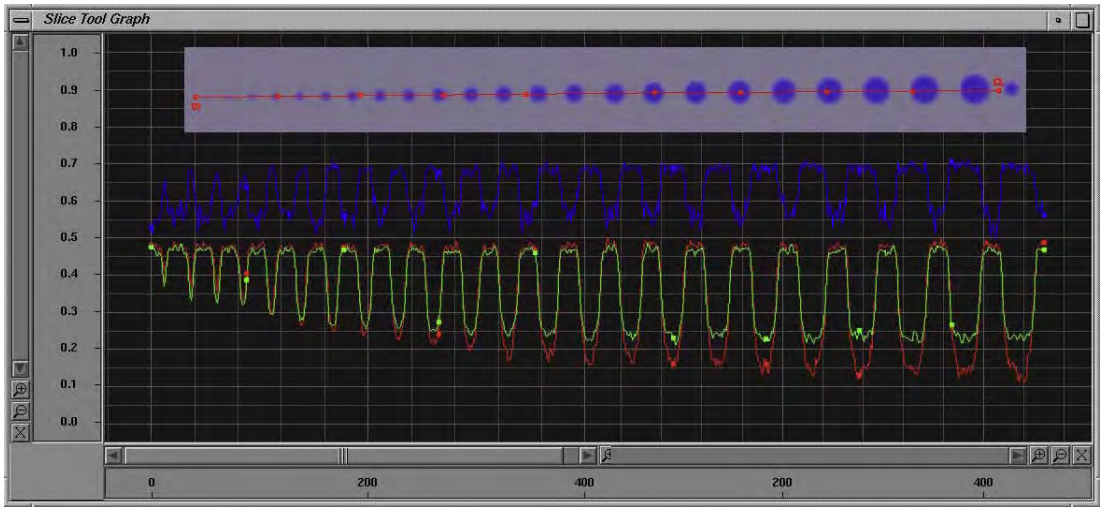
Visual 21: LED frame counter close up

A sophisticated LED frame counter identifies each frame of an eighty-one frame “cross wedge” which involves a permutation of nine step wedges of the foreground versus the background.



Visual 22: Drill index

A “drill index” in white, gray and flesh tone provides . . .

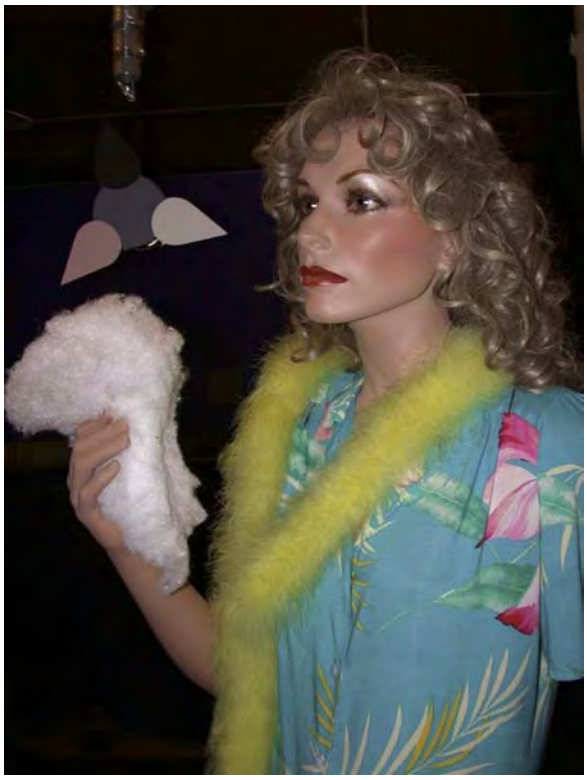


Visual 23: Steve Wright “slice” image showing edge artifact analysis

. . . for analysis and quantification of certain edge artifacts. Blue and Green backing materials are provided, and a liquor glass provides both background transmission and highlight glints. Candle flame can be provided for flame and smoke rendition.

Visual 24: Kay demonstrating black void

The conventional gray scale is extended to include black velvet as well as a black void (a hole cut in the panel letting on to a canister lined with black velvet.). Since the complete image had to be reliably consistent over time, a live person such as Pytlak had used was out of the question.



Visual 25: Close-up of Esmeralda

Thus a very lifelike store mannequin was acquired, provided with a rather frizzy blonde wig, a multicolored shirt and dubbed “Esmeralda” after a character in Tennessee Williams play, “Camino Real.” Esmeralda proved to be invaluable not only in the evaluation of filmstocks but of every aspect of Bluescreen traveling matte photography.

Visual 26: Wardrobe test

Articles of wardrobe and other production design elements could be readily vetted for their matting performance, as could bluescreen backing materials, lighting schemes and much more.

