Preserving Early Motion Picture History with the Kinetta Archival Scanner

The Paper Print Collection at the Library of Congress is a monumental repository of early cinema – the only collection of its kind in the world – and an anomaly: it came into being almost by accident.

In 1894, United States copyright law had provisions for still photography, but none that covered motion pictures. Myth has it that Thomas Edison (famed for going to extreme lengths to protect his intellectual property) thought that transforming motion pictures into "photographs" – by printing them onto photographic paper instead of film – would qualify them for copyright. Who says a "photograph" can't be 35mm wide and 50 feet long?

Scholars say it's simpler – one of Edison's chief engineers, W.K. Laurie Dickson, submitted "Fred Ott's Sneeze" printed on paper, since he'd been submitting photographs on paper since 1885. It was copyrighted as "Edison Kinetoscopic Record of a Sneeze" – the first motion picture granted this protection – on January 7, 1894. (And so began the chain of events that led to the Sonny Bono Copyright Extension Act.)

These were cutthroat times – and piracy was rampant. Siegmund Lubin, an early nemesis of Edison's, was especially brazen – he sold pirated dupes of Edison films as early as 1902 and shot a scene-by-scene copy of "The Great Train Robbery" in 1904. Copyrights and patents were a useful weapons: Edison sued Lubin six times in nine years.

In 1908 Edison and nine other companies (including Lubin) pooled their patents and formed the Motion Picture Trust Company, which employed more brutal methods: their hired goons were notorious for smashing

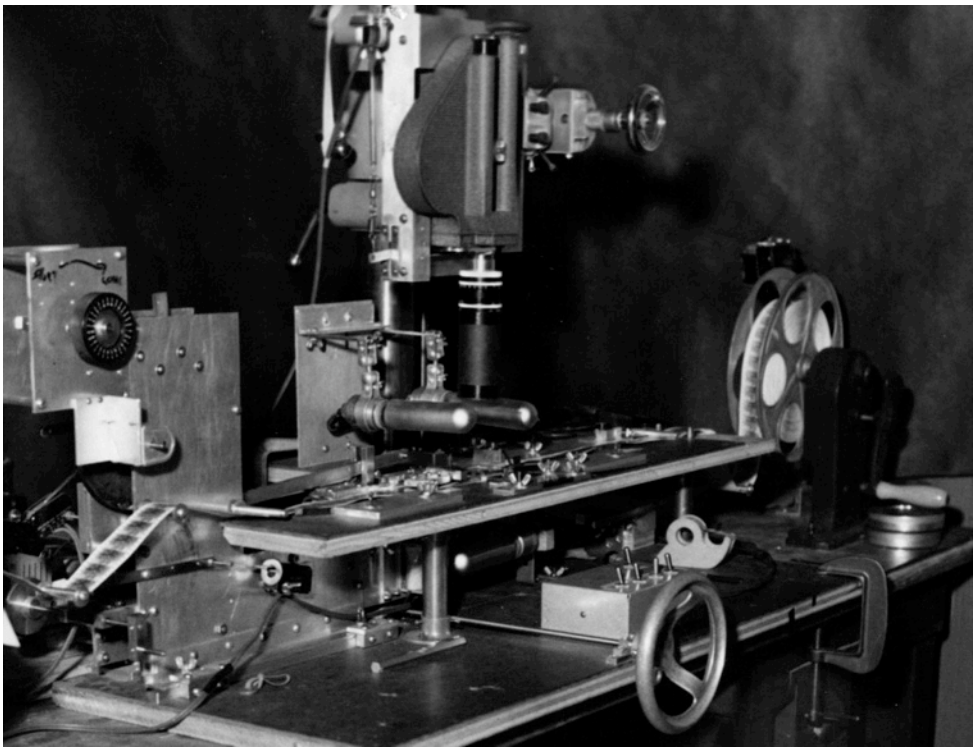
William S. Hart in The Bargain*, scanned from a paper print. Currently being restored by the Library of Congress Motion Picture Conservation Center.*

the cameras of non-members, who called themselves "independents." The Trust restricted film length to two-reels – they insisted audiences didn't have the attention span for longer fare. In an attempt to keep costs down, the identity of their actors was kept secret – fame could lead to greed. To escape harassment, many "independents" went West – and Hollywood was born.

