Association of Moving Image Archivists Presentation

August 25th, 2012

Trickery and Deceit

by

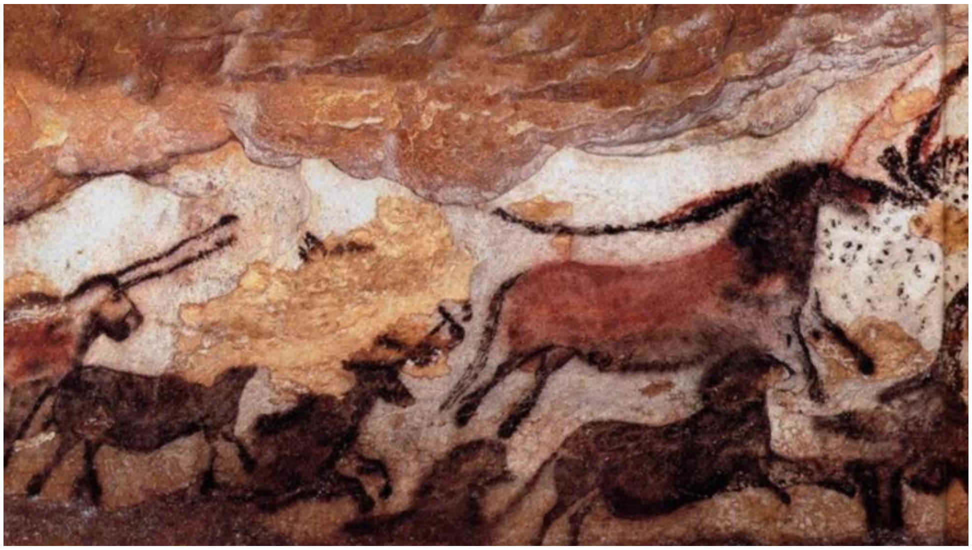
Jonathan Erland

BETTER FILMS THROUGH TRICKERY AND DECEIT

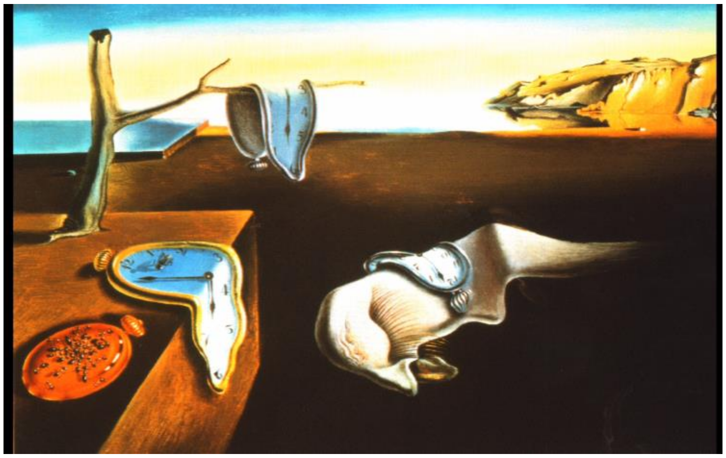
UNIVERSITY OF SOUTHERN CALIFORNIA

SCFX

SPECIAL EFFECTS ORGANIZATION



Long before the invention of movies, and certainly from the very inception of graphic art, the creative spirit of the artist has sought to enchant and beguile the viewer.



Not content to simply render the world as is was - artists sought to render the world that existed only in their mind's eye.

Even our earliest moving picture experiments included fantasy.

While many of the earliest motion pictures simply reveled in the sheer shock value basic to the phenomena.

William Dickson (Alfred Clark) at Edison, produced what may be the first FX shot the *Execution of Mary, Queen of Scots*, in 1895.

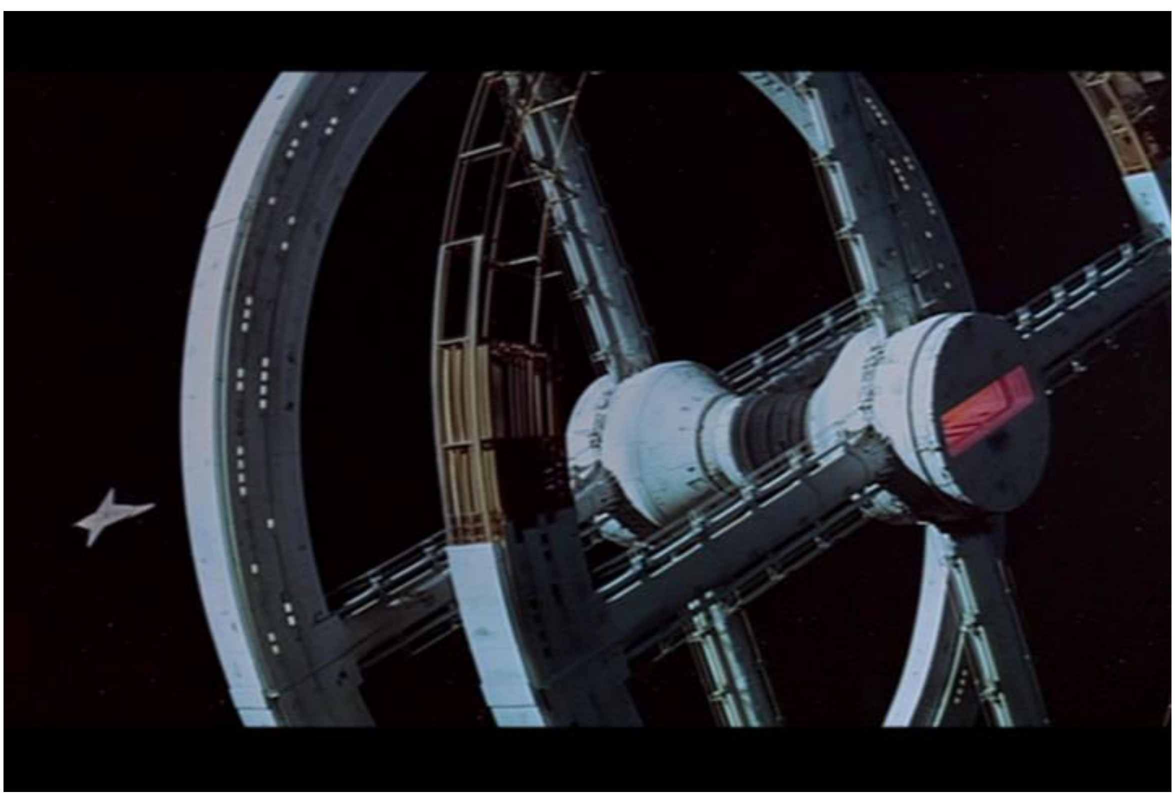
And my profession was born.

That same year, the Lumière brothers showed projected movies to the public for the first time, and the magician Georges Méliès was there to see it. He forthwith resolved to purchase a camera and, illusion being Méliès vocation,

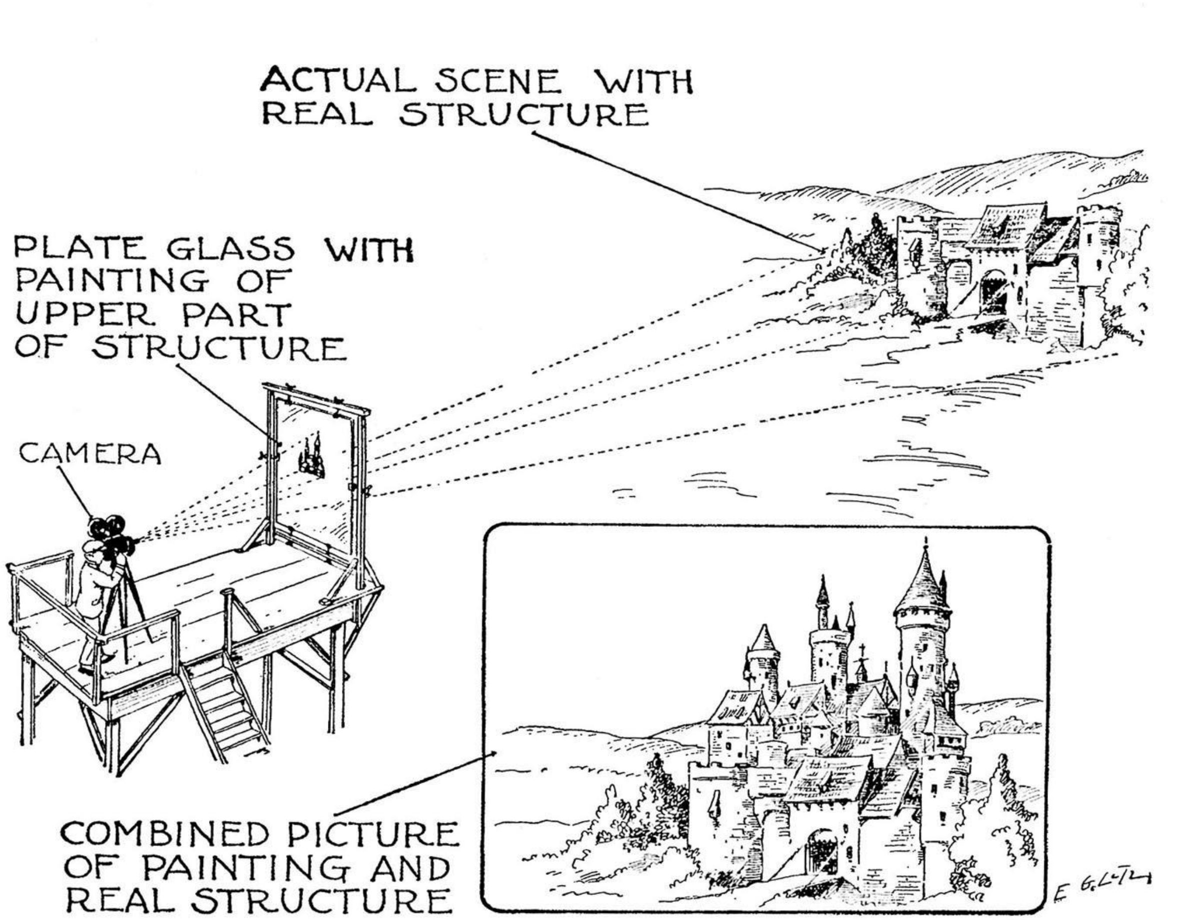
commenced one of the most extraordinary careers our art form has ever known. Méliès was already an accomplished and famous stage magician when he first saw the Lumierre brothers demonstration of motion pictures. He immediately, and almost uniquely at the time, grasped the implications of the new technology. When he couldn't immediately buy a camera, (the Lumierre's refused to sell him one) he decided to build one, and then commenced to essentially invent the screenplay and movie "magic". With "Hugo" still fresh in the minds of all of us I won't dwell on his story here, except to observe a small detail that may have escaped notice. In an art form barely a decade old, Méliès produced the first "homage" moment in a film.

We find Edison's three blacksmiths reprised in the workshop where Méliès moon shot is being built. Edison in turn, was possibly paying homage to Stampfer. While Méliès' vision was advanced, his equipment was relatively primitive, and he was constrained almost entirely to in-camera "tricks," exposing several elements sequentially and backwinding the film between takes. The only camera that could do this reliably at the time was Robert W. Paul's. As insurance against the inevitable mistakes, he often used two such cameras side by side, thus, it is said, inadvertently producing the 3D versions you can see today in Martin Scorcese's *Hugo*. Though it's reasonable to ask, was it really inadvertent? Stereo imaging was wildly popular at the time. He would have been stumped by the display problem but he may have thought a solution to that might soon arise.

As archaic as this technique may seem, it's actually timeless, and decades later produced many of the gorgeous scenes we remember from Stanley Kubrick's *2001*.



Early in the twentieth century, and with motion pictures barely twenty-five years old, Norman Dawn demonstrated the technique of combining, in- camera, an actual scene together with a painting.



He initially did this to show the “restoration” of a California Mission. By painting on a sheet of glass through which the actual scene could be seen, both the ruin and the painting appeared in the final image. He thus had created the art of matte painting.

This was followed quite rapidly by hanging miniatures which offered the advantage that the shadow lines would remain consistent. In the late eighties Apogee Productions produced this demonstration of these techniques for the Florida Universal Studio Tours.

First we'll see a matte painting depicting the Hollywood sign seen above the roofs of the Florida park.

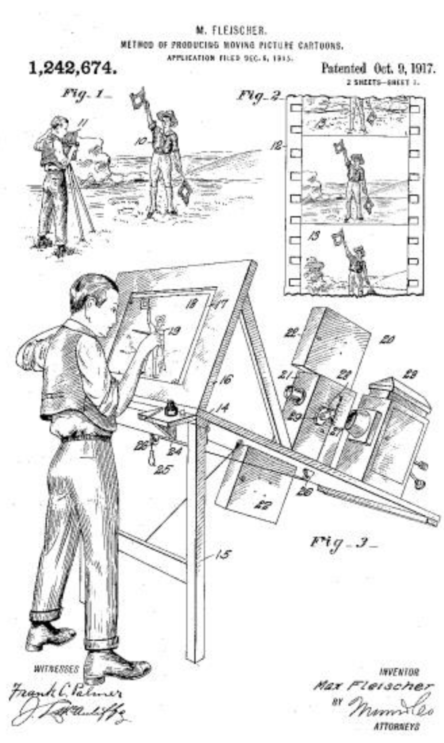
Here we can see Jenna Hollma, the matte painter revealing the “cheat.”

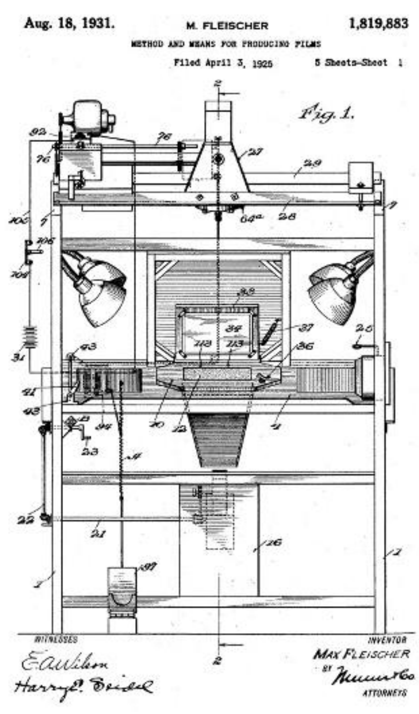
And here, somewhat more at home in Florida, is quite an exquisite miniature of the space shuttle.

Here’s a brief glimpse of both matte paintings and hanging miniatures all together in one tour de force scene from Jim Danforth’s “*West of Kashmir*” produced in the late 1980's demonstrating the validity of these earliest techniques. Watch for the surprise at the end of this scene.

And there's an interesting anecdote to the production of the scene you just saw. That entire set was built on the tennis court of Jim's mother-in-law in Van Nuys California. Jim is a genius, and he was so intent on simply getting his shot, that we had to twist his arm to shoot the tag shot where the camera is moved.

Around the same time as Dawn's matte paintings some adventurous souls began to conjure the notion that composite images could be made from images, indeed, even moving images. In other words, separately filmed images could somehow be combined by re-photographing them onto the same piece of film. Thus, rather than the static matte of matte painting technique, we would have to have mattes that moved around from frame to frame or that -   traveled, - hence traveling mattes.





One of the earliest approaches was invented, around nineteen fourteen by the animation genius Max Fleischer, the creator of Betty Boop and much more. His process is called rotoscoping, in which the mattes are hand drawn, frame-by-frame from original photography. Armed with a “set” of such mattes it’s possible to combine two separate filmed elements into a single image. It was, however, exceedingly tedious and exacting to do. Another approach would be to somehow cause the image to “generate” a matte through a photochemical process.

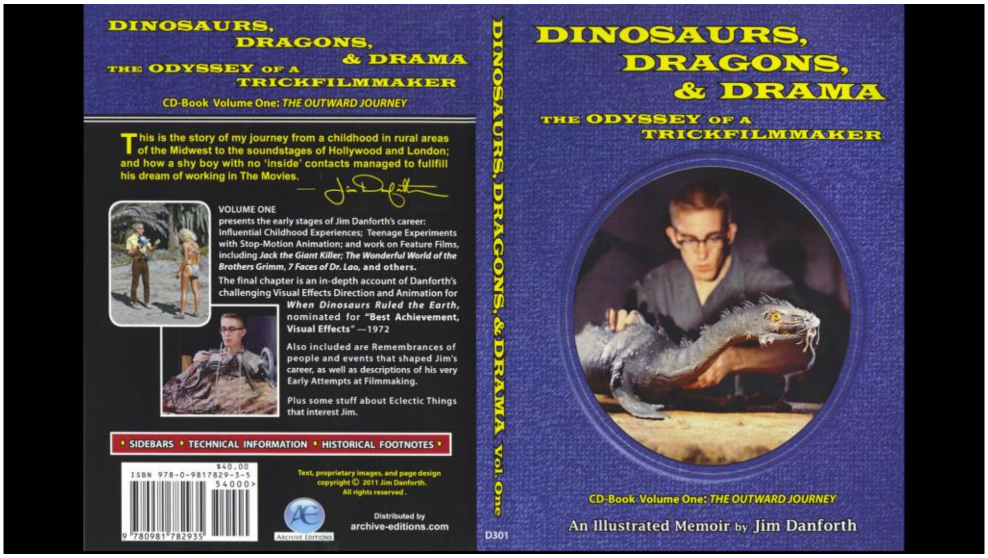
It took another genius, Frank Williams to develop just such a process, in 1916, filming subjects initially against a black backing, and subsequently, coloured backings. A precursor to bluescreen.