Visual 27: Wedges

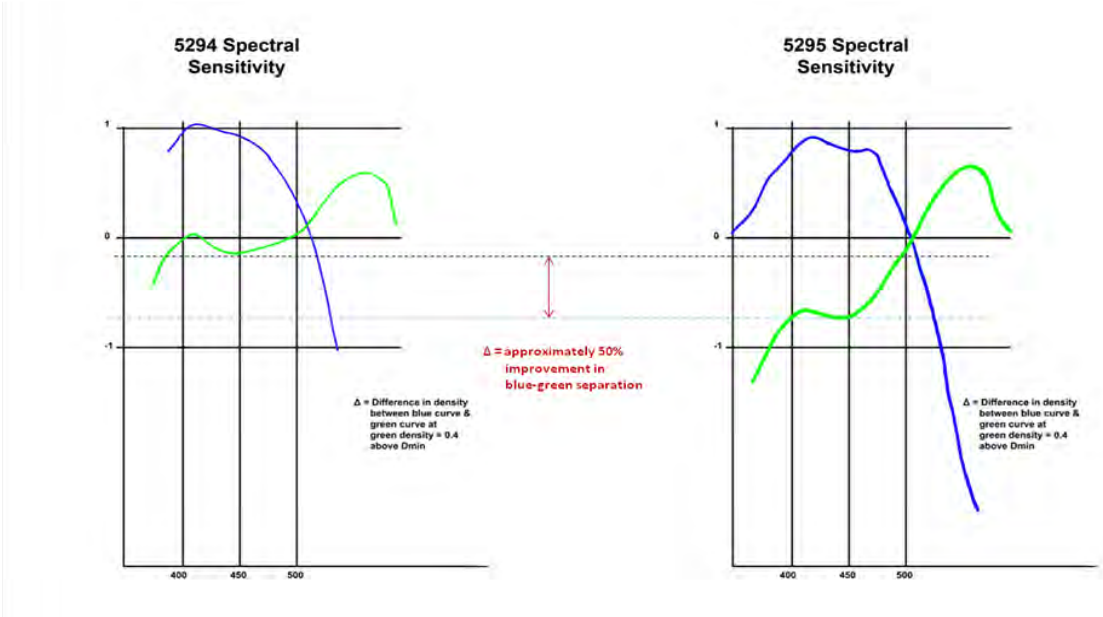
Wedges and cross wedges could be shot showing the effect of various foreground versus background lighting ratios. Such “Esmeralda wedges” came to be distributed widely in the visual effects community; even Apogee’s arch rival I.L.M. received them.

Visual 28: SMPTE paper slide with Kodak, BOSS Apogee

Indeed a corporate technological "truce" of sorts prevailed during that period as all three of the major effects houses; Apogee, BOSS Films and I.L.M. worked with Eastman Kodak to resolve the Bluescreen crisis posed by 5294.

Visual 29: Kodak 5295 slide from SMPTE paper

In 1986, Kodak introduced ECN 5295, a specifically Bluescreen compatible stock



Visual 30: Spectral Sensitivities – 5294 vs 5295

which, besides the chromatic sensitivity required for bluescreen also included tighter tolerance in the perforations making for a steadier image. The new stock also introduced to a small degree, the new "platelet" silver halide crystal dubbed, "T-grain", designed to heighten the sensitivity of the stock.

In 1990, evidently encouraged by the enormous success of ECN 5295 which quickly captured the Bluescreen market, and was being enthusiastically adopted by cinematographers for general photography in large part because of its improved colour rendition (of all things!),

Visual 31: Kodak 5296

Kodak introduced ECN 5296. The new stock was essentially all "T-grain," and quite soon we began to discover its dark side.

A comprehensive discussion of the problems associated with 96 was presented in the Paper, “High Speed Emulsion Stress Syndrome” read by me before this Society at the Toronto Conference in 1992,

High Speed Emulsion Stress Syndrome

Jonathan Erland, SMPTE
134rd SMPTE Conference, Toronto, Canada
Paper # 64
Session C, Thursday, November 12th, 1992 8:50 A.M.
Film House, 424 Adelaide Street East
Authors Meeting, 7:00 A.M., Room 103B
Total presentation time - twenty minutes
Session Chair: Tom Allwood

Thank you, Mr. Chairman

A little over two years ago, many of us who work the field of special effects began to experience disconcerting flickering anomalies in some of the footage we shot. Frequently this flickering was quite subtle, and it was sometimes even possible to dismiss it as projector flicker. However, as the footage was frequently being used to create such effects as split screen composites, projector flicker was quickly ruled out because the effect was compounded in a composite and, to our dismay, revealed the split.

Let's look at a short piece of tape that illustrates the problem:

VISUAL - TAPE: Pillsbury **(Tape - from 8:36 to 9:04, 30 secs.)**

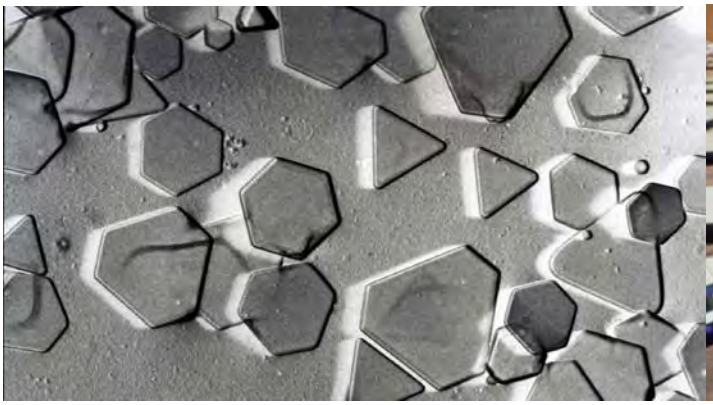
This paper then, will deal with how this problem presented itself and how it was eventually diagnosed and finally corrected.

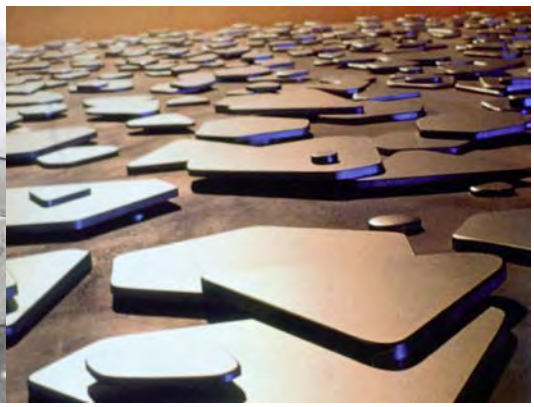
From the earliest beginnings of the motion picture industry, the actinic sensitivity, or "speed" of photographic emulsions has been an obsession of cinematographers. Some of the more fanatical practitioners have gone to extreme lengths to obtain the images they sought. One such is Stanley Kubrick, who insisted that a candlelight scene in Barry Lyndon should be shot in actual candlight. To achieve this, he had a special Zeis lens modified by Ed DiGiulio at Cinema Products to fit a Mitchell BNC with a stop of F 0.7.