Paper prints were – quite unintentionally – a preservationist's dream. Almost all 35mm motion pictures produced before 1950 were shot and printed on nitrate film – which deteriorates quickly when improperly stored. In many instances, the paper prints held by the Library of Congress are the sole surviving versions of films made between 1894 and 1915.

The quality of the paper prints did not matter to those who made them – they were made to fulfill a legal requirement, with no expectation that anyone would actually look at them. Some are quite beautiful; others are printed on cheap paper. The lab work is highly variable.

The paper prints were forgotten until the late 1930's, when Howard Walls of the U.S. Copyright Office



The original Niver Printer with 16mm camera

discovered the collection languishing under a staircase at the Library of Congress. He set about cataloging them, and in 1942 got permission to attempt to restore the films.

Georges Melies' Le Roi Du Maquillage

Since then, there have been many attempts to copy the collection back onto motion picture film, using traditional photographic methods. Kemp Niver did pioneering work in the 1940s and 1950s, for which he won an Academy Award. The Niver Printer was a clever mechanical device that employed some truly bizarre mechanisms – short pieces of hacksaw blades, as well as safety-pin tips, were used to grip the print and pull it along, often causing severe damage to the paper. The system was, as one archivist put it charitably, more "results-oriented" than "preservation-oriented." (Fortunately, the Copyright Office required the deposit of two prints per title, so at least one print remained intact, to be copied anew.)

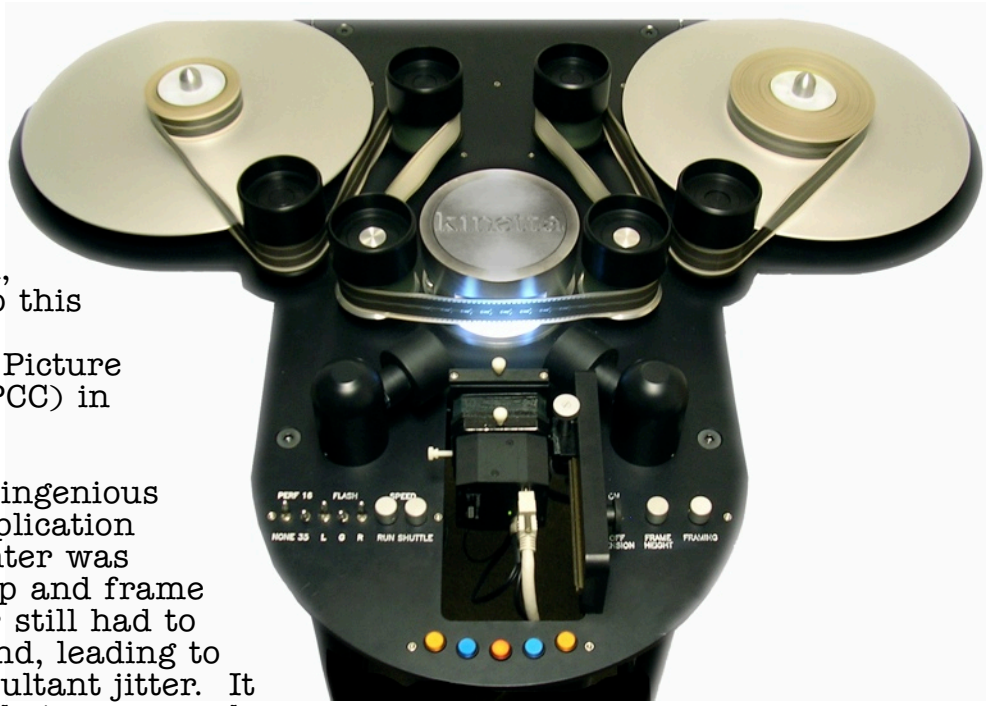
Turning paper into movies was a novel idea, and let the world rediscover films that had gone unseen for decades. But the transformation was not alchemy – it was a slow and tedious process, with decidedly mixed results. With only a camera viewfinder as a guide, it was difficult to re-register each frame accurately – leading to significant jitter in the image. The 16mm copies didn't capture all the detail in the paper prints, and the uneven print quality made reproducing the full dynamic range of the image difficult. In a perfect world, different shots could be processed to different gammas – not easily done in 16mm.