This scene from *Barney Oldfield's Race For Life* in 1913 may have been an early use of Williams process and is certainly an excellent demonstration of why one would use it. The details of his process are both too lengthy and too painful to relate in the time we have, but it was at least a beginning.

Well, it was more than a beginning. The teens of the last century simply erupted into a raging inferno of technological development. Much of the effort was directed at developing colour motion pictures. Many of these notions envisioned the use of prisms and beam-splitters, obviously inspired by Isaac Newton and James Clark Maxwell

though many, like this one, were staggeringly impractical.

I simply have to show you this tour de force effort by Frank Williams in the 1927 Fox production, *Sunrise*. Given the relative infancy of the technology at their disposal, it's astounding what he was able to achieve.



While we don't have time today, much of the technology we're discussing here is covered in some detail in Jim Danforth's DVD book which is a treasure trove of knowledge.

PATENT SPECIFICATION

Application Date: June 16, 1920. No. 16,315/20. 169,233

Complete Accepted: Sept. 16, 1921.

COMPLETE SPECIFICATION.

A New or Improved Process of Producing Photographic Silhouettes.

I, HANS GOETZ, of Sendlingertorplatz 1, München, Germany, a citizen of the German Republic, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

It is an observed fact that if a photographic negative and a finished diapositive obtained therefrom are placed one upon the other in register, facing each other, a uniform transparency is obtained, as the light parts of the diapositive are on the dark parts of the negative, and *vice versa*.

Now, my invention relates specifically to the utilization of this circumstance in making photographic silhouettes and the employment of these silhouettes in combination printing, in which one picture is superimposed upon another. But while heretofore combination printing could be accomplished only by the employment of silhouettes cut out by hand and by certain manual work for covering the background, the process to which this invention refers is a purely mechanical one without requiring any such manual interference. This permits the insertion of the most complicated objects and also the making of kinematographic combination prints.

I first photograph the object intended for silhouetting, which I will call *b*, placing it in front of a pure black background, which I will call *s*, the said background appearing as a blank on the glass or whatever it may be, in accordance with the optical inversion of lights and shades.

For the better understanding of my statements, as herein set forth, let me designate the negative received as N^s_b, the suffix to represent the object and the exponent the color of the background.

Without changing the position of the object *b* nor that of the photographic apparatus I now substitute for the black background a pure white one, which I will call *w*, and then take another photograph. The new negative, which I herein designate as N^w_b accordingly shows a black background, while the figure appears negatively in the same way as on N^s_b. Of this second negative I make a diapositive, herein designated D^w_b, the object *b* appearing on the same as positive and the background as transparent.

By placing the diapositive D^w_b upon the first obtained negative N^s_b an altogether transparent background is obtained, but the object *b* is positive in one picture and negative in the other, and accordingly, by this superposition a uniformly covered silhouette is obtained.

Instead of placing the negative on the diapositive, the two pictures may be photographically superimposed one upon the other. This may be done by first developing the negative N^w_b, leaving for the present the negative N^s_b undeveloped. Then the diapositive D^w_b, instead of being printed upon a new plate, is printed from the developed negative N^w_b direct upon the film or coating of the undeveloped negative N^s_b, so that after the development of the latter a complete silhouette will be obtained.

The taking of successive pictures before a black and a white background, as described, is, however, not generally practicable with objects which are in motion. In this case I therefore prefer one background of an intensive color, as for instance, red. Avoiding as much as possible stereoscopic parallax, I simultaneously take the object upon two plates, placing, however, before one of the object lenses a plate of transparent material, known and herein designated as a filter, of the color of the background, say, red,

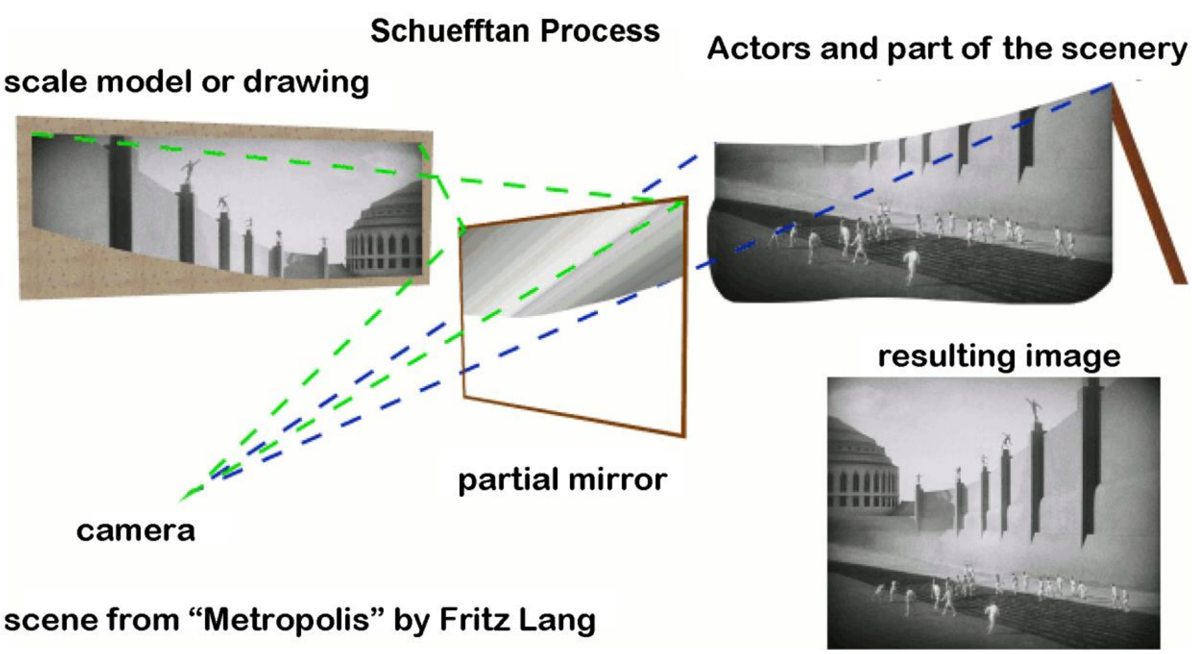
[*Price* 1/-]

Hans Goetz, of Munich, Germany, whose 1920 application contains the elemental observation that is at the core of bluescreen traveling matte process: that positives and negatives cancel each other, both in monochrome and, importantly, in color.

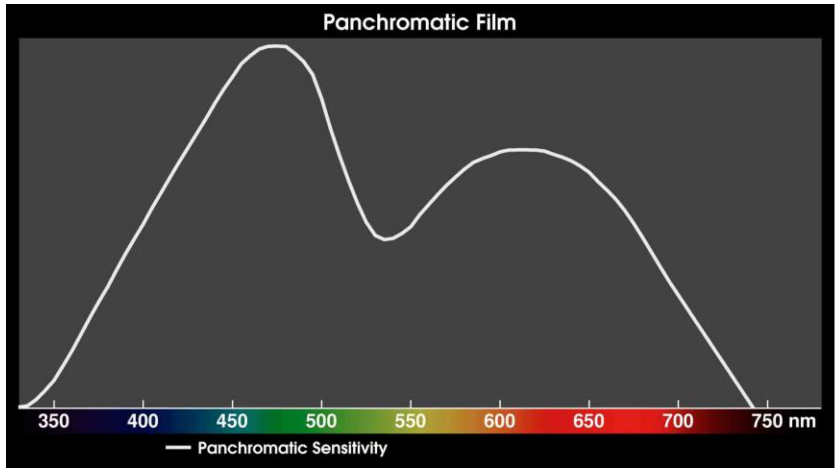
He goes on to describe a process using a Red backing instead of black and then using two cameras (and conceivably a beam-splitter) to record the scene via green and red filters. We'll come back to this in a moment, but as we're still in the twenties, we have to acknowledge that all the components of traveling mattes are still in the nascent stage and struggling. As is the concept of color cinematography.

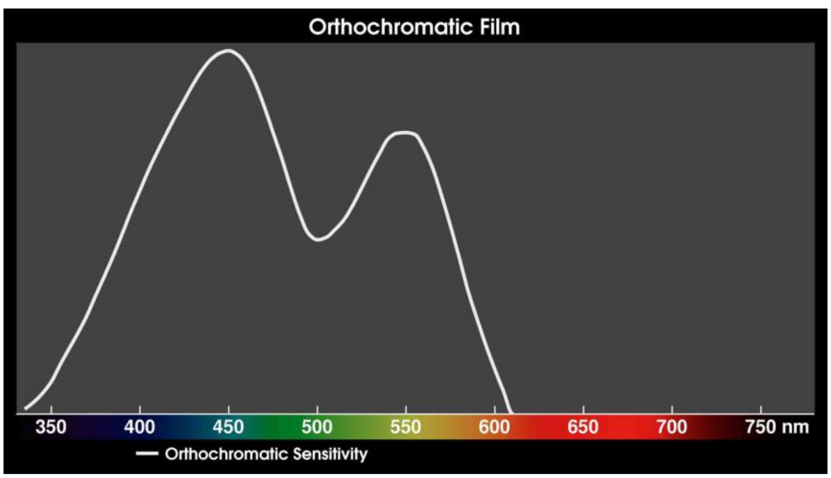
Herb Kalmus started work on the Technicolor process as early as 1912 and had some success with a two color process in the twenties, but the fabled three strip Technicolor didn't materialize until 1934.

So through the twenties, the dominant composite photography techniques remained the venerable Méliès in-camera shots along with matte paintings, hanging miniatures and Schuftan mirror shots.



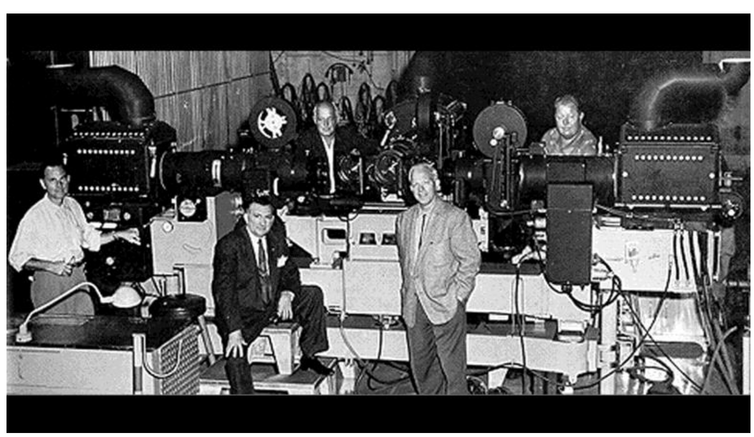
Of course, a principal limitation of these wonderful techniques is that they do not move, and for a motion picture medium that's a definite drawback. An obvious solution would be to film a foreground action in front of a screen on which was projected a previously filmed scene. But "rear projection" and, to a degree, all the technologies we've been discussing here, were being held up by the lack of the same things, high speed panchromatic film which was not in plentiful supply until the late twenties and the electrification of cinematography.





The orthochromatic film 'til then available was sensitive to mainly blue/green light which, for motion pictures, was supplied by daylight, mercury vapor or arc lights. Re-photography with such a stock will simply amplify its emphasis on blue/green.

When it arrived, however, panchromatic film impacted everything. Studio lighting was transformed, art direction was transformed, colour cinematography became feasible, process projection, optical cameras. Electrification, of course, also brought sound and so these two developments



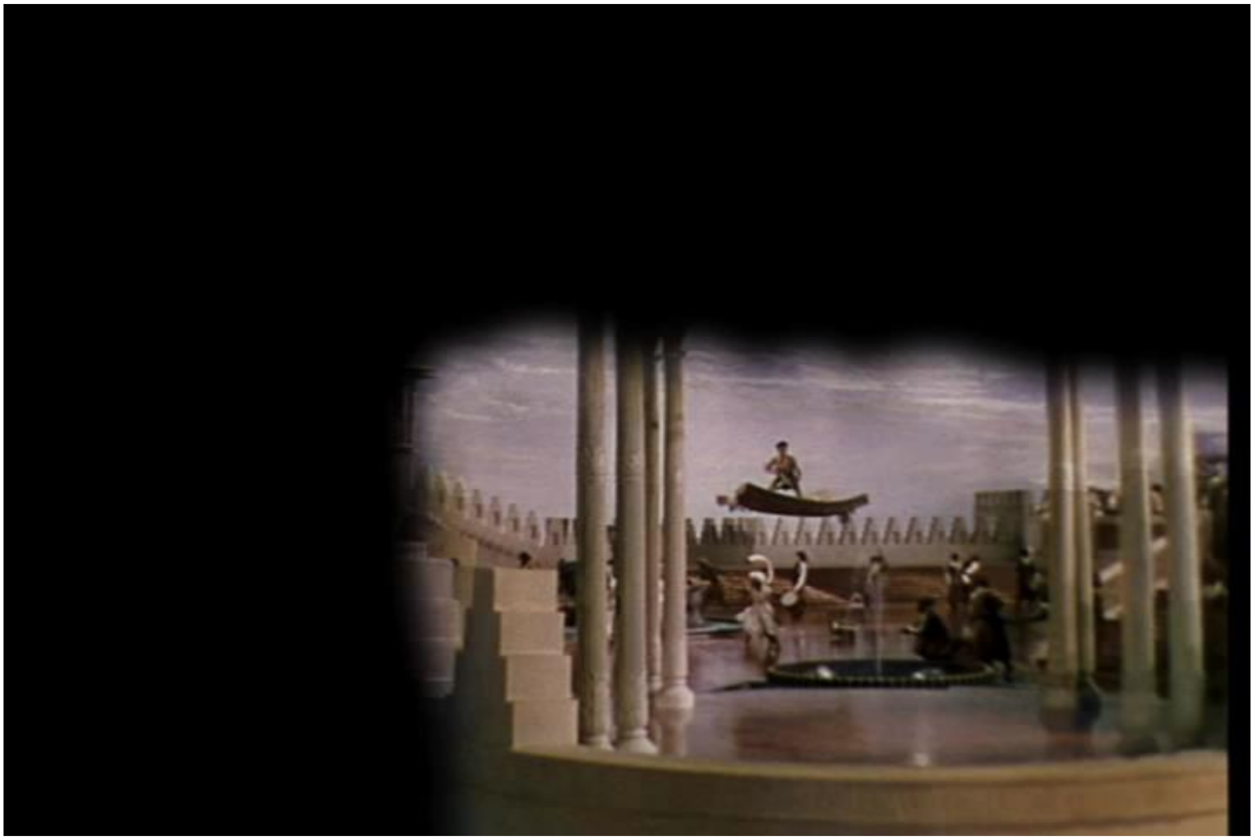
opened a floodgate of creativity.

Metropolis in 1927, demonstrated the then known gamut of effects technique, matte paintings, hanging miniatures, Schuftan mirror shots and including this rear projection simulated television screen (TV had just been demonstrated in 1927.) *Metropolis* may well be the first use of rear projection and required a daunting mechanical linkage between the camera and the projector. Fox used the process on *Liliom* in 1930, and at Paramount Farciot Edouart ASC developed the technique to a fine art with three synchronized projectors to build up the screen brightness and uniformity.

But for all these advances, rear projection had difficulty overcoming the often apparent distinction between the original image and the re-photographed one. Plus, it was exceedingly difficult to completely immerse the foreground element into the background one.

And that feature was going to be imperative in the fantasy film that Sir Alexander Korda was concocting in his mind as the thirties came to an end.

The film, of course, was to be a remake of the Douglas Fairbanks, nineteen twenty-four, black and white classic hit, *The Thief of Bagdad*. Unlike the Fairbanks hand tinted colour, the Korda production was to be in the glorious three strip Technicolor process. On top of that, it would display the full gamut of the visual effects of the day, including what may be the first major use of Bluescreen in a process developed by Larry Butler.