VISUAL - SLIDE: Barry Lyndon 1 .

Visual 32: Title page, “High Speed Emulsion Stress Syndrome” paper

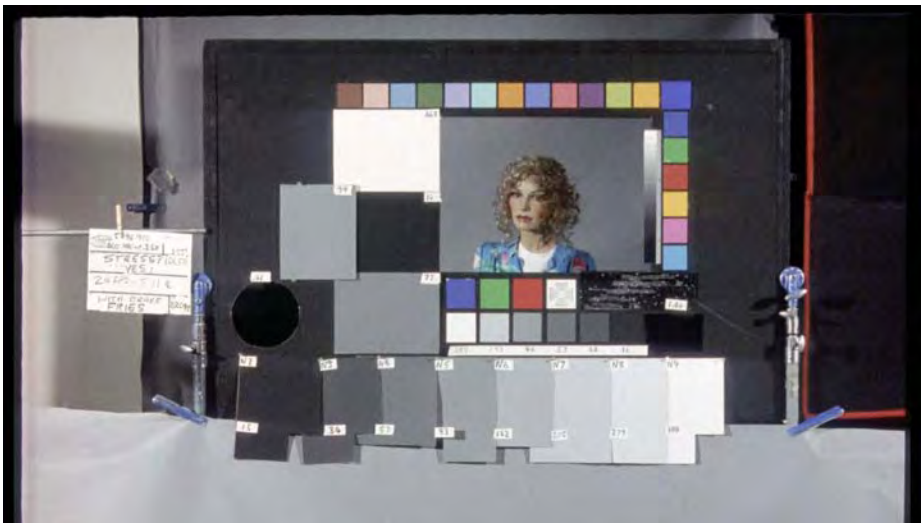
but the gist of the matter was that the new crystal shape was susceptible to the stress associated with moving the ribbon of film through the camera mechanism and being bent around the rollers.





Visual 33: “T” grain crystal image from Stress paper *Visual 34: Artist’s drawing of T-Grain structure*

Under certain conditions, and somewhat erratically, the relatively flat shaped “T” grain crystals would dislocate electrons momntarily due to a piezoelectric effect and, since it relied for its “exposure” on the acquisition of extra electrons (in the form of photons coming in via the camera lens) the “switching” effect from the unexposed state to the exposed state, was disrupted.



Visual 35: Esmeralda frame from stress analysis

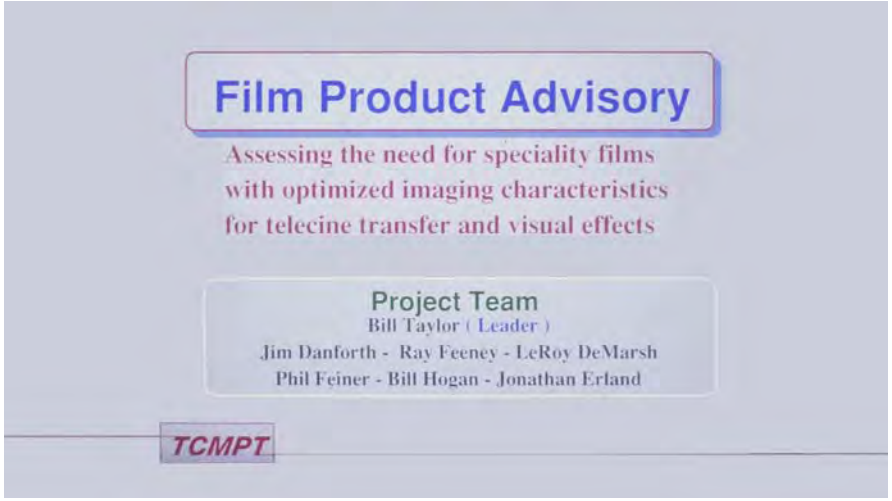
The “Esmeralda” stage was heavily exercised throughout the investigations which lasted many months. Though the research project was ultimately successful, with relatively modest alterations to camera mechanisms effectively neutralizing the problems, Apogee itself fulfilled the nightmare scenario common in our industry and foundered.

As Apogee by that time owed me substantially in the form of unpaid wages and un-reimbursed expenses, I negotiated to take over essentially my office, its related apparatus and paraphernalia. So I “swam out to the wreck” many times to salvage what I could. Of course, this included Esmeralda.

Visual 36: Digital Green® screen set from “Looney Toons”

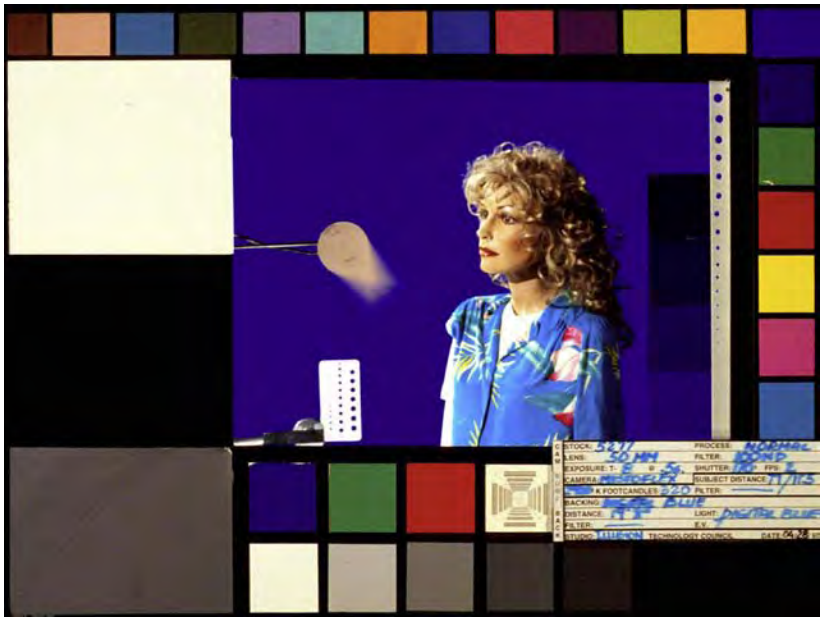
In the aftermath of the demise of Apogee, my wife Kay and I founded our own enterprise, Composite Components Company, which continued to develop traveling matte technology and matériel notably the “Digital” series of backings, and assumed responsibility for the ongoing development of Esmeralda.