Bill Ault using the modified Niver Printer at UCLA

But it was a significant start, and led to a wider appreciation of early cinema.

In the 1980s, the Library of Congress contracted with the UCLA Film and Television Archive to re-master some of the collection onto 35mm film.

Bill Ault (who had worked with Kemp Niver) did the work, using a gentler, modified version of the original Niver Printer. When the contract ended, the Library decided to do this work in-house at their Motion Picture Conservation Center (MPCC) in Dayton, Ohio.



The prototype Kinetta Paper Print Scanner at the Library of Congress

The MPCC devised some ingenious tricks to improve the duplication process. Their TRIS printer was equipped with a video tap and frame buffer – but the operator still had to align every frame by hand, leading to operator fatigue, and resultant jitter. It took about twenty seconds to copy each frame. The rough net, per eight hours, was 1440 frames – about ninety seconds of a silent film.

In 2003, Ken Weissman and Frank Wylie of the LOC MPCC asked Kinetta to design a digital replacement for the TRIS printer. The manual process was too slow – at 100 feet per day, restoration of the collection would take decades. Kinetta was designing an archival film scanner, and it was clear that this could be modified to handle paper prints.

Rather than advance paper prints frame-by-frame and attempt to align it perfectly, we chose a far gentler method: continuous movement coupled with pulsed light. Two diffused pulsed-xenon lamps are triggered by proprietary optical sensors, freezing the image on the moving paper print for capture by a digital camera. This data is captured as a 12-bit LOG 2K monochrome DPX file – and stored on hard drives.

An important design parameter was the ability to scan extremely damaged material without requiring major repairs –

which can be extremely time-consuming. The threading path is short and simple – the paper print wraps around six 3" particle transfer rollers (PTRs) – which labs use to remove dirt and dust – and over the curved gate, which lets even warped prints lie flat with only minimal tension.

The motor control system, designed by Henry Morton, uses his patented dancer-arm control system, maintaining film tension perfectly. The position of the dancer arm is read by a Hall-effect sensor that tracks the position of a magnet mounted at the pivot-point of the arm.

But instead of providing back-tension to the feed platter, the system actually advances the film forward to the gate, so accurately that the dancer arms barely move. A pair of PTRs, on either side of the gate, serve as drive rollers, advancing the film without sprockets – which are taboo for old material.