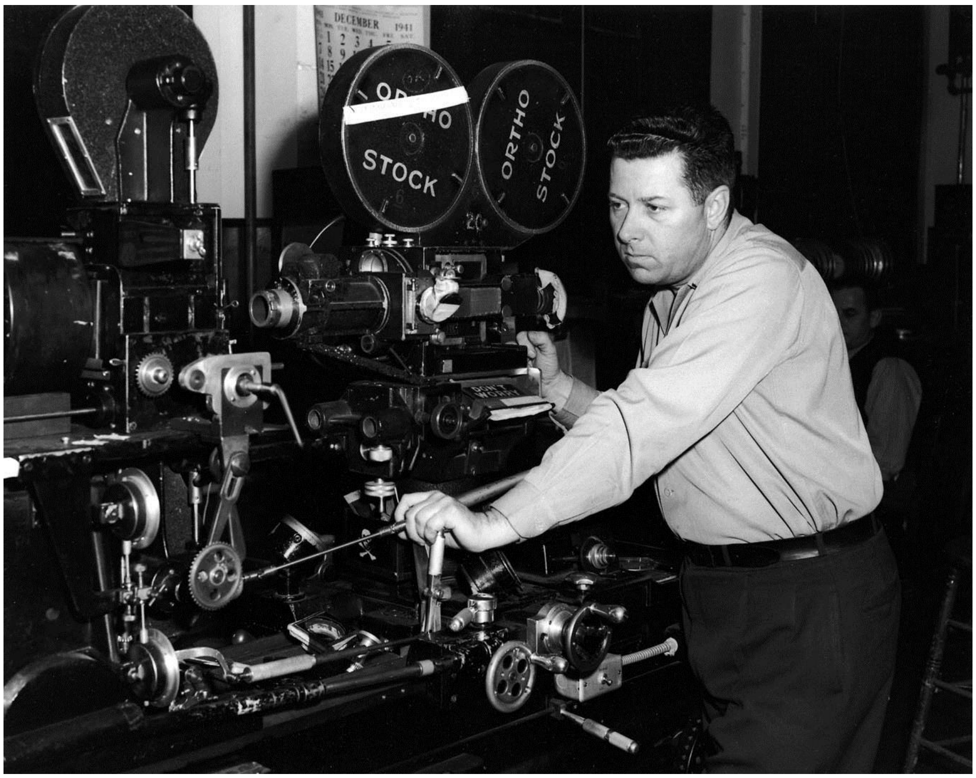
It’s obvious that, while the paintings and miniatures techniques are fully matured and superb, the bluescreen technique still had a long way to go.

We don’t have to look far to find why. The process requires the ability to accurately register and re-photograph the various elements, and making those elements requires certain specific filmstocks.

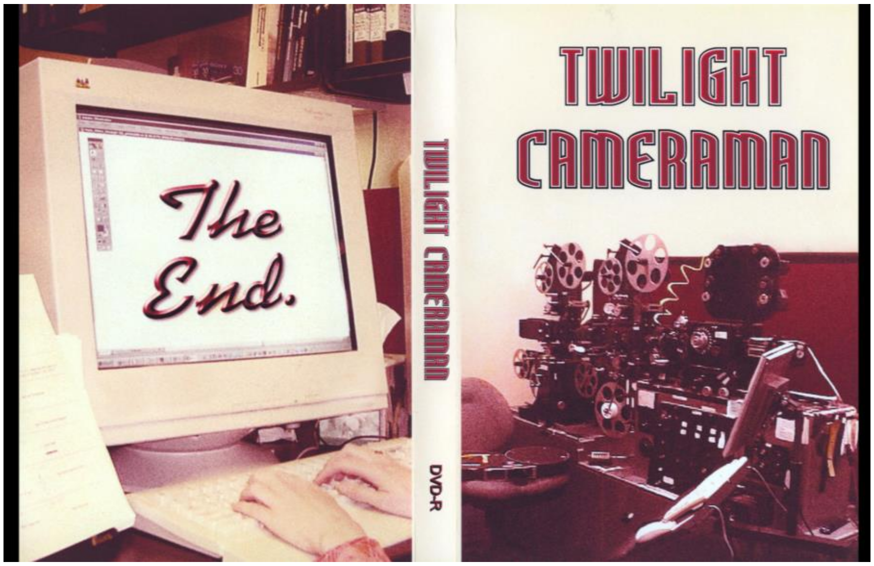
What made it feasible for *Thief* was that the original photography was recorded in three-strip Technicolor. The essence of the Technicolor process was to record the three colours, red, green & blue, on black and white filmstocks. The heart of the technicolor camera was a prism on two faces of which were camera movements. One movement recorded the green component; the other movement carried two stocks, bi-packed together, one was orthochromatic, and sensitive only to blue light. It was coated with a red dye. The filmstock behind was panchromatic, but because of the red-dyed stock in front of it, would only receive red light.

Technicolor was the dominant, almost exclusive, colour process for twenty years, from 1934 to 54, when monopack Eastman Color became available. My career manages to go back just far enough to have witnessed the shooting of the last three-strip production *Raising a Riot*, shot in England in 1954. Loading the camera looked for all the world like spaghetti and meat sauce. This process inherently gave Butler the three registered black and white separation negatives basic to the blue-screen process.

The next important element you need for Bluescreen is the device the namesake of this theatre is renowned for. Linwood Dunn's, "Acme-Dunn Optical Printer."



And, for a remarkable insight into the world of an optical camera operator,

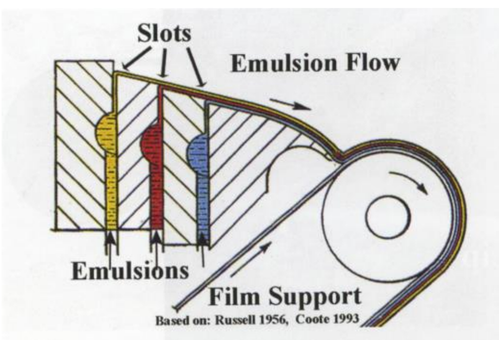


Mark Sawicki's wonderful movie, *Twilight Cameraman*. It documents what is now a lost art.

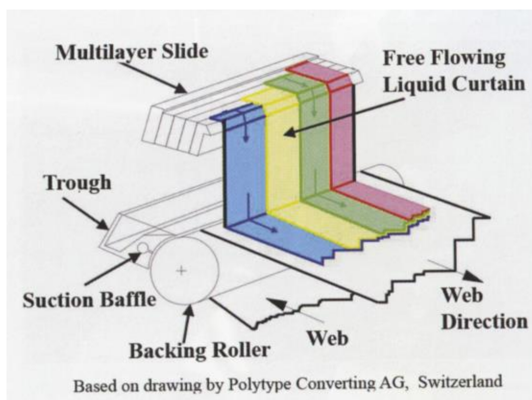
And when Eastman monopak color negative film became available in the early fifties, you definitely needed such a printer. You then also needed black and white "separation" stocks with which to make the equivalent of the Technicolor three strip elements, and you also needed a fine grain hi-con stock with which to make the mattes themselves.

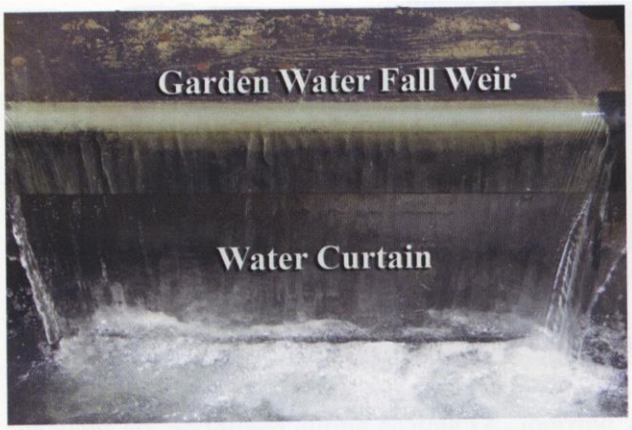
We don't have time for a complete description of the process that creates this incredible material, but we should at least take a look at the most critical part.

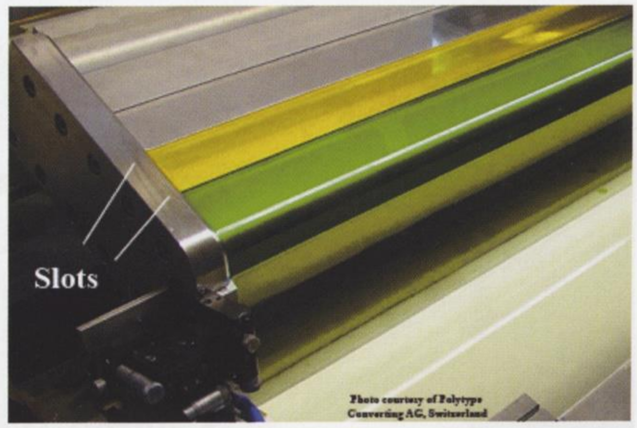
We all know that photographic film is comprised of a sheet of plastic with an emulsion coated onto it, but just how that coating occurs is not all that widely known.

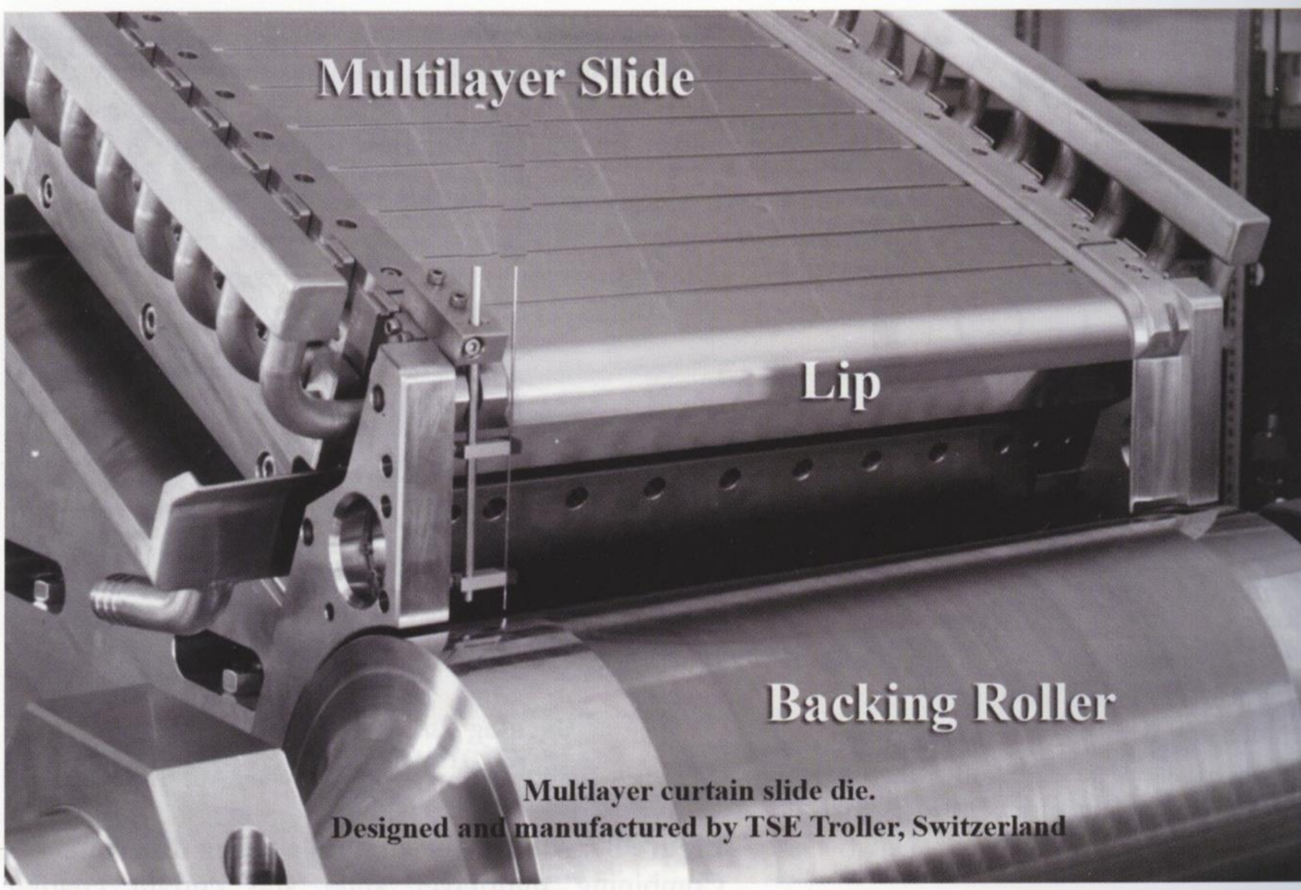


Fortunately, Robert Shanebrook, a retired Kodak employee has written a small book called, "Making Kodak Film." These few illustrations from that book illustrate the critical moment in the creation of filmstock. We can see that the various different layers of the film emulsion, and there could be twenty of them, are floated one on top of the other, and then literally "dropped" onto the sheet plastic much like a waterfall. As it falls, it is stretched ever thinner so that each layer is only a few nanometers thick and performs a specific function, such as being sensitive to Red light or Blue, or providing a filter or some other function.





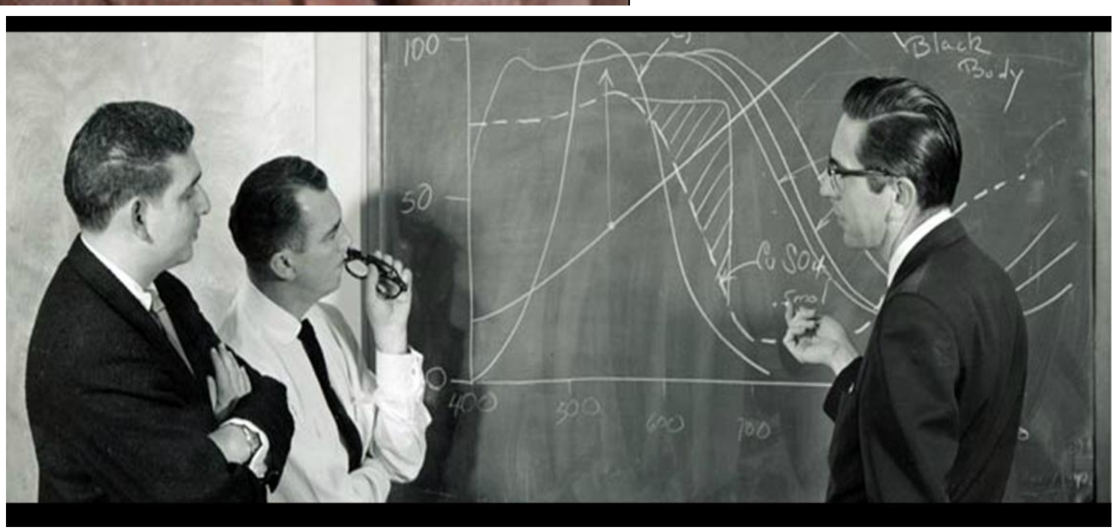




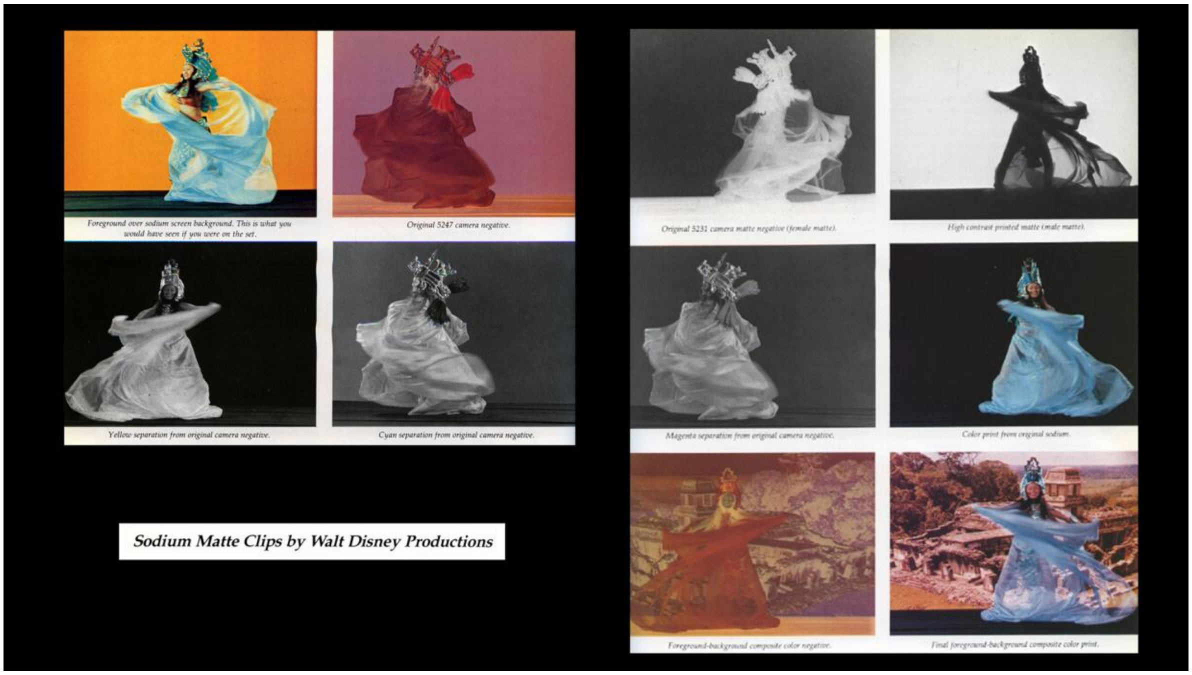
Multlayer curtain slide die.
Designed and manufactured by TSE Troller, Switzerland

From William Wedgewood, some two hundred years ago, with the first silver nitrate images, to the modern colour film we have today, is an astounding journey and definitely one of the "gigantic" ideas. And one I think many of us hope will stick around for a long time to come.

So now, with all the elements to perform Blue-screen in place, you needed just one more thing, you needed Petro Vlahos, to devise a procedure that wove all these pieces together into a viable system.



At about the same time, Petro, as well as some folks at J.Arthur Rank, in England, devised a process that remains competitive even today.