Of course, Esmeralda now had to operate under new auspices.



Visual 37: TCMPT slide from SMPTE Report

And so, so for a time, that auspices was the Technology Council of the Motion Picture and Television Industry an organization that a number of us had formed to fill the gap left by the demise of the Research Council back in the sixties. A major impetus to create the TCMPT was, of course, the ability to continue such work as was done on the bluescreen filmstock and Stress Syndrome projects.
While the TCMPT was in place and would have been the logical home for Esmeralda, the Council had not yet, and in fact, never would rise to the level of having any facility. Nonetheless, the Council undertook a filmstock analysis project as a function of a filmstock advisory group and Esmeralda commenced a nomadic period in which she would be briefly hosted in some friendly facility.

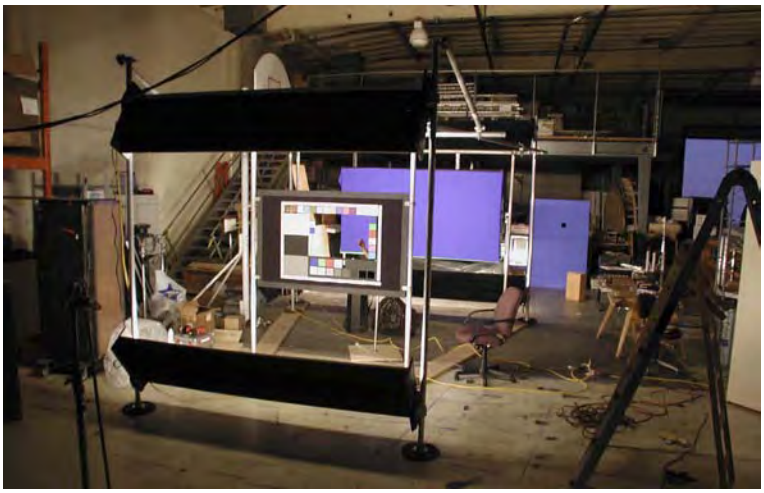


Visual 38: Still from Esmeralda at Illusion Arts

The first of these was Illusion Arts, where a substantial effort was made.

Visual 39: Esmeralda at G.M.D. stage

Later, she was hosted on the stage at Grant McCune Design . . .



Visual 40: Esmeralda at Ultimatte stage

. . . as well as the stage at the Ultimatte Corporation (a manufacturer of traveling matte technology.)

After a valiant ten year effort, the TCMPT quietly became dormant and Esmeralda was taken under the wing of the Visual Effects Society and its Technology Committee, . . .

Visual 41: VES logo

. . . and an effort was undertaken to proceed with the TCMPT filmstock project. However, like the TCMPT, the VES also had no real facilities and relatively modest financial resources.

Meanwhile, the effort, ongoing within the Academy for many years, to re-establish the Science and Technology Council had at last born fruit. In 2003, the Board of Governors had approved budget and staffing and an executive search launched for a Director.

Visual 42: Andy Maltz, Director, Academy Science and Technology Council

In December, Andy Maltz, formerly President and CEO of Avica Technology, became the Director of the Academy Science and Technology Council and he has since reported on the reconstitution of the Council to this Society at the Fall conference in New York in 2005. Anyway, as soon as the Council phones were installed, (actually, Spring of 2004), I called Andy and requested the use of some of the unused space in the Pickford Center. An area that had been used for equipment pre-assembly and storage during the construction of the Lin Dunn theatre was now made available for "Esmeralda." The space, though "cozy," was just right to fit the re-designed apparatus.

Since the demise of Apogee Productions, of course, the original concept of mounting the Esmeralda apparatus on a matte stage was no longer viable (except for a time at Illusion Arts, though even there the matte stage has since been abandoned). A redesign was required so that the Esmeralda stage could function as a free standing operation capable of being set up on any available stage space. However, the loss of the matte stage structure also brought the benefit of being able to extend and expand the original design, and this opportunity was exploited extensively.

Visual 43: Construction at of new Esmeralda rig at Composite Components Company

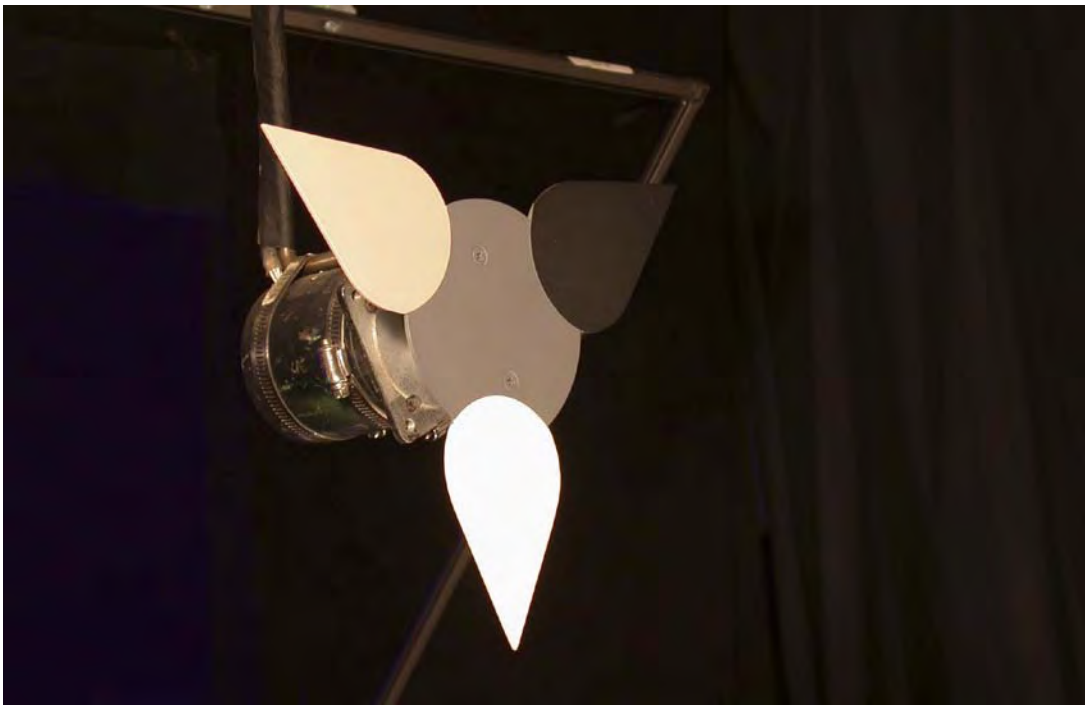
In lieu of the matte stage structure, the new design employs the SpeedRail® pipe rig approach ubiquitous in the industry.