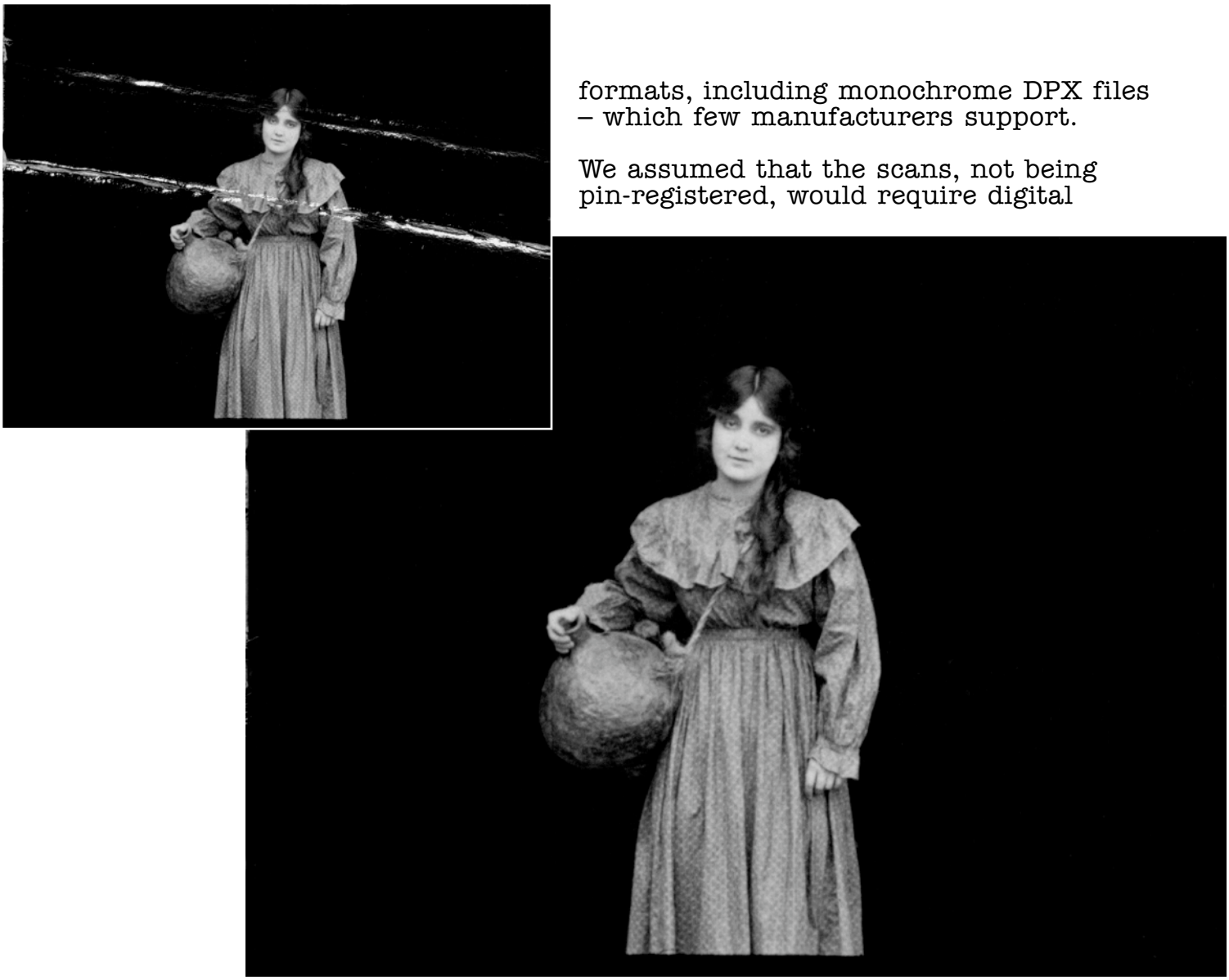
Prints are scanned at speeds up to 8 frames per second. Our new version will do 2K scans at about 16 fps, and 4K at about 5 fps. Capture speed is limited by the current generation of sensors, and will improve.

The Bargain*, scanned from a paper print – before and after restoration.*

Once the film is digitally captured, it's restored using MTI's CORRECT software for dirt, dust, and scratch removal, and Adobe After Effects for stabilization, image repositioning, and grading. It's clear that better grading software is needed – Assimilate's Scratch or Iridas' Speedgrade DI are likely choices – both are elegant and accommodate dozens of data

formats, including monochrome DPX files – which few manufacturers support.

We assumed that the scans, not being pin-registered, would require digital



The Bargain*, scanned from a paper print – before and after restoration.*

stabilization – but to the surprise of all, the optical perforation sensors are excellent – and only footage with registration problems in the original material has required digital stabilization.

Frank Wylie noted the advantages and disadvantages of good registration. "The steadiness of images from this scanner is quite amazing. Material copied using older technologies – the TRIS and Niver printers – looked perfectly acceptable on-screen for the most part, until one scanned the same material on the Kinetta. The new scans possessed a depth, a 3D-like quality, that was missing on the other captures. A rude facsimile of a motion picture suddenly becomes a motion picture again; you are not constantly pulled out of the action by the mental effort required to process unsteady images. The gradations of the image – once muddy and ill-defined – emerge, along with newly-revealed details: seams in wallpaper, the shine on shoes, threads in a policeman's uniform, the absurd crepe mustaches of the bit players, and a thousand others that are shocking in their clarity.

"Unfortunately, we independently verified a maxim known to all who do digital restoration: the more you repair or remove, the more you see to repair or remove! The registration is so good that we quickly became jaded about image steadiness; we now bemoan the fact that many of these negatives were not printed to paper until after their initial release print run. And let me tell you, they were NOT very careful with printing negatives back then! Nonetheless, we are quite happy to have the 'problem' of steady images, so we can concentrate on problems integral to the paper print copy process itself."