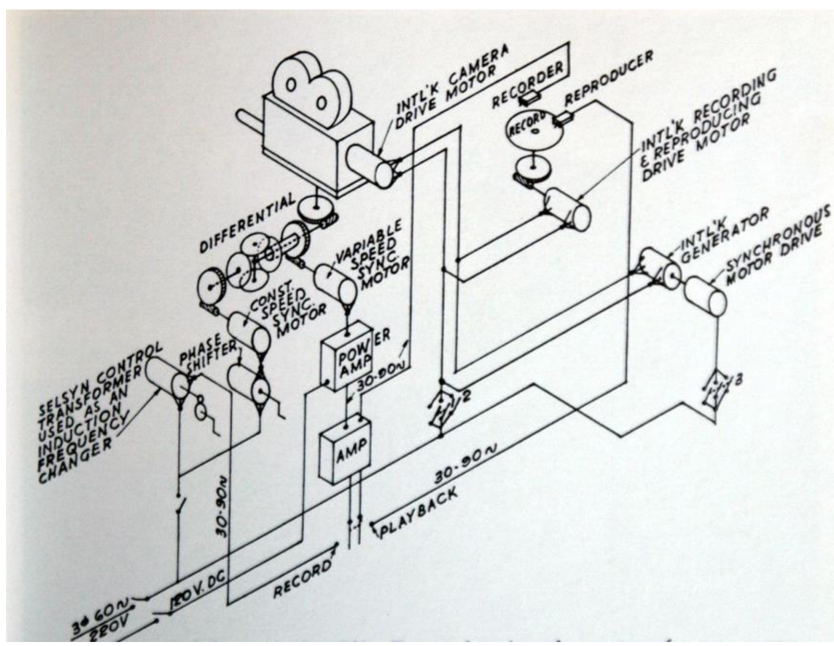
It was the Sodium Vapour Process and used the Technicolor camera with a specially modified prism, now running with the new Eastman monopak negative, plus a monochrome stock that recorded only a narrow band of yellow. Effectively, this created a four record process which provided for much better retention of ambiguous imagery such as diaphanous fabrics as well as smoke and motion blur

such as, spectacularly in this shot from Alfred Hitchcock's, *The Birds.*

It was also famously used to make *Mary Poppins*.

It's one great drawback was its dependence on the `Technicolor camera. However, Bluescreen, was sufficiently advanced that we were now in a position to make, *Star Wars*.

However, besides blue-screen, Star Wars would depend heavily on a massive advance of what was then an arcane fringe technique - motion control. For the last thirty-five years or so, it's been the popular notion that motion control photography was inaugurated on Star Wars. Like much else we've discussed so far today, it isn't quite that simple.



At MGM as far back as 1949, O. L. Dupey had created a "repeater head" for use with matte paintings. This system allowed a camera to operate in a more or less conventional way on a sound stage in principal photography. However, the camera had encoders attached to the controls. As the camera was operated every move was recorded so that the camera could repeat precisely the same move while filming a matte painting.

The means for that recording was quite astonishing. Wax phonograph records recorded the data just as they would have recorded sound.

As with everything else we've discussed, motion control had plenty of precedents. There is a rich history of what we broadly term "automata."

One example of such was featured in the Martin Scorcese film "Hugo." It seems from every culture and period of history, we find examples. Some are simple efforts such as clock towers that parade patron saints when the bells ring. Others, like the "Hugo" example were extremely intricate, and able to write, or play musical instruments.

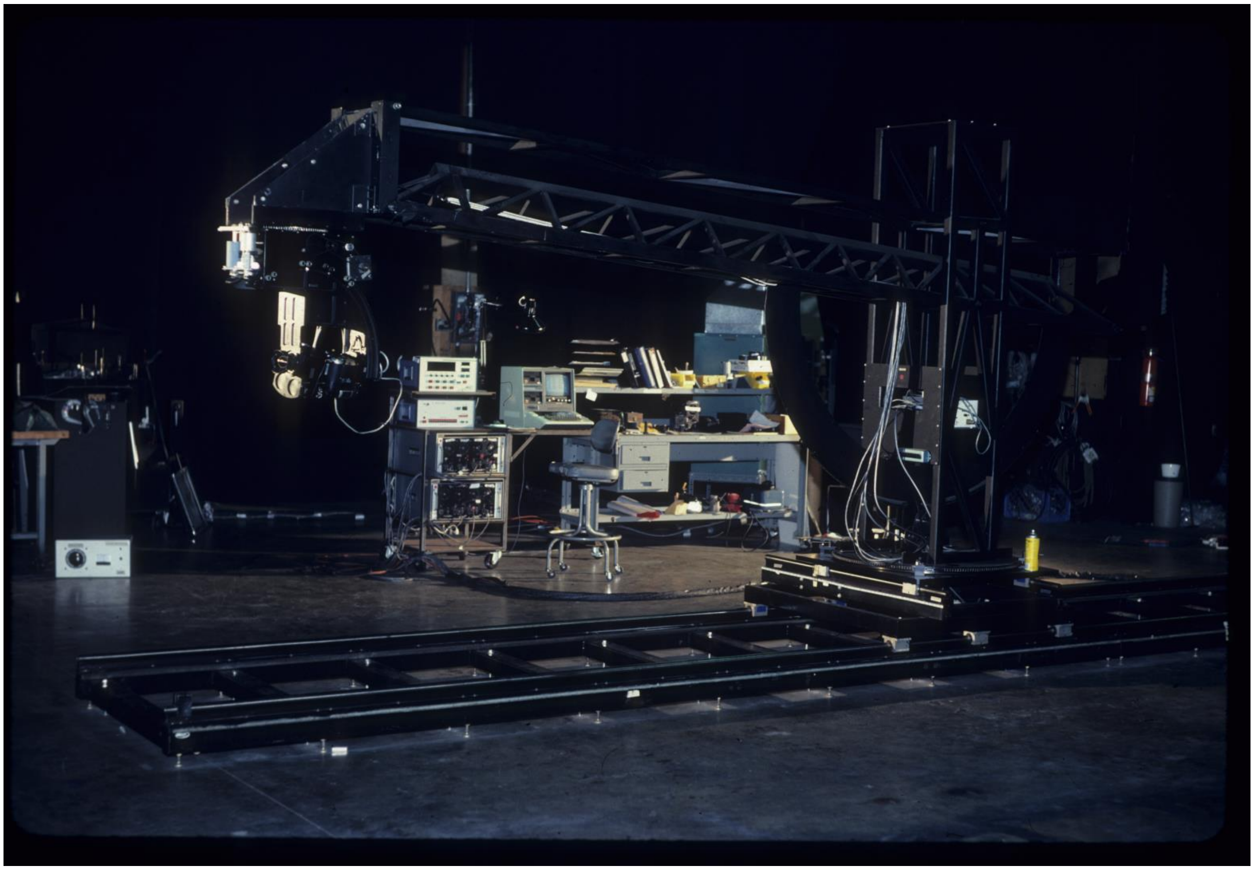
More recently, in 1964, I was part of a group that produced several automated puppet theatres designed by Charles Eames for the New York World's Fair.

At that same event, Walt Disney introduced his automata Abraham Lincoln. And, of course, there followed a plethora of such technology in Disneyland and a host of theme park attractions such as Universal Studios and the like.

Motion control has had a “hand” in almost every manufactured item you purchase.

So the motion control of Star Wars, was the beneficiary of a rich heritage. It was, nonetheless, a unique application for such technology and presented plenty of problems for its pioneers like Jerry Jeffress and Al Miller.

It was also, of course, strikingly different from the concept outlined by the director of Star wars, George Lucas, who had envisioned a scenario that involved building miniature space ships, (we kept that bit) and then having a black draped stage and a bunch of stage hands dressed all in black, running around on the stage carrying the spaceship models and executing the dog fights called for in his script. No, it’s alright really. I know what some of you may be thinking. But I'm seventy-three now, my career's winding down and it's unlikely I'll be needing to ask George Lucas for a job again.

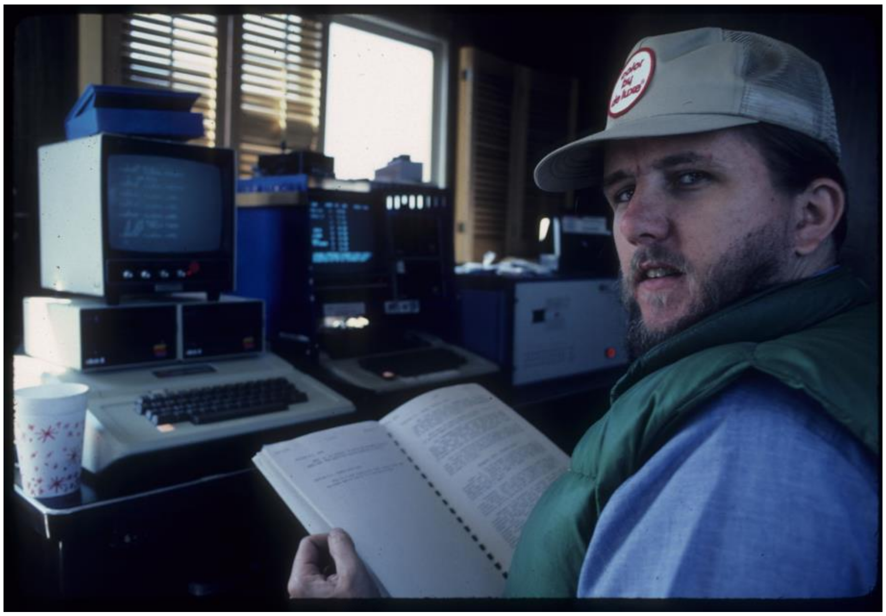


In the event, John Dykstra, was able to dissuade George from that course, and created the now famous Dykstraflex camera system. Although, on a sequel to Star Wars I am informed the original plan was employed but for elements several layers deep in a composite.

There are a number of reasons why the motion control approach was essential. Obviously a subject moving over considerable distances relative to the camera requires such deep focus that either enormous quantities of light are required or, more sensibly, very long exposures. Then frequently several exposures of the same ship executing the same move are required to separately record things such as lights and engine effects which will have different exposures.

It's often assumed that motion control meant computer control. That's true of motion control today. But in the early days we simply didn't have computers. Except for the giant mainframes IBM made. The same is true for the Eames puppet theatres and Disney's Abraham Lincoln. In the early days of motion control magnetic tape recorded the data, and so it wasn't really all that different from the Dupey wax record method.

And before them, the automata used clockwork power and essentially masses of rotating cams which effectively "remembered" and repeated the required motions.



For the production of "Star Trek - The Motion Picture" in 1979, Paul Johnson adapted the Star Wars era motion control to a truly computerized system based on the then relatively new Apple II computer.

Now instead of manually maneuvering the camera through each axis of motion and recording these moves on tape, all the movements could be programmed at the computer and recorded in the computer memory and the new floppy disc drives.

Adjustments could be made on a frame by frame basis and operations like curve smoothing and the use of key frames greatly improved the functionality of the system.

But there's another way to remember and repeat motion and perform highly intelligent maneuvers like curve smoothing, and it's far more ancient even than the automata of antiquity. So let's take a look at one of the more humbling examples someone in my profession can experience.

This is a dance duet from the 1944 Columbia film "Cover Girl" directed by Charles Vidor, called Alter Ego, in which Gene Kelly as Danny McGuire dances with his alter ego.

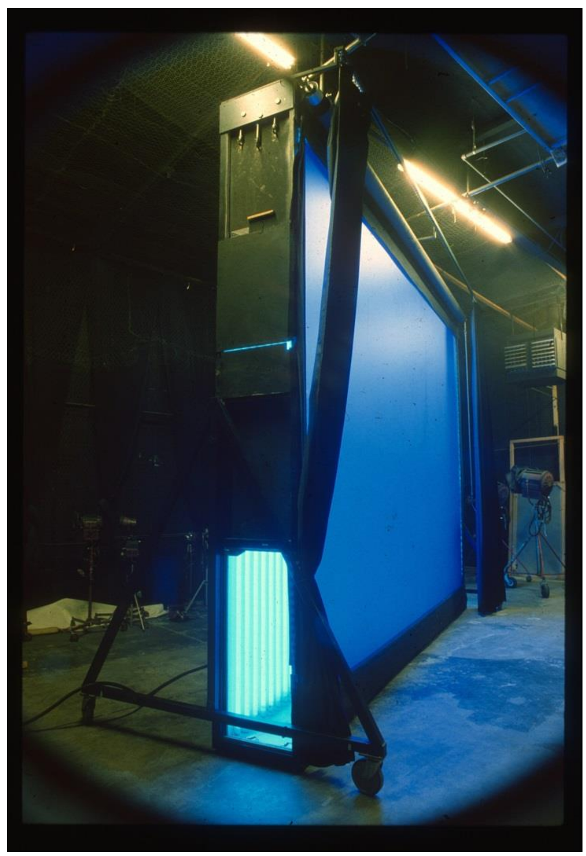
Gene Kelly and Stanley Donen had rejected the notion that a double could dance with Gene Kelly because there simply wasn't one. It would have to have been a twin. They conceived a way that Kelly could dance literally with himself. When they told the director Charles Vidor about it he pronounced it impossible and refused to have anything to do with it. So they went ahead and did it anyway.

So what you're going to see are two successive takes made of the dance with Kelley playing first himself and then his alter ego. Between takes, the whole set was blacked off with duvetyne. Now, had the camera been locked off it would then have been at least a feasible matter for Kelly to dance the two roles without ever crossing through himself. However, the dance routine required that the camera move, and not just camera pans and tilts but almost constant dolly moves were required and even dolly track was out of the question. So Stanley Donen, a brilliant choreographer, set about to turn the whole camera crew into dancers –

- with the precision of the Rockettes at the Radio City Music Hall. They had music track of course so they had what passed for time code. And they rehearsed over and over until they could produce this DX. Two successive takes combined in camera. Aside from the spectacular leap over himself, note the subtle details like the eye contact the two Kelly's maintain.

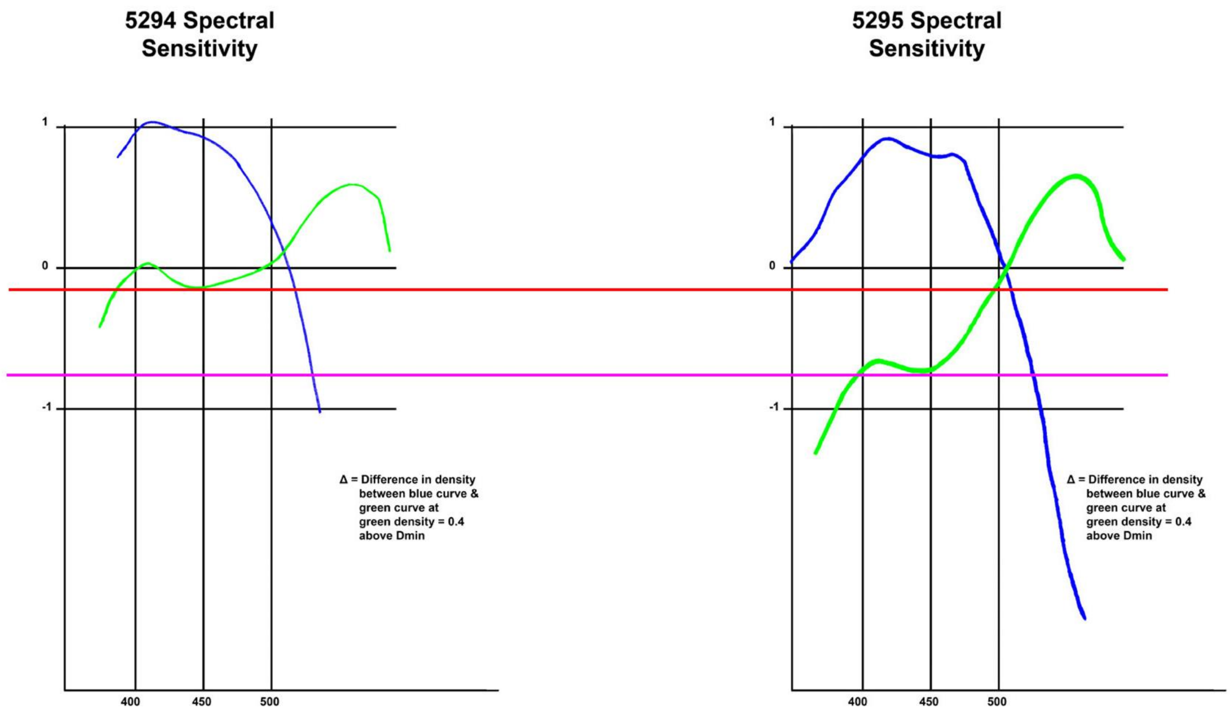
This isn't just humbling for people of my trade, but actors today who complain about having to perform in the absence of other characters in a scene should take a look at this.