Visual 44: Front stage area

The space is divided into three main areas each isolated by Duvateen drapes. The front stage comprises the space directly in front of the main easel and contains the lighting for the main easel, the camera location, the control station and of course the main easel with the two dimensional material such as LAD patches, etc.

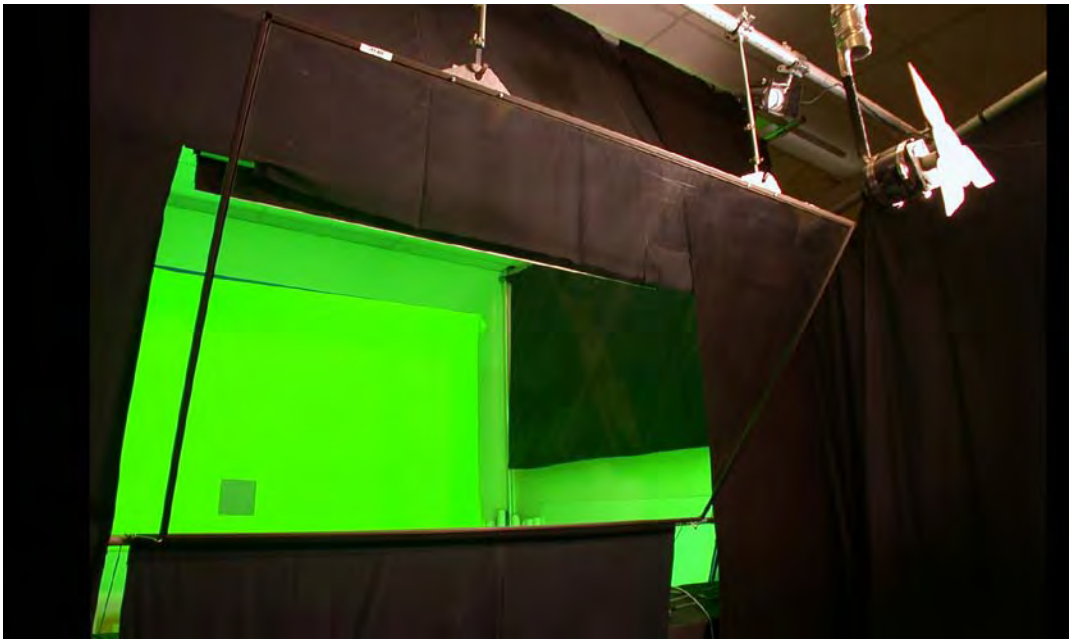
Visual 45: Mid-stage area

The mid-stage contains the three dimensional objects such as Esmeralda herself as well as her lighting,



Visual 46: Whirlygig

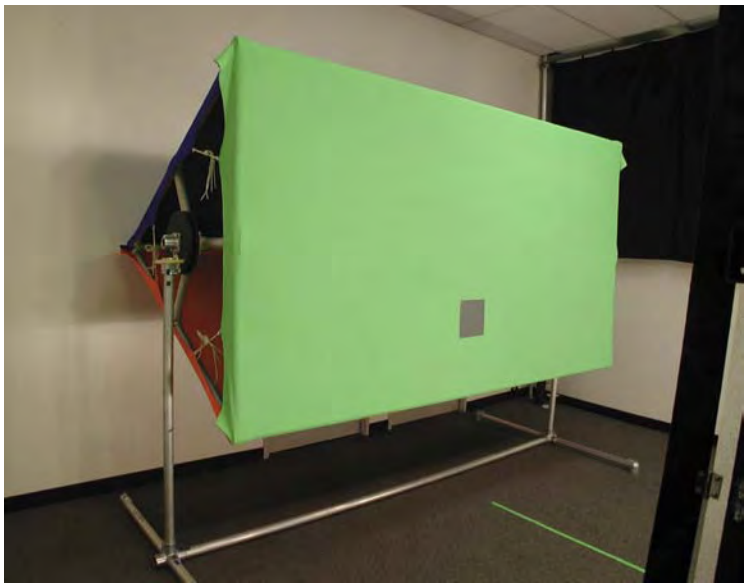
the motion control “Whirlygig” and assorted other objects to be photographed . . .