The Kinetta 4K Film Recorder

After the film is cleaned up digitally, it is recorded back to 35mm film using a Kinetta 4K Film Recorder. (A special monochrome version optimized for 1:1.33 aspect ratio material, recording to the full "silent" aperture, was built for the LOC.) Output speed, depending on film stock, is between 1 and 3 frames-per-second.

Although the prototype scanner was built specifically for paper prints, we modified it to scan both 16mm and 35mm film. The configuration is similar to an optical printer – so the image can be easily repositioned, cropped, and rotated – optically, not digitally – maximizing pixel usage.

The scanning gate is interchangeable, accommodating paper or film prints, and formats including 8mm, S8, 9.5, 16, S16, 17.5, 22, 28, and 35mm.

The film is illuminated with extremely diffuse light – eliminating most scratches that aren't printed into the material. We are upgrading the Library's scanner to include Kinetta's patent-pending OpenShadow™ technology, originally developed for our digital cinema camera. OpenShadow greatly expands the dynamic range of the sensor – useful with material that has gained too much contrast in duplication.

Since there are around three thousand paper prints in the collection, we didn't think the film gates would get much use. But while we were installing the system, someone donated seven reels of unique WW I footage of the Battle of Liege -- it was nitrate, and in very poor condition. The Library tested to see if it could be printed on their highly-modified "shrunken-head" optical and contact printers,

An unrestored frame from the severely damaged World War I footage of the Battle of Liege.

but the prints were so fragile that they crumbled when wrapped around the rollers.

The severe perforation damage hadn't been repaired, which would have been required for conventional printing. This can take weeks – a skilled restoration artist repairs the film with clear tape and an X-Acto knife, cutting each perforation out by hand – shrunken film can't be repaired with conventional splicers or perforation repair tape.

There was little hope that this film would make it through the scanner. But with nothing to lose, we threaded up a reel, hit the run button, and waited.

After an anxious moment, we realized that the film was running smoothly through the scanner, without a hitch. We started looking at (and capturing to hard disk) material that was thought to be lost forever. (The film has since deteriorated seriously – it's turning into goo – it was digitized just in time.)

The Library recently restored two Chaplin shorts – "Gentlemen of Nerve" and "Dough and Dynamite" – the best versions were paper prints – and

Chaplin's Gentlemen of Nerve – *scanned from a paper print*

they are currently working on William S. Hart's first feature, "The Bargain" (1914).

Chaplin's Gentlemen of Nerve – *scanned from a paper print*

Pat Loughney, curator of the motion picture department at George Eastman House, and director of the L. Jeffrey Selznick School of Film Preservation, saw the Library's restoration of Chaplin's "Gentlemen of Nerve" at Il Cinema Ritrovato in Bologna, mixed in with other Chaplin shorts printed from film material. "Nobody there could tell the 35mm prints they were seeing were copied from 'paper print' originals in the Library of Congress."

Chaplin's Gentlemen of Nerve – *scanned from a paper print*

I was often struck by the contrast between the early films we were trying to save (coils of paper in cardboard boxes) and the high-tech gear required to do this work. As a filmmaker – and long-time film purist -- I originally resisted what I saw as the encroachment of digital technology into filmmaking.

But then I see archives, with aisle after aisle of "mystery cans" – material that there's no money to preserve

photochemically – films that will be lost forever... unless it becomes affordable for archives to non-judgmentally scan all their holdings, not just the "A" titles. It can cost $40,000 and up to preserve a B&W feature (not including restoration work).

We're working to reduce the cost of scanning – to less than $20 for a reel (1000 35mm feet) of film at 2K – including storing the data on 2 LTO-3 tapes. (Most of the cost is the tapes.) Restoration software is included with the scanner. That $40,000 could pay for scanning nearly 1400 films (and making access DVDs or tapes).

Come see us at AMIA 2008 -- we'll be showing our new desktop scanner and our Viva Restoration Software privately. Email to schedule an appointment.

Last year's model -- come see what's new at AMIA 2008.

Email: jeff@kinetta.com