For *Star Wars*, we also had to devise a very powerful blue-screen based on the Academy Award winning Stewart translucent rear lit vinyl which, in its translucent white form, was used for rear projection process. High output fluorescent tubes were added



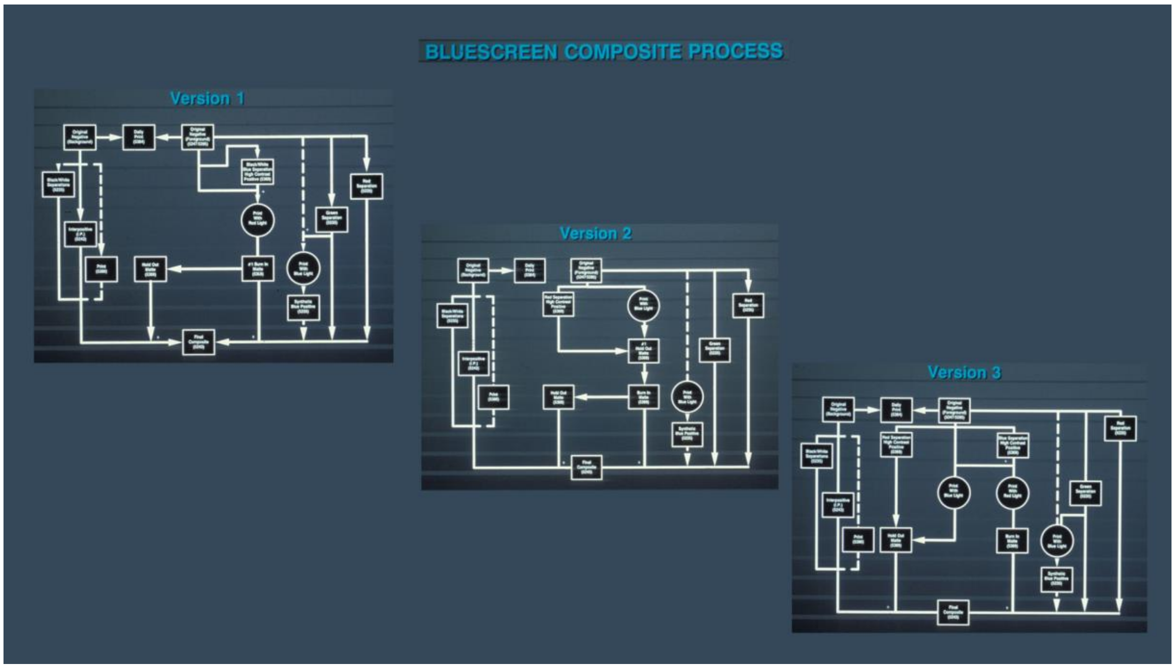
which were much more efficient than incandescent light. And much cooler.

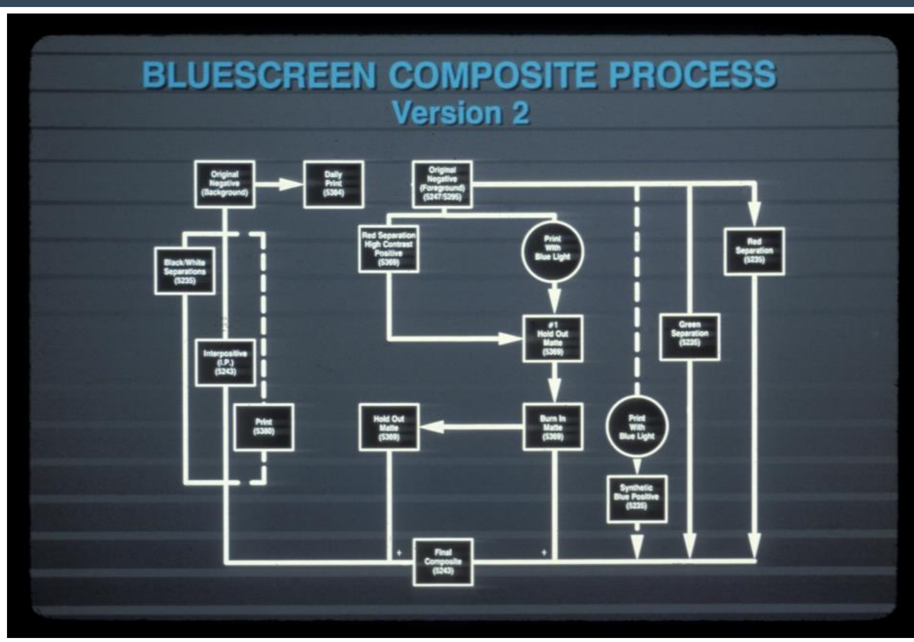
Even with these improvements, it was still necessary to work closely with our colleagues at Eastman Kodak to develop color negative that would provide the essential separation between the colours.



Here we can see a comparison between Eastman negative 5294 which was notoriously bad for blue-screen work, and its replacement 5295, which was equally notoriously excellent for blue screen, and I think you can clearly see why!

There are many variations on the bluescreen process and here we can see three of them:





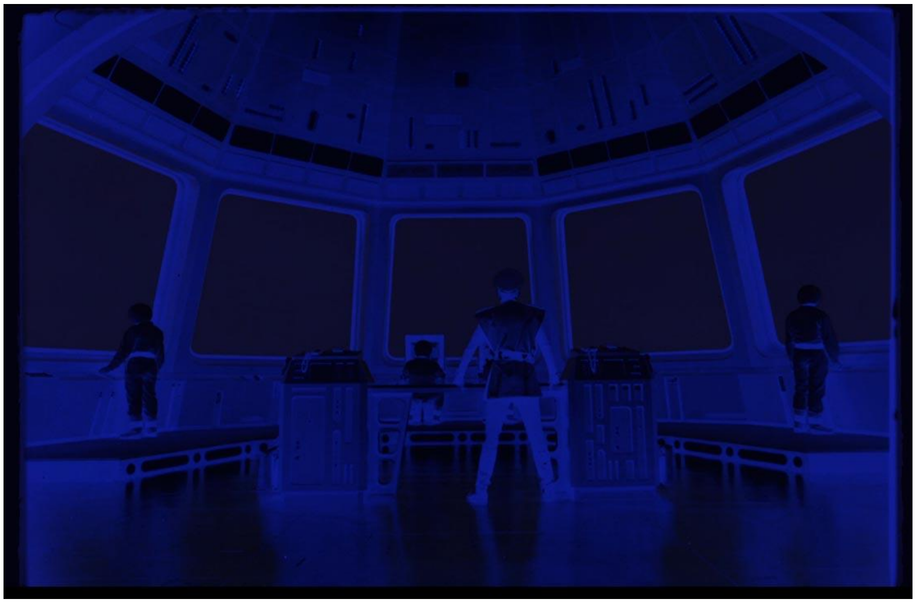
Variation #2 is the one preferred by Roger Dorney who ran the optical department at Apogee. In general, the procedure is as follows: The foreground action scene is staged in front of a blue backing and photographed on color negative stock.

The colour negative is then sent to either an optical printer or an electronic scanner and computer workstation for compositing into the scene. In either case, the matte, of course, is the key element in this process, and it may help to explain in more detail how we build it. Let's look at some enlargements of the elements.

First we take the original negative

which has the familiar orange cast to it that facilitates printing the negative to a color print film. For this demonstration, we've made a version of the negative that has the orange cast removed.

When I place a blue filter over it,



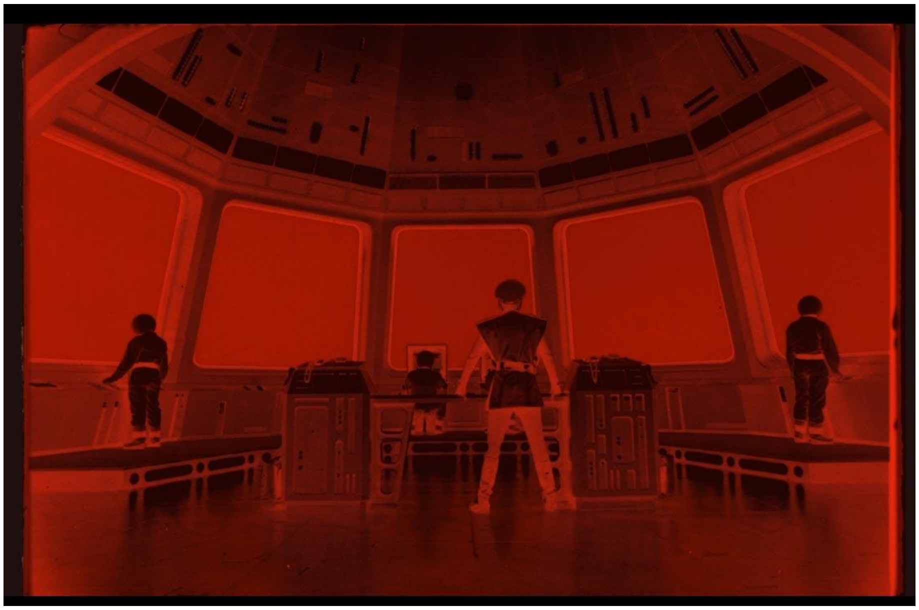
we can see that the blue areas of the image will be able to print through to the black and white Hi-Con film.

The result will be this image

in which the windows where the bluescreen was seen are clear - and, as we can see immediately, it couldn't serve as a matte because there is obvious exposure in a number of places besides the bluescreen. We can see lights, for example, where there's as much blue exposure as there was from the bluescreen itself, and we can also see Blue Spill all over the floor where the screen was being reflected back to the camera. Besides all that, it's obvious that there's a blue component throughout the whole image.

What makes it possible to make the matte, however, is that there's also a red and green component to all these non-bluescreen areas of the image. Being at the opposite end of the spectrum from blue, the red component constitutes a sort of chromatic negative of the blue positive we just made. So, if we take our negative

and add a Red filter,



we can see those areas of the image that'll print as clear in a red Hi-Con Positive

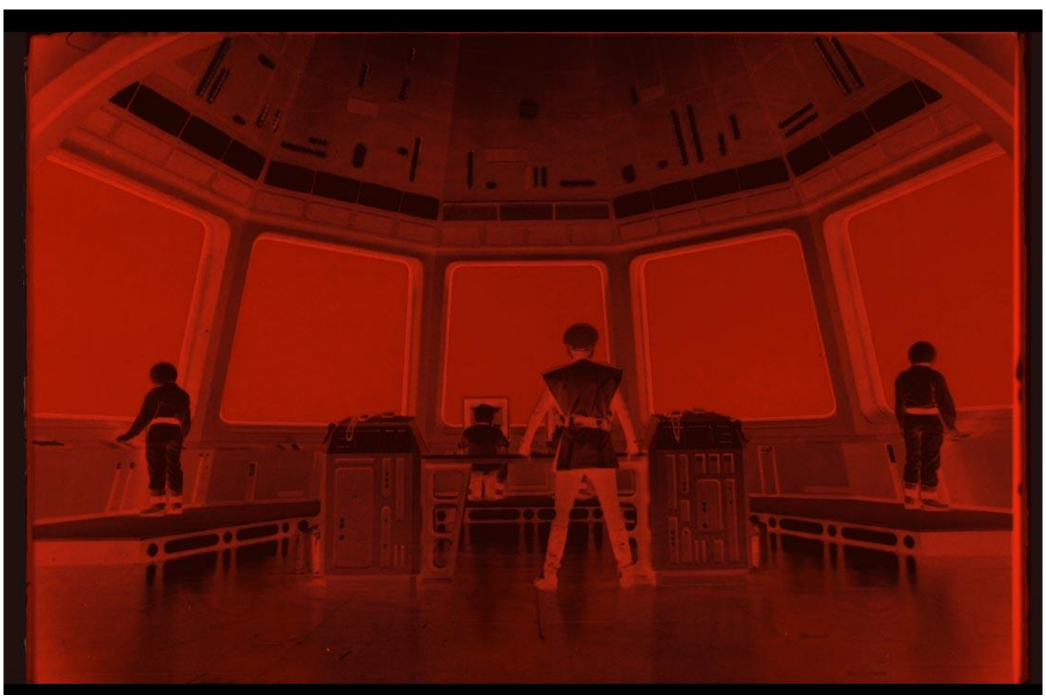
namely the lights, where there was also as much red exposure as there was blue, and also these areas on the floor where we had blue spill, but where we also had the red exposure that's under the blue spill. On the other hand, there's no red exposure in the bluescreen area, so this area will print as black in the Red Hi-Con Positive.

Now this image wouldn't work as a matte for the same reasons, in reverse, that the Blue Hi-Con Print wouldn't work; there's exposure (or lack of it) in the wrong places in the image.

As Goetz said earlier, we're all familiar with the fact that a photographic negative and its positive will cancel each other out if we superimpose them. Well, with color film we have three color records. In fact, three different films stacked on top of each other. And thus we can have six potential images - the three positives plus the three negatives - and each of these will be different. It's this difference we're able to exploit in order to make our mattes.

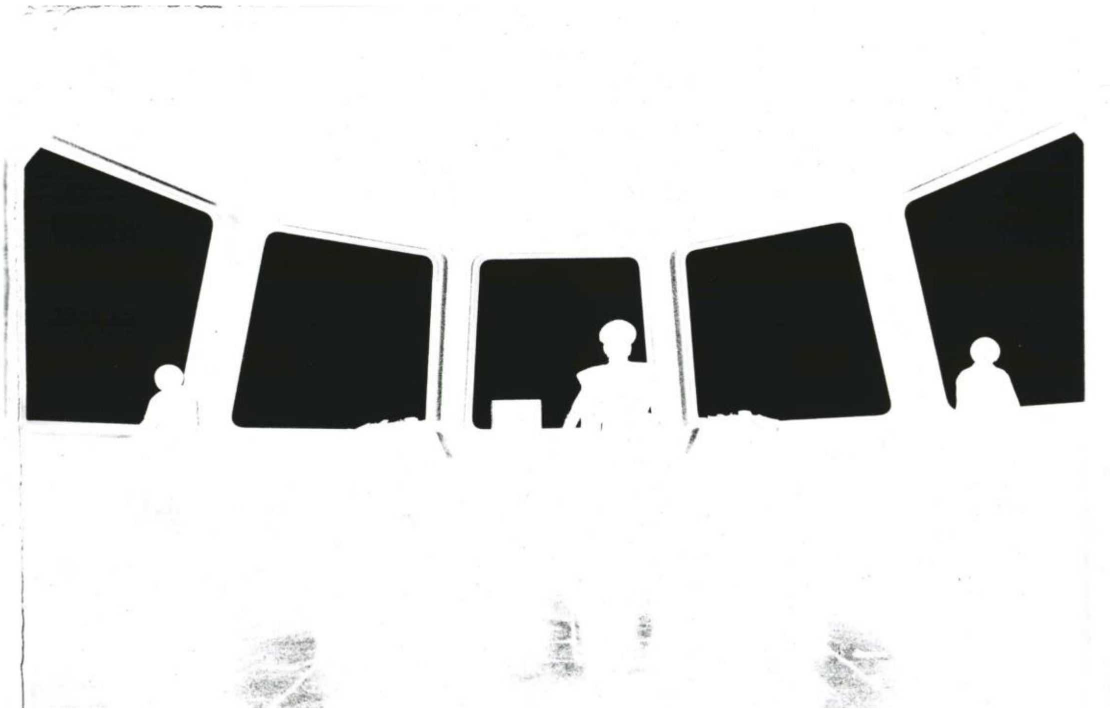
So, as we can observe here,

what the original negative, sandwiched together with a red filter, -



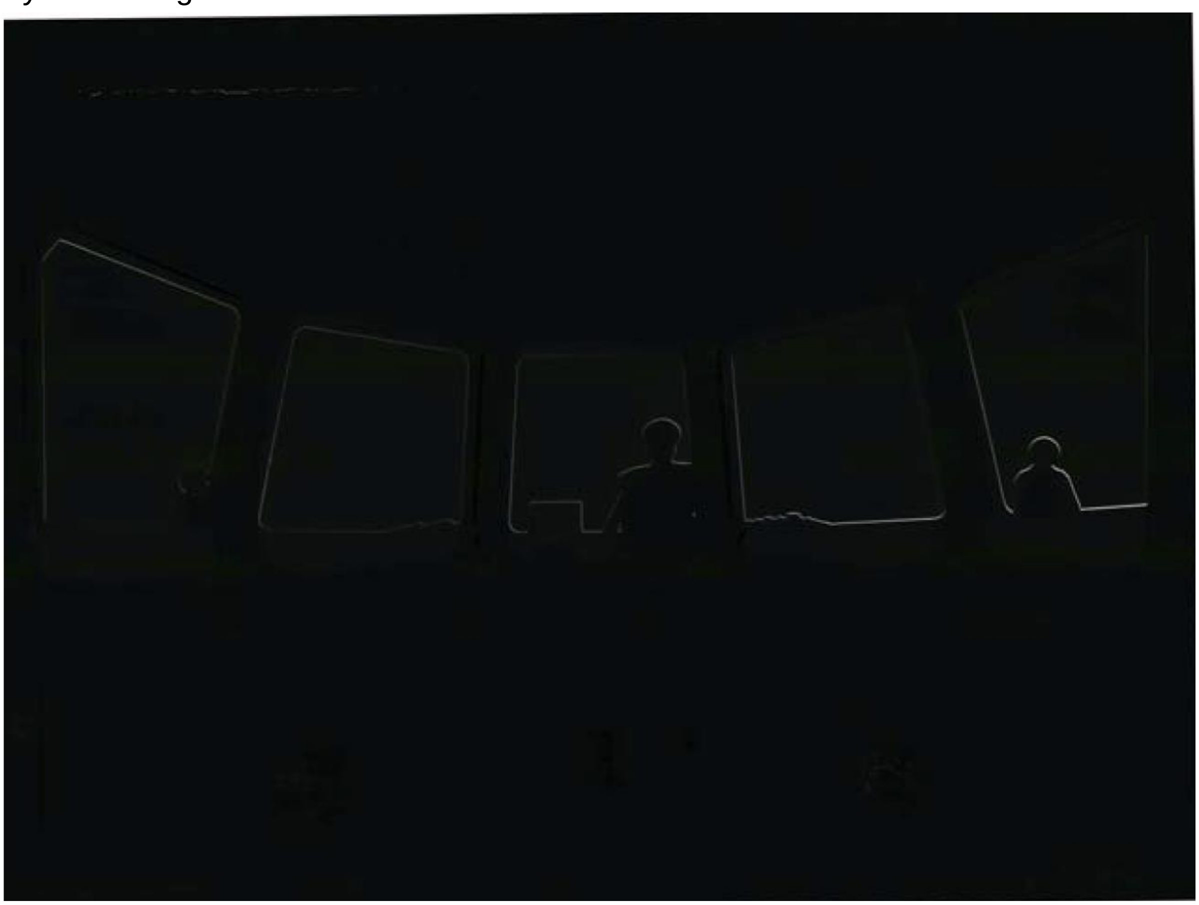
and the hi-con positive made from the blue record of the same negative

have in common is that the blue-screen area is clear in both cases. But elsewhere, the combination of the positive and negative images cancel each other out. Therefore, when we expose this to another piece of black and white 5369, the result will be -



- something we call a number one burn-in matte, which is reversed to form a hold-out matte.