Visual 47: Filter

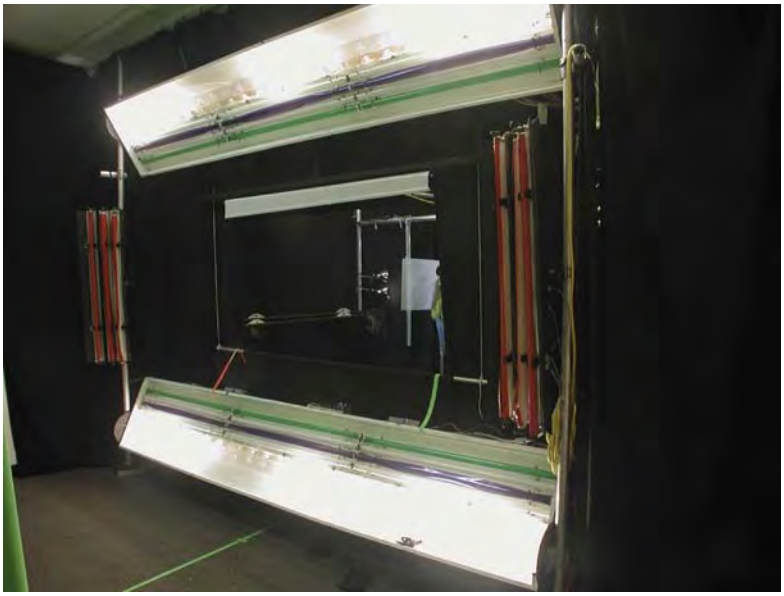
. . . as well as a unique filter station with large filters covering the entire field of view and angled so as to eliminate reflections.

The rear stage contains a three sided truss structure . . .



Visual: 48: Screens on truss in Rear stage area

. . . on which are normally mounted traveling matte backings in Blue, Green and Red, though these could be replaced with any backing of interest.



Visual 49: Lighting gear for screen

The lighting instruments in the rear stage include a variety of fluorescent lamps as well as quartz halogen strip lights, and any other luminaire of interest could be positioned there. Indeed, over the years the lighting has been improved and now includes the Award winning Dedolights. Still more improvements are being provided to accommodate the Digital Camera Test Program of the Academy's Science and Technology Council.

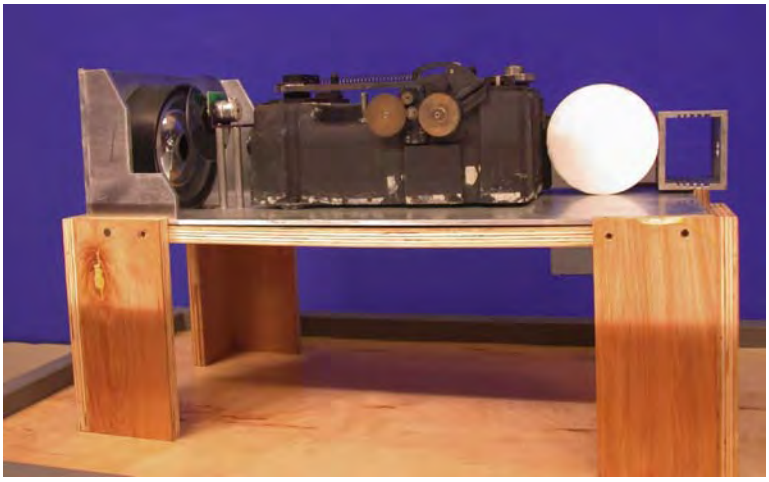
Visual 50: Esmeralda easel outside at Pickford Center Visual 51: Doug Smith test in Pickford parking lot

The essential elements of the "Esmeralda" stage can be moved outside when actual daylight is required for testing. Here we see Academy Award winning Visual Effects Supervisor Doug Smith conducting tests.

There are a variety of ancillary systems associated with the main Esmeralda easel. And these grow almost daily. They include:

Visual 52: Monochrometer

A Bausch and Lomb monochrometer equipped with xenon light source, a rotating variable neutral density filter; an integrating chamber; and a monitoring spectrometer. This provides the ability to derive spectral response curves for imaging devices both film and electronic.

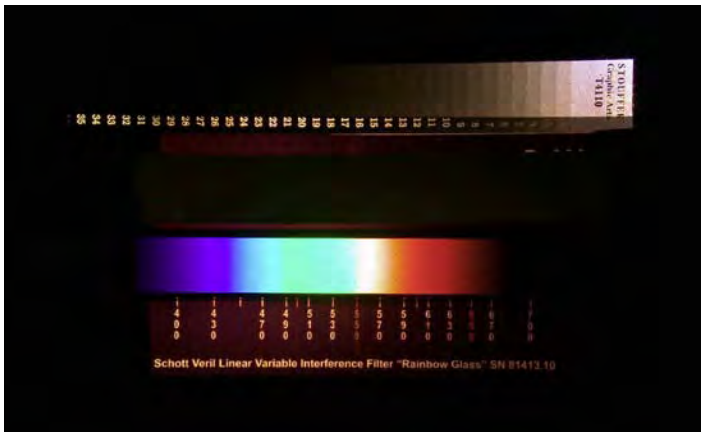


Visual 53: Condenser rig

A set of large format enlarger condenser lenses provides the ability to deliver a collimated illumination in a field up to ten inches wide.

Visual 54: "Rainbow" glass image

This is essential when using targets such as the Schott Veril Linear Variable Interference Filter "Rainbow" glass, a filter that produces a full colour spectrum.



Visual 55: Large Macbeth Chart mounted on easel

Colour rendering of different light sources, e.g. discharge lamps such as fluorescent, HMI, LED, and so forth, versus incandescent) can be assessed using this split screen feature as follows: an oversize Macbeth Chart (app. 40" wide and as such possibly the largest Macbeth chart in the world!) is mounted on the main easel.

Visual 56: 3-Panel Book Flat with foreground Macbeth chart

a three panel "book flat" is placed between the camera and the main easel.

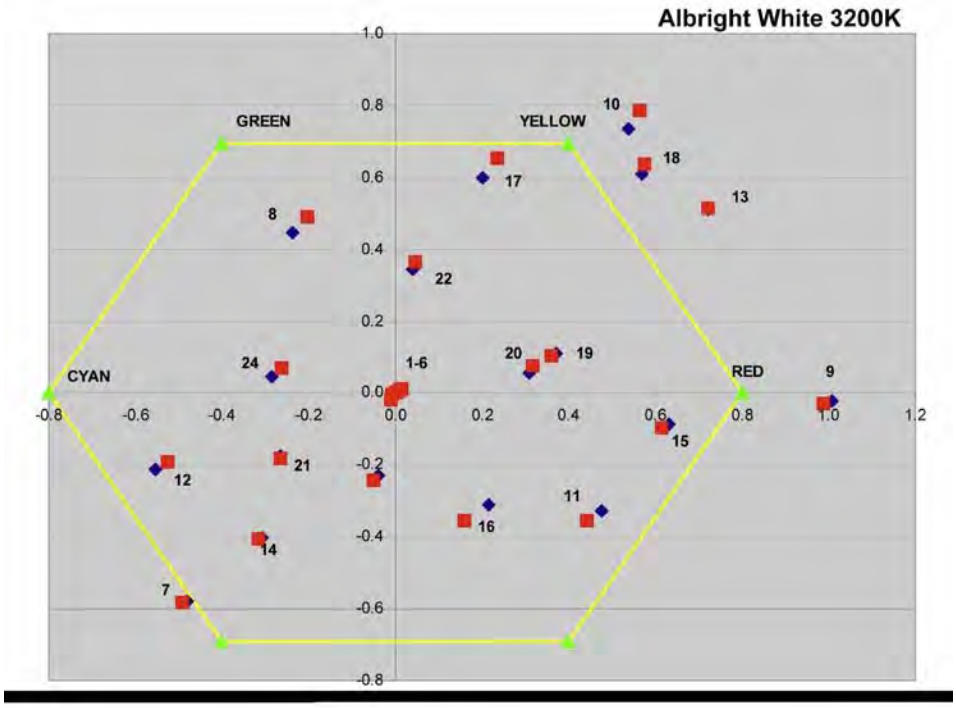
The center panel of the book flat contains a smaller version of the Macbeth Chart (app. 18" wide) with the upper half of each colour chip removed.

Visual 57: Smaller "cutaway" Macbeth chart close up

When properly aligned and viewed from the camera position, the foreground chart lines up perfectly with the background chart.

Visual 58: Camera POV of the "Split screen Macbeth" Chart

It's then possible to illuminate the foreground chart with the illuminant source of interest (e.g. a fluorescent lamp, HMI or other) and the background chart with a standard reference illuminant (e.g. incandescent). Images are then recorded on the media of interest (e.g. different filmstocks or digital cinema cameras, etc.).



Visual 59: *Graphic developed by Mitch Bogdanawicz showing disparity between Macbeth Chip loci and representative fluorescent lamp*

Both visual observation and computer analysis will reveal the metameric "shifts" that may result.

Visual 60: *Chart case*

The front easel can accommodate targets up to approximately sixty-three inches wide. These are mounted on rigid panels sixty-eight inches by twenty-eight inches that mount in front of the Esmeralda easel. They are housed in a rolling case.

Visual 61: David Corley with Large DSC Laboratories' ChromaDuMonde™ chart on easel

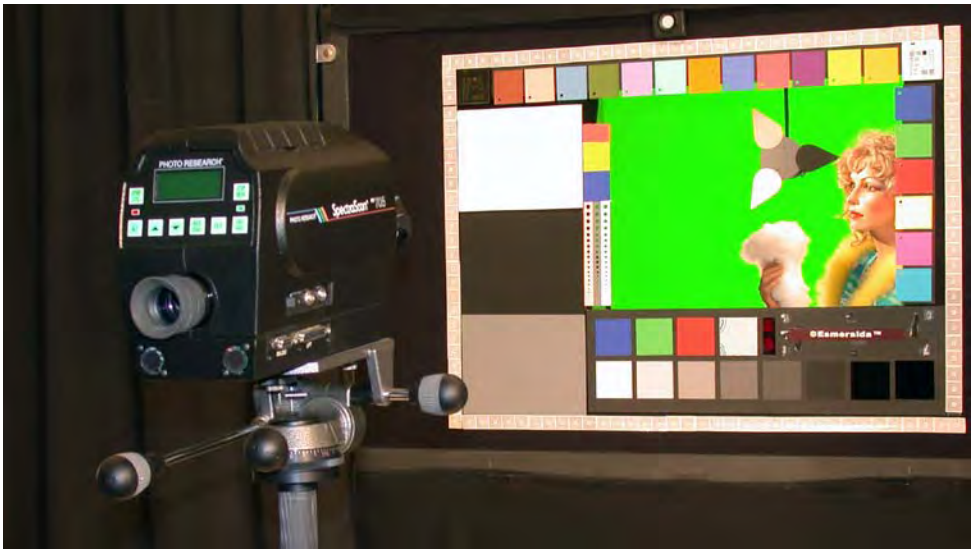
The collection includes a number of David Corely's DSC charts such as this ChromaDuMonde built especially by David for Esmeralda in this extra large size.

Visual 62: Chart mounting station

Charts are mounted to the panels using a forty-eight inch wide adhesive "transfer" tape from 3M. This station is essentially a large format tape dispenser.

Visual 63: Metrological devices – X-Rites

The Lab is provided with a variety of metrological devices: An X-Rite 310 colour densitometer for analyzing both positive and negative film; an X-Rite 810 reflection colour densitometer which can analyze materials to be photographed; both an Ocean Optics spectrometer . . .