By combining these two mattes



we can illustrate a very important consideration in the mattes that's revealed by this fine white line that we observe here. This represents a very slight space between the two mattes which results in an overlapping, or double exposure, of just the very edges of the foreground and background images. By contrast, if the matte images were actually to overlap each other, the result would be an area of the composite image that received no exposure and thus would be rendered as black. In this way, fringing, or matte lines are eliminated. By modifying the exposure and development of the matte image, it's possible to adjust the size of this gap, and this process is known as "sizing the matte".

By the way, the image we've been using for this illustration is from the 1986 Mel Brooks film *Spaceballs.*

Of course, what we've just demonstrated is now archaic, as we presently do all this in a computer where, instead of breaking the image apart into three components of Red,

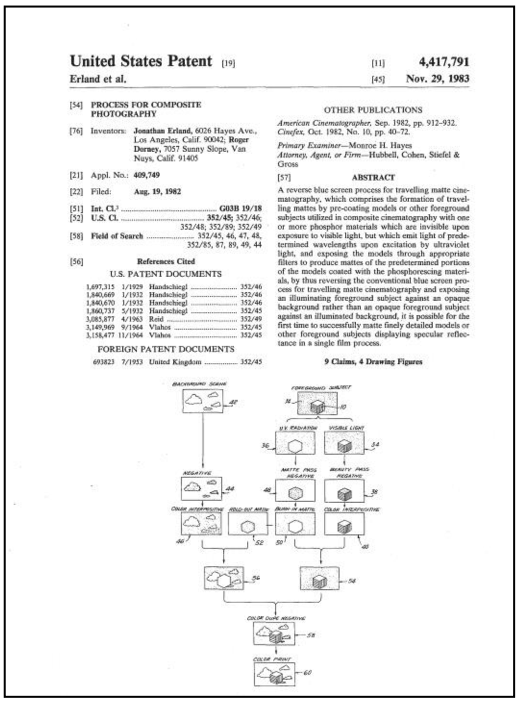
Green and Blue, we today, thanks to Alvy Ray Smith and Ed Catmull, break each image up into individual pixels, or "picture elements" comprised of R,G,B, and luminance values from which we can derive a variable "opacity" image that we call the "alpha channel" essentially the matte from the old days but it's a half tone matte instead of a high con matte, so it's now much easier to retain ambiguous imagery like smoke and such. Importantly, being digital, its counter matte always fits perfectly.

These are images from Oleg Alexander's production Primitive.

However, as good as the process had now become, it still had problems. For example it

couldn't cope with objects in the scene that reflected the bluescreen light from their surfaces. Such as the case with Clint Eastwood's film "Firefox" which featured a very shiny black plane.

To solve that we had to develop "Reverse Blue Screen."



United States Patent [19] [11] **4,417,791**

Erland et al. [45] **Nov. 29, 1983**

[54] **PROCESS FOR COMPOSITE PHOTOGRAPHY**

[76] Inventors: **Jonathan Erland,** 6026 Hayes Ave., Los Angeles, Calif. 90042; **Roger Dorney,** 7057 Sunny Slope, Van Nuys, Calif. 91405

[21] Appl. No.: **409,749**

[22] Filed: **Aug. 19, 1982**

[51] **Int. Cl.**3 .... **G03B 19/18**

[52] **U.S. Cl.** **352/45;** 352/46; 352/48; 352/89; 352/49

[58] **Field of Search** 352/45, 46, 47, 48, 352/85, 87, 89, 49, 44

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Primary Examiner—Monroe H. Hayes
Attorney, Agent, or Firm—Hubbell, Cohen, Stiefel & Gross

[57] **ABSTRACT**

A reverse blue screen process for travelling matte cinematography, which comprises the formation of travelling mattes by pre-coating models or other foreground subjects utilized in composite cinematography with one or more phosphor materials which are invisible upon exposure to visible light, but which emit light of predetermined wavelengths upon excitation by ultraviolet light, and exposing the models through appropriate filters to produce mattes of the predetermined portions of the models coated with the phosphorescing materials, by thus reversing the conventional blue screen process for travelling matte cinematography and exposing an illuminating foreground subject against an opaque background rather than an opaque foreground subject against an illuminated background, it is possible for the first time to successfully matte finely detailed models or other foreground subjects displaying specular reflectance in a single film process.

9 Claims, 4 Drawing Figures

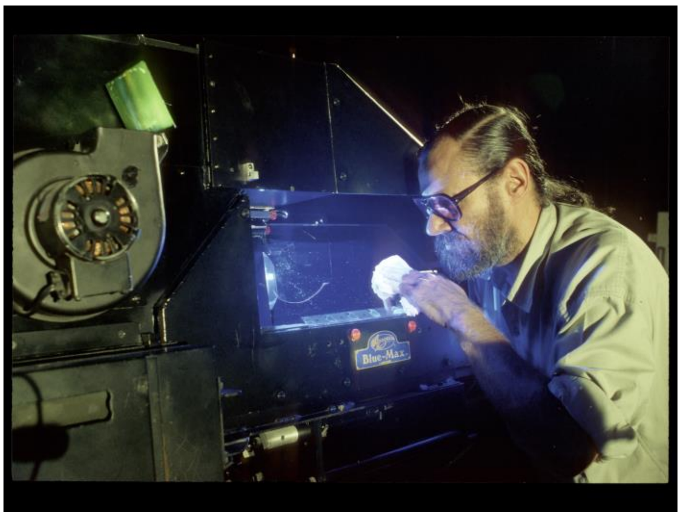
The gist of Reverse Bluescreen is that we can exploit motion control technique to acquire a separate matte record. We simply coat the subject with an invisible phosphor that only glows under blacklight. By making multiple passes sequentially under white light and black light, we can obtain our mattes much as with Sodium Vapour. But the big advantage here is the elimination of "spill" light on the subject.
But, of course we couldn't use this solution for live action.

So what do you do if you want to make a film like "2010" which features spaceships with people floating around in shiny and very reflective space suits??

For that, we had to develop the “Blue-Max,” a blue flux front projector to use in conjunction with a Scotchlite retro-reflective screen (for which 3M scientists won an Academy Award in 1968).

The earliest version of this technique was created by that grand master Bill Abbott, ASC. He was working on Tora, Tora, Tora shooting front projection scenes with a submarine. As often happened his plates, the filmed backgrounds he was to project, were inadequate, possibly badly timed. So he

thought, I'll shoot this blue screen and fix the plates in optical. But it was immediately obvious he'd have blue spill off the smooth wet surfaces of the sub. So the brilliant man thought, fine, I have a projector here, so I'll just project blue light and since it's coherent it won't produce spill. So he placed a 47B filter in the projector and it promptly burned to a crisp. Ever resourceful, Bill then had a small glass vessel made and found a blue dye to put in it and presto, blue light. That too, of course, got hot enough to boil the water, but at least not immediately



Blue-Max, of course, was somewhat more sophisticated than that. We use a short arc Mercury vapor light and add dichroic interference filters to isolate the 436 nm Mercury line, and we provided quite a deft way to "dim" a discharge light.

We however, also discovered we had to solve a problem with the front projection screen itself.

The Scotchlite material itself is created as a two foot wide roll. The machinery that produced, however, was liable to produce some subtle streaks in density. If one simply created a large screen by rolling out the material as one would for, say, making a roof, then the streaks could become apparent.

Over the years various attempts had been made to “break up” the streaks by cutting the material into squares or whatever, but these still tended to create discernable patterns. Tearing the material up produced a random pattern but wasn’t at all practical.

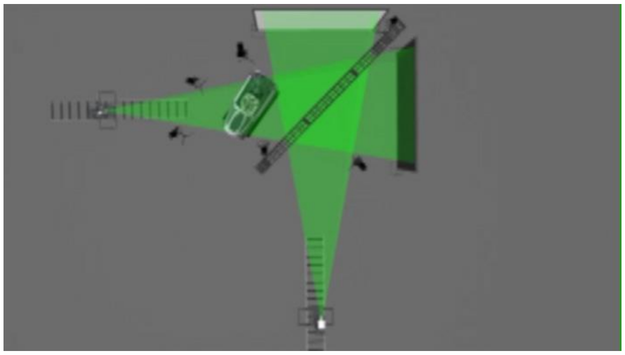
We finally settled on a pattern like this, which is a hexagon with a sine wave replacing the straight edges. These “tiles” produced a homogenous surface which worked very well.

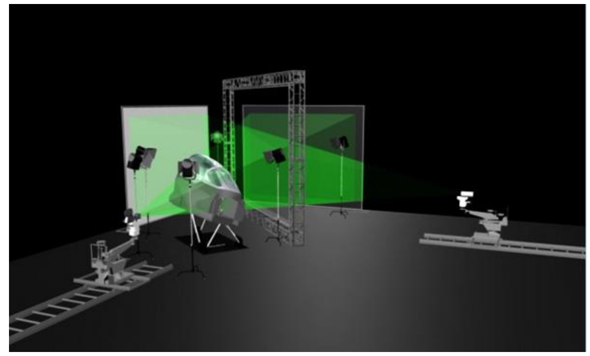
While the Blue-Max worked well for many shots

Such as this shot from the Gremlin, it, too, had problems.

Such as backscatter flare and direct kicks of the projected light.

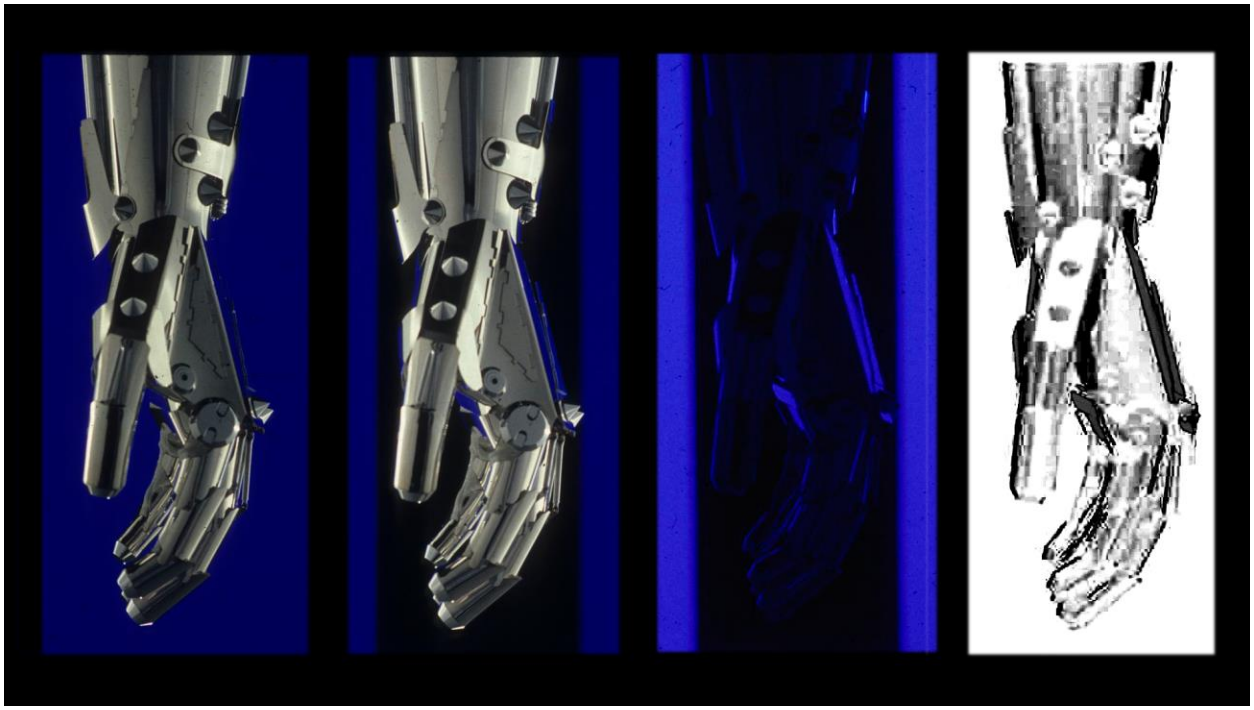
So, to solve that problem we had to develop Reverse Front Projection.





This process solved for almost all the issues we'd confronted. Like the Blue-Max, it used pure Mercury lines for the best separation a filmstock could provide.

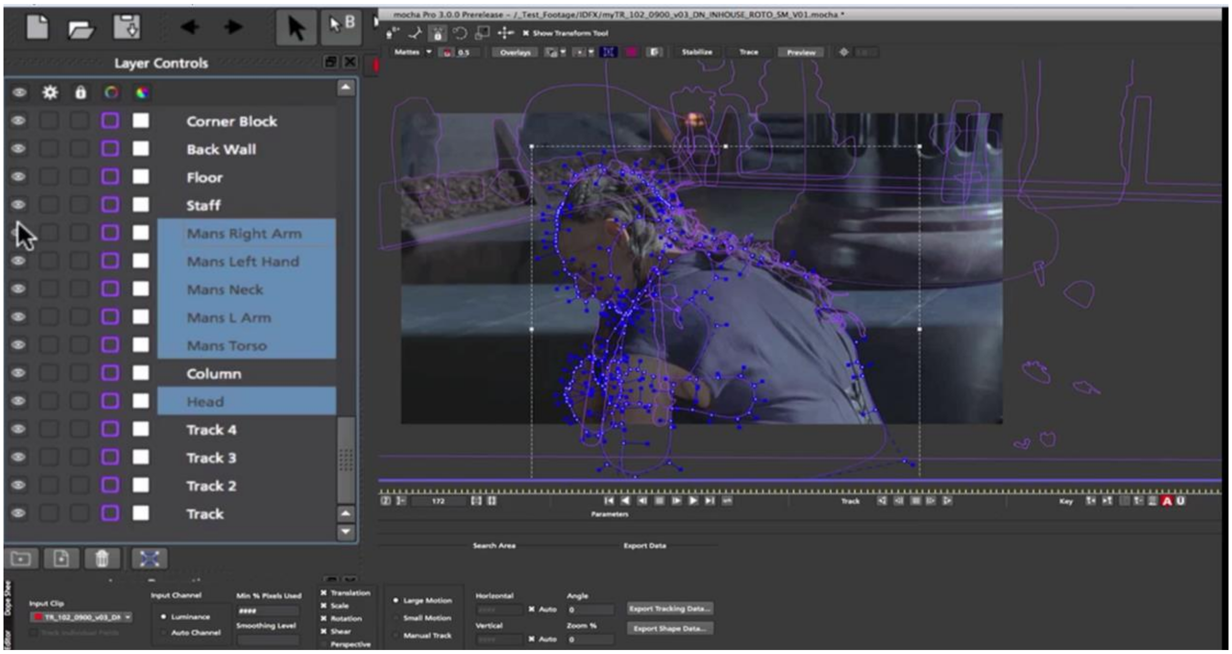
All the matting light was collimated so there was absolutely no scattered light to wrap fine details and, unlike the front projection of Blue-Max, no light is coming from the camera to kick back to the lens.



Now the only problem is that there are hardly any Front Projection screens left and it’s very difficult to get very large pellicles - the largest currently being some ten feet high by some thirty feet wide.

We’ve only skimmed the surface of all of these techniques, so, if you’d like more detail, almost everything I’ve discussed here today, has been covered in SMPTE Papers in our Journal, and much of it is also in the American Cinematographer handbook.

So, here we are, however, at the dawn of the twenty-first century, just one hundred years from the inception of traveling mattes, and we have at our disposal the ultimate process,



or, at least the dominant process preferred by the industry today. Yes, it's - "rotoscoping."