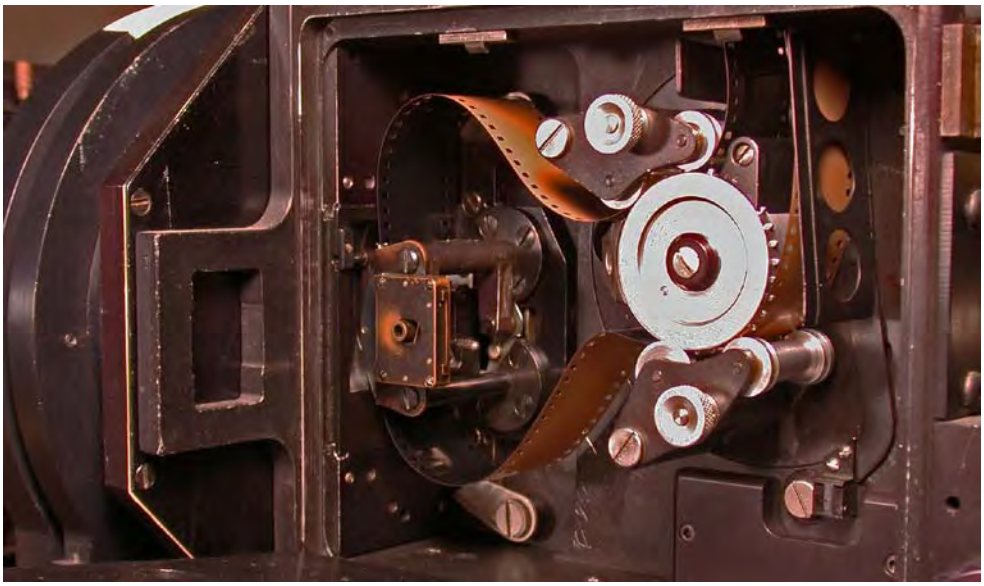


Visual 64: Photo Research Spectroradiometer

.and a PhotoResearch spectroradiometer plus a variety of light meters including Minolta colour meters.

Visual 65: Mystoflex camera

While we may no longer be on the wonderful matte stage of the old Apogee days, we still retain the superb performance of a motion control matte camera. Today we have the “Mystoflex” on loan to us from Illusion Arts a renowned effects facility. Unlike a regular stage camera, matte cameras are a variant of an optical camera.



Visual 66: Bell and Howell pin-registered movement

In this case, a Bell and Howell pin registered movement is capable of running backwards and forwards and can achieve perfect registration over multiple exposures. The one thing it cannot do is run at sound speed. The lens, on loan from Panavision, is a 75mm. Primo prime lens.

Visual 67: Close-up of Moco monitor

The camera and several other items around the stage, are operated by a motion control system, on loan to us from John Sullivan, built by Lynx Robotics which was Al Miller and Paul Johnson both of whom were awarded by the Academy for their contributions to this field.

Visual 68: Digital camera test – Foreground monitor shows the Esmeralda easel
B. Sean Fairburn and Petielle on left.

We've got just a few seconds left on the clock, so let's just take a look at some of the recent activities on the stage. These are mainly from digital cinema camera tests.

Visual 69: Digital camera tests on Esmeralda Stage with Peter Anderson, A.S.C., Melanie Ilich-Toay and Jonathan Erland

A Note About the Aesthetics.

The present iteration of the Esmeralda stage was created with extreme economy in mind, and thus the construction of some elements in plywood, the use of household electrical switches, surplus electrical and optical equipment, begged and borrowed equipment and the like is quite evident.

Visual 70: Peter Anderson, A.S.C. at easel with ISO 12233 Target Chart, B. Sean Fairburn in center

It was built with the personal funds and labour of Jon and Kay Erland at a cost of approximately $30,000 in cash and many hundreds of hours in labour. In the real world of for profit industry, such an undertaking would easily run from a quarter to half a million dollars and would look and feel marvelous.

Visual 71: More activity on stage from digital camera tests

As it is, it's merely wonderful. (We would, however, point out that, in her present quarters, this being the Academy after all, the Esmeralda stage is perhaps unique in the industry in that it enjoys the luxury of wall to wall carpeting!)

In summary then, we have shown the Esmeralda stage provides a "quasi standardized" means to assess the efficacy of image acquisition apparatus and materièl.

Visual 72: Charles Francis Jenkins

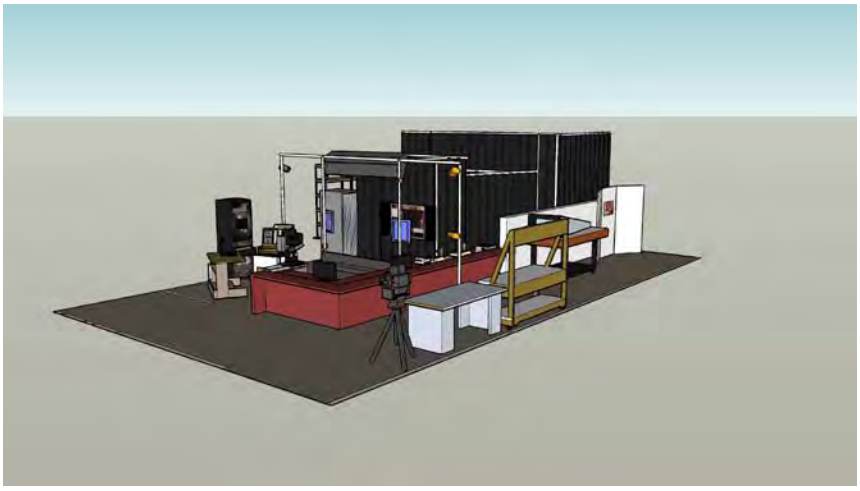
While the lab may not, of course, fall within the realm of our renowned SMPTE standards, I feel it does fall well within the scope of work envisioned for the Society by our founder Charles Francis Jenkins, at the time of our founding in 1916. Then, as now, the level of technological turmoil was very high, and, while turmoil often accompanies progress, it also breeds confusion which impedes the very progress we seek to encourage.

Visual 73: Logos of industry societies

It is the common goal of this whole family of honorary societies to advance the science of motion pictures and foster cooperation for technological progress and the pursuit of excellence in our art form.

It was in that spirit and with a view to reducing confusion that the “Esmeralda” stage was developed, and we’re delighted to have been able to make this presentation today.

Thank you, Mr. Chairman.



Visual 74: Slowly rotating SketchUp overview of the Esmeralda stage