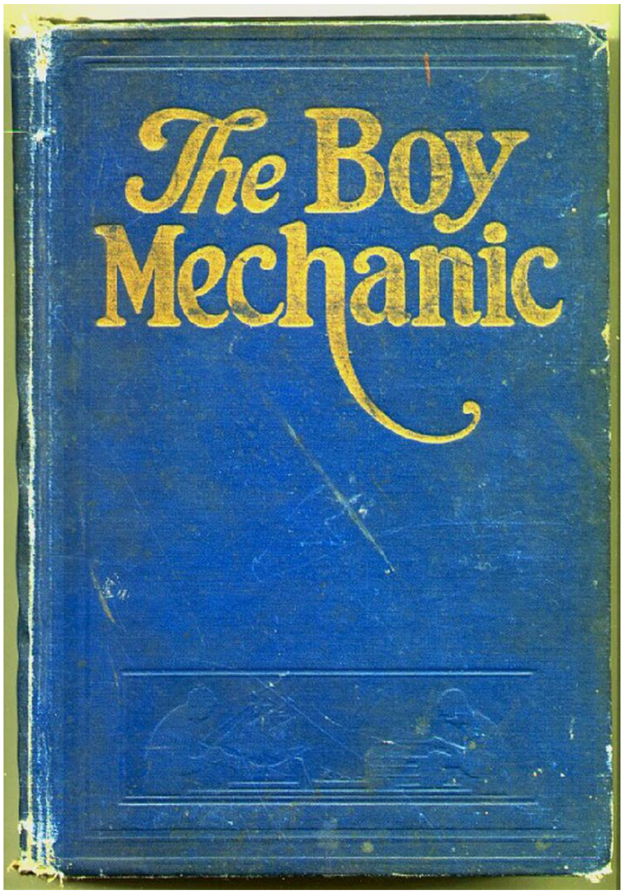
But now it's computer assisted "roto" and this is an example of one such program.

Of course, a great deal is not covered in the SMPTE Journals or other such publications. Let's look at a couple.

Few people fortunate enough to have seen, 2001 - A Space Odyssey will ever forget the effect of the slit scan sequence for the Stargate Corridor. Several notable careers were founded or at least greatly enhanced by the mesmerizing effect of the technique.

The technique has now become ubiquitous on television station logos and commercials.

All of this would, I am sure, be a source of great amusement to a certain Mr. T.B. Lambert who wrote an article in a book entitled, The Boy Mechanic, Volume II, 1000 Things For Boys To Do published by Popular Mechanics in 1915.



By the way, I really urge us all to take a look at this remarkable book from the perspective of what teenagers were doing with their spare time in 1915 versus 2012.

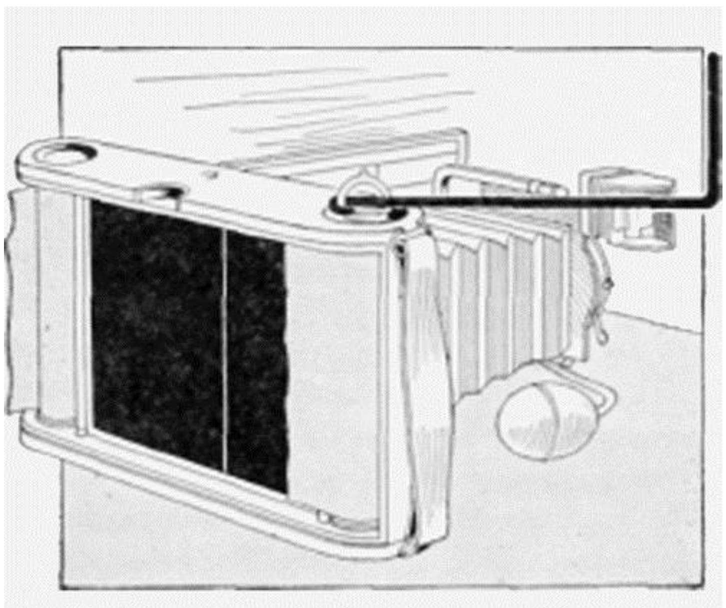
This book, for example, teaches how to build your own movie camera and projector and how to process the film. Or how to build your own telephone. But this next one particularly captured my imagination. How to build your own glider. And, having done so, here's what you do:

"Take the glider to the top of a hill, step into the center of the main frame just a little back of the center of the wings. Put your arms around the arm pieces, face the wind and run a few steps. You will be lifted off the ground and carried down the slope. The balancing is done by shifting the legs. The glides should be short at first, but by daily practice, and, as the operator gains skill, glides can be made up to a length of several hundred feet. Do not attempt to fly in a wind having a velocity of more than 15 miles an hour."

Today we'd teach the same kid how to find the app that'll build him a “virtual” glider, heaven forbid he should actually try to fly one.

But this is why Mr. Lambert is part of this talk.

In his wonderful volume Mr. Lambert describes how to construct a Mile-O-View Camera.



He discusses a "complete apparatus for taking continuous panoramic pictures of any length" from a moving railway train.

Mr. Lambert then goes on to describe how to take an ordinary roll film camera (ordinary in 1915 that is!) and equip it with a thin piece of cardboard in which has been cut a very thin slit. This cardboard is placed at the film plane of the camera and secured with tape or glue such that the slit is situated vertically at the centre of the frame. Then a piece of sturdy wire is bent into a handle and secured to the take-up knob of the camera. At this point you are ready to go into the slit-scan business! All you have to do is aim the camera at some moving object (such as the speeding landscape) and crank the handle so that the film is drawn past the slit at some appropriate rate of speed.

Admittedly, Mr. Lambert had in mind a normally rendered view of the passing scenery in a panoramic image of indeterminate length. But it is clear from the following admonitions that he was aware of the creative potential inherent in the process:

> The following point must be considered:...the camera must be perfectly steady and not twisted out of position by turning the crank, otherwise the resulting picture will be **wavy**. Turning the film too fast will make the picture **elongated**, and too slowly , **condensed**. Should the camera be pointed otherwise than at right angles the picture will be **distorted**.
>
> - T. B. Lambert, from The Boy Mechanic

At this point I should like to express, a debt of gratitude to Mr. Lambert, wherever he may be, for the insight he provided with his Mile-O-View Camera.

Let us now take a look at what can be achieved when we exploit the possibilities to which Mr. Lambert alluded.

In a 1984 production, entitled Mac and Me, Apogee was required to collect some specimens of Martian life and return them to Earth. The Martians were to be collected by an un-manned space probe equipped with a vacuum system designed to suck up samples of Martian rocks and the like.

Inadvertently the Martian creatures are ingested by the space probe and returned to Earth, forming the basis for the story, providing a visual effect that simultaneously provided a rationale for the return to Earth of the Martian creatures with an assurance that they were unharmed by the experience called for something unique.

The concept was developed that these creatures were capable of plastic, or rubbery qualities and thus could be swallowed up by a vacuum cleaner without undue harm. The next step was to develop a practical method of accomplishing that effect. Computer Generated Imagery (C.G.I.) was an immediate candidate. The example of the Stained Glass Man from ”Young Sherlock Holmes” was fresh in the minds of the entire visual effects community.

An analysis of the time and cost of this approach revealed that several months of programming would be required at a great expense. An alternative strategy was therefore required.

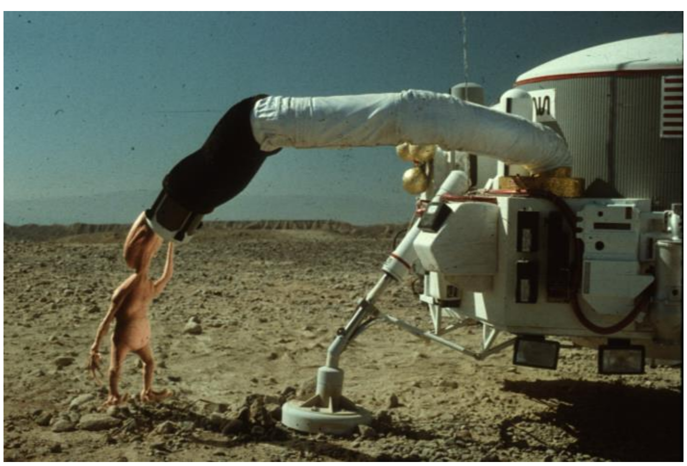
The solution that emerged was, as is so often the case, a combination of old and new technology. Mr Lamberts 1915 vintage, slit-scan distortions accomplished with the precision and predictability that can be provided by the type of modern motion control systems for which Apogee was renowned.

Plus, of course, the skills of Apogee FX DP Doug Smith, who went on to win an Oscar a few years later, for Independence Day,

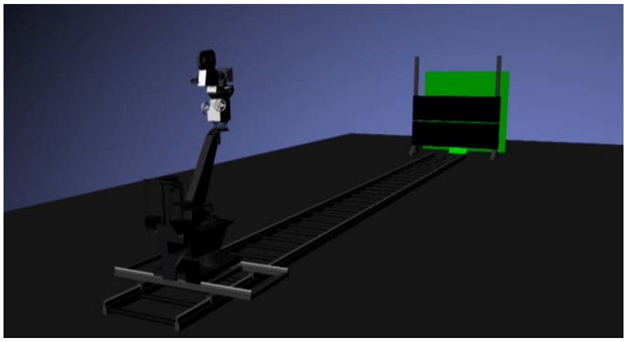
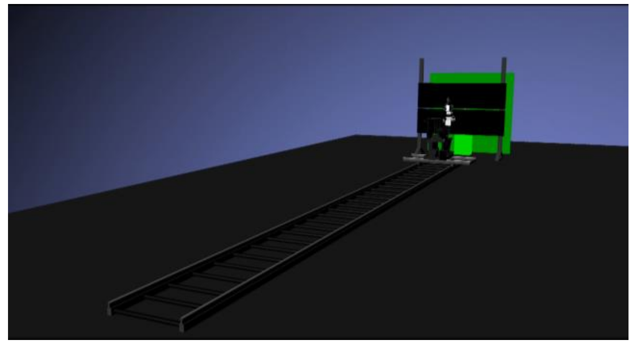
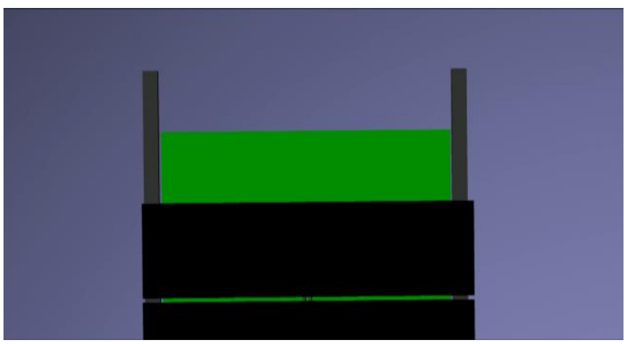
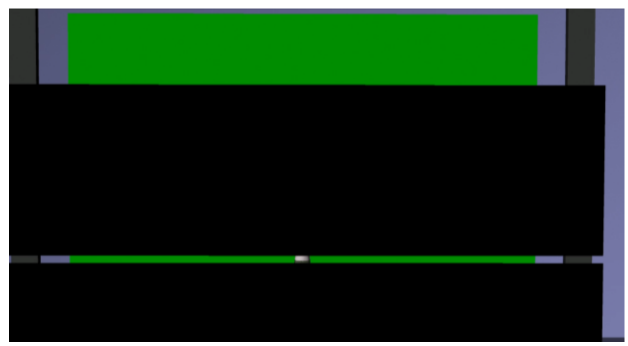
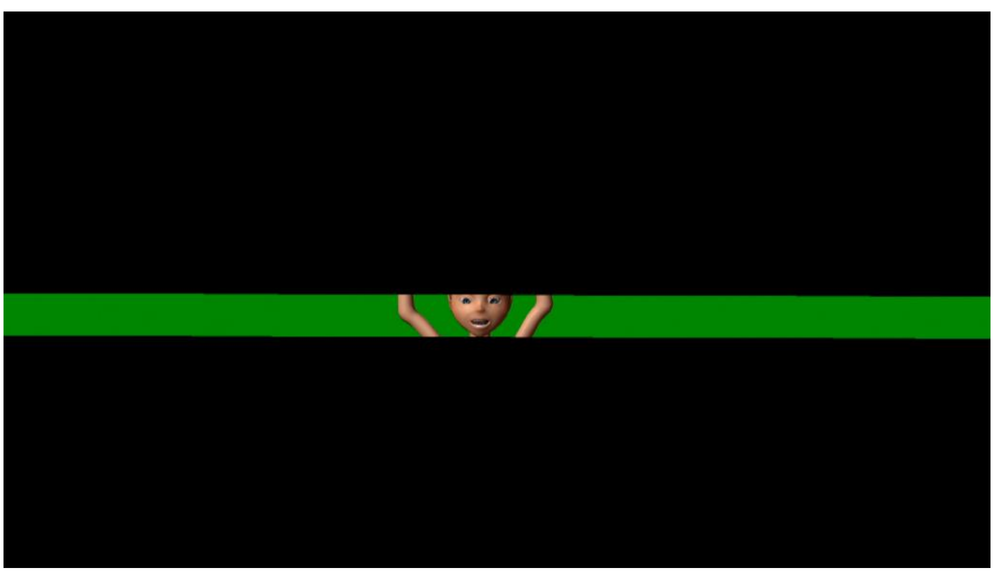
as well as our motion control wizard Alvah Miller who also has Academy Awards for motion control.

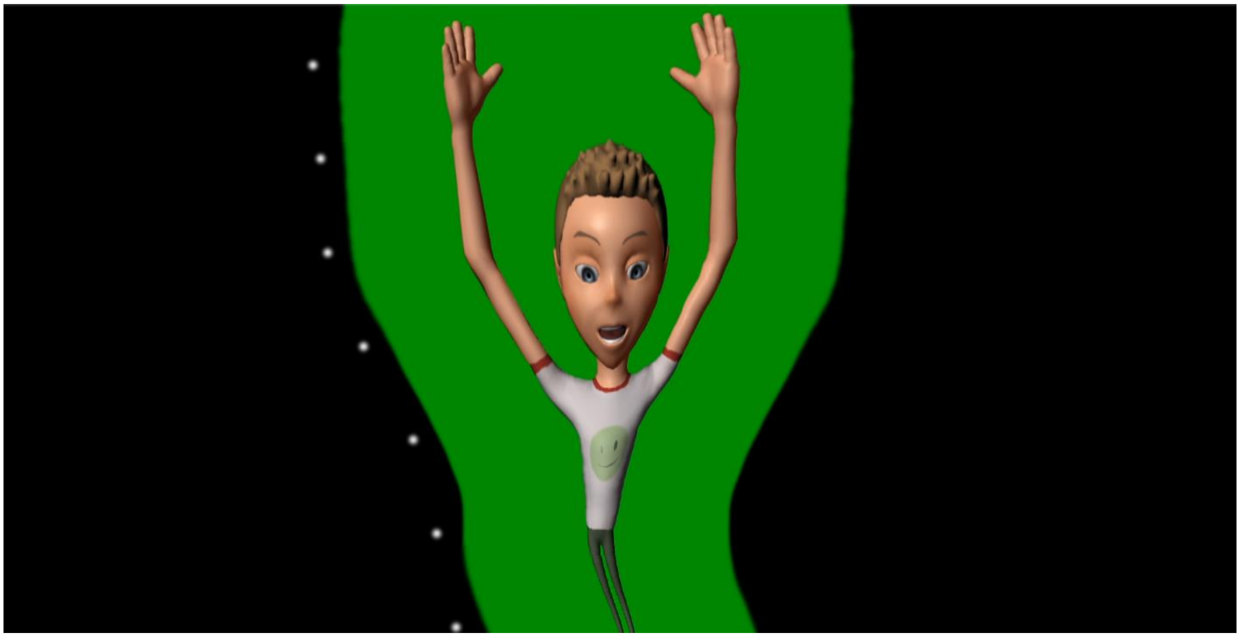
First let's look at some stills of the complete composite image.

Here in a sequence you can see the extent of the manipulation of the Martian creatures. They appear to be as elastic as taffy. As the vacuum pulls at them they twist and turn, stretch and elongate and eventually are snapped up by the vacuum device.

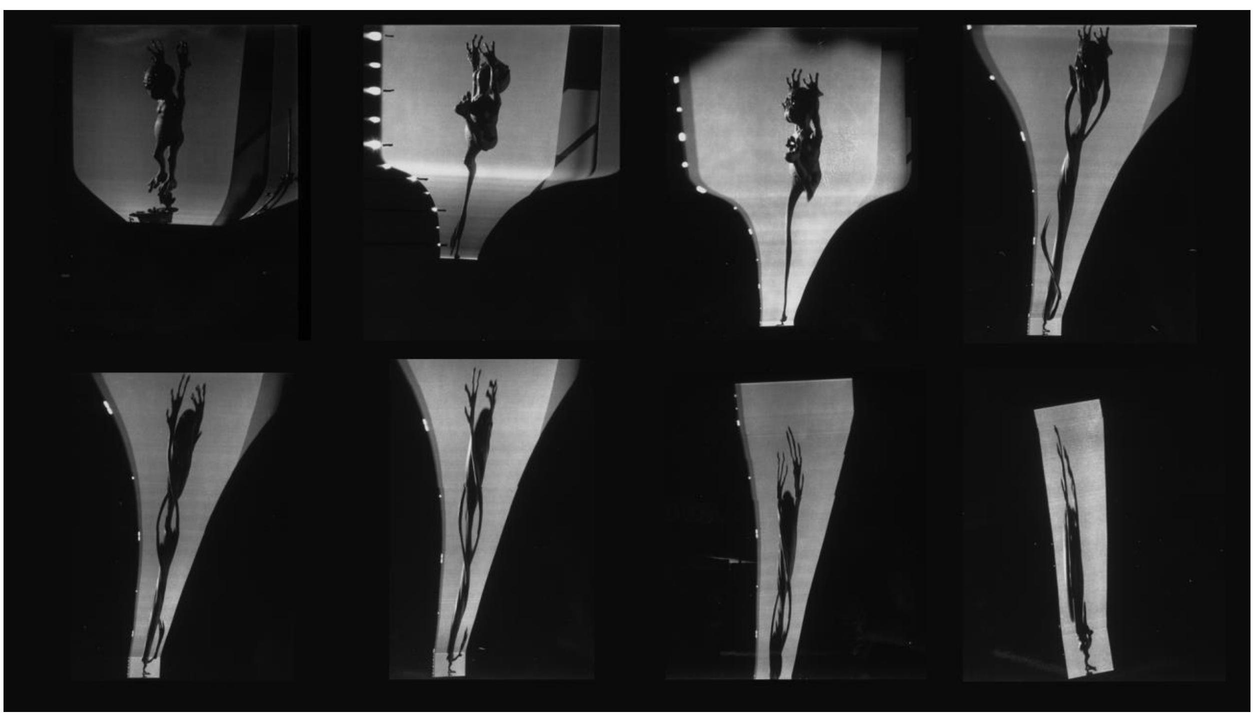


This happens a couple of times during the show. The first, obviously, on Mars when the creatures are first encountered and the second time on earth when one of them is scooped up in a conventional household vacuum cleaner.



We'll see the complete sequences later on during the running of the Apogee feature demo reel. But let's look now at some of the test polaroids that were produced during the programming phase of the shoot.



Here we can see the extent of the track moves involved as evidenced by the drastic change in the shape of the film frame. This also dramatizes the extent of the focus correction that had to be incorporated to which one has to add the very sophisticated exposure algorithm required to compensate for the different rates at which both the camera and the slit were moving in relation to the subject.

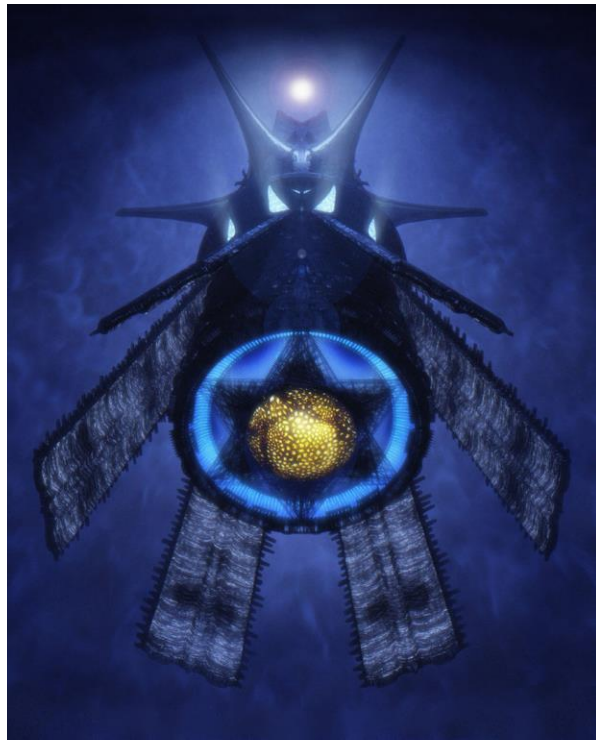
In addition to the computer controlled movements of the camera, the slit and the subject there were also stop motion animation functions performed by Kevin Dole, a noted animator and director. The stage crew was obliged to execute an entire shot as a continuous operation and that meant staying at their posts for seventeen hours non-stop.

To all the foregoing complications one has to add the additional complexities brought on by the fact that the scene was also a blue-screen composite. Even so, after about three weeks of preparation and programming and a similar period of shooting and compositing these scenes were ready for inclusion in the motion picture. A considerably shorter time than had been estimated for accomplishing the same thing in the C.G.I. domain.

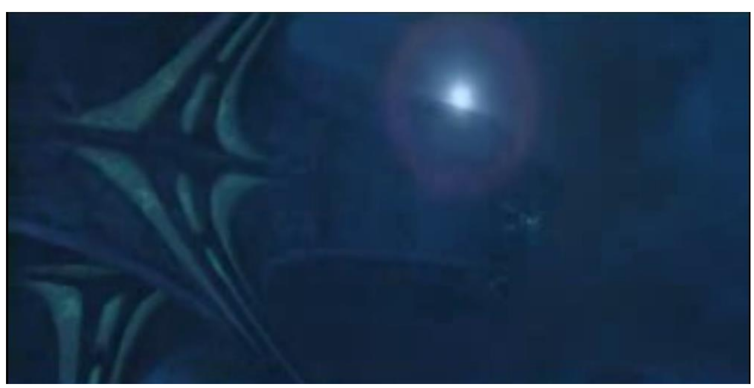
In preparing for this presentation I called Doug Smith, who now works with Rhythm n' Hues, and besides refreshing my memory about the execution of these shots, I asked him how things have changed, for such a shot, in the intervening quarter century. Doug said that, although with today's technology, we could do a better job; morphing applications in CGI exist and so forth, nonetheless he guessed that it would still take as long as it had a quarter century ago, and, even adjusting for inflation, the cost would still be as great or greater.

Here's another example of the kind of thinking that Mr Lambert might have written about but that today would be referred straight to CGI app.

When Apogee was engaged to work on Star Trek : The Motion Picture, the production was already in crisis with much of the production time already expended and firm release dates set in stone. One of our tasks was to construct and film the Voyager space craft or V'ger as it was known in the film.



Sid Mead had designed a sweeping aerodynamic shape some forty feet long which ordinarily would have entailed assembling huge blocks of foam plastic and sculpting the shape. We simply didn't have the time. Our solution was to sew together large sheets of spandex and stretch them over a simple frameworks of angle iron. By attaching old fashioned garter snaps at various strategic places we could pull the spandex into the shape required and achieve the smooth aerodynamic design Sid had envisioned. That done we saturated the spandex with epoxy resin which set up to produce a rigid but eggshell thin shape. This we backed up with spray urethane foam. We went on from there to cut sections away and add a vast amount of surface detail.



Let's take a look now at some more of that now archaic form of filmaking. This is the Apogee demo reel of, about 1990. As you watch it, contemplate that everything you see was pre-cgi, pre computer. Photo-chemical compositing and very deft cinematography produced all the images you'll see. As it says in the title of this presentation, "Better Films Through Trickery and Deceit."

But all that was in the past, on the other side of the "digital divide." In the last twenty years motion pictures have been transformed. But since we've just lived through those years you don't need me to tell you about CGI, or performance capture, high dynamic range and virtual production and "apps" that create fur, and water and fire on demand.

But, as I said much earlier, I use history to light my way to the future. And so now I'd like to spend a few minutes on one aspect of the future that intrigues me, and quite a few others also.

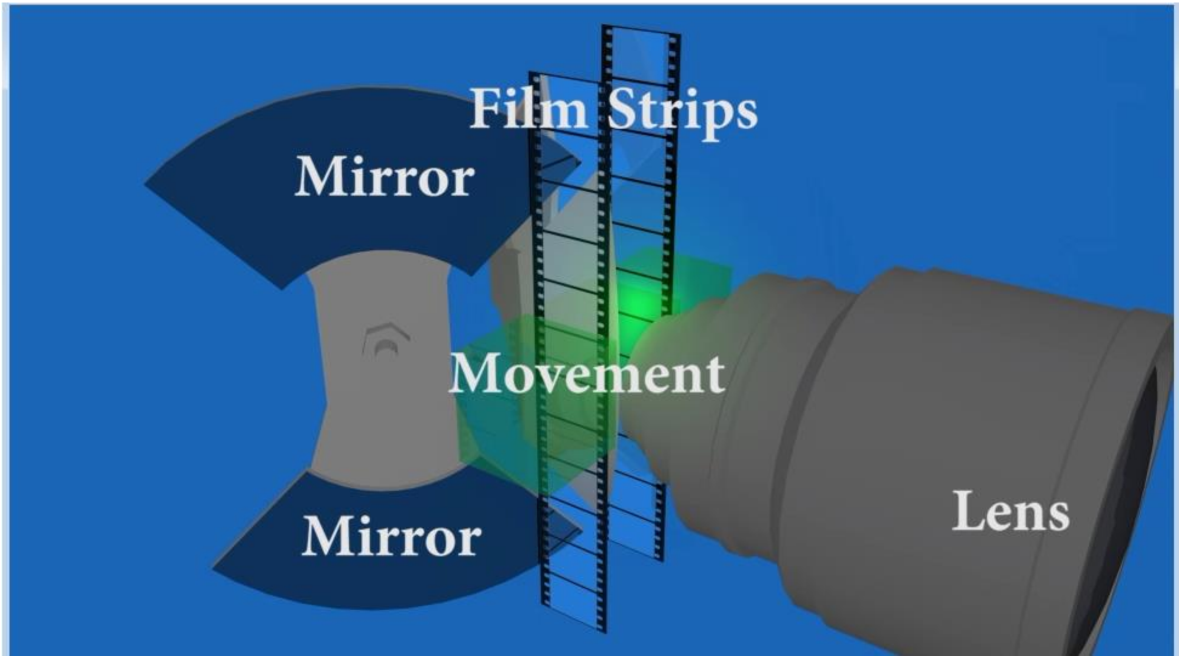
We've been hearing a lot just lately about HFR (high frame rate) production. "The Hobbit" will release in 48 fps. We hear that Jim Cameron is contemplating "Avatar 2" as a 60 fps production in 2015. The case is made that high frame rates substantially improve the effect of 3D stereo films, and generally produce a more real and '"immersive" experience for all films 3D or 2D. Douglas Trumbull's brilliant "Showscan" films were, or course, a tour de force demonstration of that premise and it's his stated goal to, "make you feel you're 'in the film and part of the film' rather than just watching it."   SMPTE has responded by codifying several new standards, such as 30, 48 50, and 60 hertz.

The direction I'm concerned with just now however, is a little different, as it lies along the other axis of the continuum, the sub-twenty four frame region, and the subtle shifts in time base, where our forebears of the silent era wove their own special magic. But brought up to date with the technology available today.

Constant motion imaging, rather than the intermittent imaging we've always lived with, has remained a film-maker's dream for many years, going all the way back to Max Skladanowsky in 1895 and the Bioscope which provided for two strips of film side by side exposed 180 deg out of phase producing continuous stereo imaging. The patent literature contains many examples often involving beam-splitters providing an image stream to two camera movements.

In 1989, I presented a SMPTE paper entitled “Research and Development: A Foundation on Which to Build a Tradition.” It was part of a twenty year effort that culminated in the restoration of the Academy Science and Technology Council.

One section read, “It would also be possible to do basic research into the motion picture phenomena itself, involving studies of the psycho-physiological effects of flicker fusion, motion sampling, screen brightness, sound, and other components of the motion picture theatrical experience.



To study this, we proposed building a constant motion picture camera, which would use two gates running two strips of film, synchronised but a hundred and eighty degrees out of phase, to photograph the entire event rather than the normal intermittently recorded half of the event. This notion, of course, has been around since the earliest days of motion pictures. Skladinowsky’s Bioscope used it for 3D continuous imaging.

This approach is the ultimate standards converter and eliminates pan strobing and wagon wheels that turn backward. A few years later, the design had evolved a bit to this:

Needless to say, there were never the resources to actually build such a camera. However, digital cameras have now made such abilities readily accessible. In the silent era of hand-cranked film, the cinematographer (along with the projectionist) enjoyed considerable control over the mind of the viewer at a subliminal level. Much of this was lost with the advent of sound, the motorization of the camera and the 24fps standard that was then imposed.

The introduction of sound on film was what made it essential to adopt the 24 hrtz standard. Prior to sound, the cinematographer was accustomed to employing all manner of psycho-physiological effects on his audience by manipulating both the acquisition and the display rate of his images. Because, in the earliest days of our art-form, cinematographers discovered that they could manipulate time itself. It's said that Méliès himself discovered this by accident when his camera jammed and the resultant film showed a tram change instantly into a pedestrian, or some such. We also learned then that humans had a psycho-physiological response to different frame rates and/or the changing time base (events happening faster or slower than reality). But one of the most important things we learned early on is that motion pictures do not reproduce "reality" but rather an "interpretation" of reality. And it's that interpretation of reality that is the very function of art.

So today's rapidly evolving technology, paradoxically, promises to restore some of the lost palette of the cinematographer from the silent era. The decoupling of flicker fusion and motion fusion, along with pitch control of sound, further free us from the omnipotent metronome. We can now, on a scene to scene basis, exploit frame rates from the teens to the hundreds, and even advance or retard the time base of the scene by as much as twenty-five percent.

By the way, I wonder how many of us are aware that this year's best picture Oscar, The Artist, besides being shot in black and white and silent, was shot at twenty-two frames per second, for projection at 24 – a time base shift of eight percent? It must be obvious to this community that our art form isn't necessarily about a literal depiction of reality; but is essentially an insightful and nuanced interpretation of reality, and we now have at our fingertips a plethora of new tools to expand that insight and interpretation.

Today, our technology has advanced to the point that we no longer are obliged to obey that standard, at least technically. We can resume altering acquisition frame rates, and display frame rates and even alter the time base (pitch control of sound can accommodate up to a 25% disparity) and achieve substantial, though subtle, psycho-physiological response in the viewer. The control over the various functions of frame rate, shutter dwell time, etc., can now be thought of as knobs on the device at the disposal of the camera operator who can "dial in" the interpretation of reality he wants. This can also be thought of in much the same way as filters, which also help the cinematographer "interpret" the nature of the reality he wants you to experience, and by and large also operate at a subliminal level.

So, a couple or three weeks ago, an intrepid little band gathered at Abel-Cine Pro's facility in Burbank where Andy Romanoff had arranged for us to borrow a Phantom camera. With us were Joe DiGennaro, Mark Weingartner, Carrie Keranen, Laura Napoli, Juliet Verni, Dan Sherlock, and Beth Sherlock. We had additional help from Jesse Rosen

We shot several scenes comprised of various types of motion. From fast and kinetic, such as stunt fighting and archery to more lyrical tai chi.

These were shot in a variety of frame rates and shutter angles including 240 fps at 360 deg shutter angle.   We're now in the process of rendering these images such that we can simulate essentially an infinite variety of frame rate and shutter angle permutations all derived from exactly the same shot.

And we can show you some of what we've done to date. But first let's start with the basics – of which the principle two are flicker fusion and motion fusion. Flicker fusion is the reason why the movies were also called "the flicks." Today, the standard frame rate, as everybody knows, is twenty-four frames per second. That twenty-four per second frame rate doesn't mean there are twenty-four "flicks" or flashes of light per second; in fact there are forty-eight, because we insert an extra blade in the shutter of the projector and interrupt the viewing of each frame so you see it twice.

Motion fusion, in turn, is governed by how much motion is occurring in the scene. Obviously if there is no motion in the scene we wouldn't need motion pictures in the first place. Very little motion requires relatively low frame-rates; highly kinetic scenes, faster frame-rates – at least for hyper-real "immersive" effects. Motion fusion is heavily impacted by intermittency, the interruption of the image by the pull down cycle. Conventional motion pictures generally entail the loss of half the event; whether it's shot at sixteen frames per second or sixty. It's simply more obvious at lower frame rates.

Let's take another look at Méliès "Trip To The Moon."

We'll see three versions on the screen together. One of them was transferred from the original sixteen frames, to twenty four. The speeding up is quite obvious viewed this way. But while the speeding up might be expected to increase image fusion, it cannot replace the missing "event" that occurred while the shutter was closed. With constant motion imaging, it is astounding how low the frame rate can be.

We find ourselves at the threshold of a new phase of motion picture technology. We need to take a moment to review the basics, and to revisit the science involved in human visual perception. Because, the very nature of the new image acquisition technology as well as the image display technology render irrelevant the frame rate and flicker fusion rates that have prevailed for the past century. We will now have the technical and artistic power to explore the psycho-physiological effect of a variable image acquisition rate as well as a variable image display rate - all within a single work. In simple terms: the higher the acquisition and display rate become, the more "realistic" the simulation of life becomes. But that doesn't necessarily correlate with greater "believability" or a desired psycho-physiological effect any more than a live theatrical performance does. In fact, the "suspension of disbelief function" of the human mind is vastly more complicated than that. With the rapid expansion of our technological capability, must come the responsibility to fully explore its artistic potential, rather than solely its commercial prospects.