A few notes on affordable
Non-Judgmental Preservation
with the Kinetta Archival Scanner

The Kinetta Archival Scanner, developed in cooperation with the Library of Congress, was originally intended for scanning the Library's paper print collection. Early tests with severely damaged film led us to develop a new scanner designed specifically for scanning extremely shrunken and/or damaged film.

The scanner is very gentle — there are no sprockets or small rollers in the film path. The smallest radius the film wraps around is a 3-inch PTR roller — there are six of them — and a curved gate. Perforations are sensed optically using proprietary technology, though film that lacks perforations can also be scanned. Torn perforations do not need to be repaired before scanning — as long as the splices hold (and we've run some really bad splices without a problem) it can be scanned. This saves a significant amount of preparation time.

Film tension is adjustable, to accommodate fragile or badly warped film. The transport uses new servo motor technology with a tremendous speed range — from one revolution per hour without cogging to 5500 rpm (which we never approach).

Gates are available for any film format from 8mm to 35mm: 8, Super-8, 9.5mm, 16mm, Super-16, 17.5mm Movette, 22mm Edison Home Kinetoscope, 28mm Pathe KOK, and 35mm 2, 3, and 4 perf formats. Larger formats available on special order. The gates are designed to handle shrinkage of about 5% — we have yet to find film we can't scan.

The Kinetta Archival Scanner captures a full frame at a time, which avoids the geometrical image distortion one gets scanning damaged film on line-array machines. It's sensor-agnostic — as new sensor technologies become available, they can be fitted to the scanner in minutes at minimal expense. New sensors are released every month, with continual improvements in speed and resolution, which bring the cost of scanning ever lower.

The light source employs state-of-the-art photonic devices in an integration sphere — very short pulses of very bright light (as low as 10 microseconds) — up to 180 amps of red, green, and blue light, controllable individually — running cool to the touch, with a very long life. The extremely diffuse light source greatly reduces the visibility of base scratches and dust.

The philosophy behind Kinetta scanners is simple — we want to make possible what we call "non-judgmental preservation." When scanning becomes affordable — really affordable, cheaper than re-canning — it will become standard practice for archives to scan and restore every film on

their shelves, not just those that are well-known or have a patron. The hope is that those mystery-cans will yield unknown treasures.

But how affordable is affordable? Traditional scanning (not always possible with damaged film) is expensive. A respected conservation lab charges €350 per minute of 35mm scanning, —about US $4400 per reel. High-end telecine scanning to HD or 2K is less expensive, but can cost hundreds of dollars per reel (depending on how much grading is done during scanning).

No archive is going to spend hundreds of dollars scanning a reel of mystery film. They might spend a few dollars to re-can it, if the funds are available. Of course, they rarely are.

But what if it were as inexpensive to scan and restore film as it is to re-can it?

That is our goal, and we think we have come pretty close to it already. To further the cause, we're introducing a new portable desktop scanner — which uses the same technology as the big scanner. It's limited in film reel size (about 1400 feet on 12" platters) and optical path (it can't use the lenses required for higher-end 4K sensors). The price is less than half of the big scanner — about $150,000 US.

But the real way to think about the cost is to calculate what it costs to scan and store a reel of film.

Take the cost of the scanner, and amortize it over five years (it will last longer, but that's an easy number to work with) and derive an hourly cost of scanning based on a 48-week year and 35-hour week, the cost of the scanner per hour ranges from $20 to $50. Add the cost of an operator — calculated here at $25 per hour. Electricity (minimal) and overhead are not included, but the cost of additional computers and storage is factored in.

What can you scan in an hour? It all is a question of scanning speed, which is tied to resolution. We can currently scan at 2400 x 1800 x 12 bits at about 15 frames per second, and 1600 x 1200 at 30 fps (good for older

Cost Per Reel — Uncompressed

Resolution	FPS	Reels/ Hour	Scan Cost	Tape (two copies)	Operator	Total
2400 x 1800	15	3.2	$6.51	$18.60	$7.81	$32.92
4K (slow)*	5	1	$47.62	$40.88	$25.00	$113.50
4K (fast, 2009)*	24	5	$9.52	$45.30	$5.00	$59.82
2K (fast, 2009)*	48	10	$4.76	$16.65	$2.50	$23.91

* Requires Large Scanner, reflected in scan cost. Costs shown include additional computers and storage.

16mm material). 4K scans are slow — about 5 fps, but we will have 4K x 3K B&W scanning at 24 fps by the end of the year. (There are significantly faster capture systems that can be added to the scanner, permitting 4K scanning at 48 fps or greater, but at about double the cost — more on this next year.)

Okay: one desktop scanner, one operator, scanning at 2.4K, can scan about 3.2 reels of film per hour. The scanner cost per reel is then $6.51, and the operator cost is $7.81 — $14.32 per reel.

You have to store that data. With LTO-3 or 4 tape — about $.10 per gigabyte — the cost of uncompressed storage is $9.30, or $18.60 to store data on two separate tapes. If you use the Cineform Archival wavelet codec (which offers many advantages over JPEG-2000) the cost of storage is reduced to $3.73 for two copies.

Which means that the cost-per-reel of scanning and storing a reel of film at 2.4K resolution (nearly 3x the resolution of 1:1.37 material transferred to pillarboxed 1080P HD) is $33 uncompressed, or $18 with Cineform.

Cost Per Reel — Cineform Archival Codec

Resolution	FPS	Reels/ Hour	Scan Cost	Tape (two copies)	Operator	Total
2400 x 1800	15	3.2	$6.51	$10.24	$7.81	$24.56
4K (slow)*	5	1	$47.62	$8.18	$25.00	$80.80
4K (fast, 2009)*	24	5	$9.52	$9.06	$5.00	$23.58
2K (fast, 2009)*	48	10	$4.76	$10.24	$2.50	$17.50

* Requires Large Scanner, reflected in scan cost. Costs shown include additional computers and storage.

Costs get better with the larger scanner and faster scanning. For 4K x 3K scanning at 24 fps, the cost per reel with operator and tape is under $60 per reel with uncompressed storage, and $23.58 with Cineform.

This gets you to a raw scan. Only the most basic grading is done during capture, to make sure no information on the film is lost. We apply a user-configured look-up table (LUT) to the image when captured for viewing, but while it is appended to the file it is non-destructive, and can be replaced when the film is graded for final use.

But the LUT is fine for access copies — and access copies of any format or resolution can be derived automatically from the raw scans. Say you want to get a web-resolution version with a watermark and logo, a DVD access copy with footage and frame count burned in (along with selected

metadata), and perhaps a BluRay version — these can be generated as a batch process with little operator involvement.

That only covers preservation. Digital restoration is usually very time-consuming — most dustbusting is still done manually, a frame at a time. Often a user will have to use many different programs — one for stabilization, another for dustbusting, a third for flicker reduction.

We have teamed up with Inna Kozlov and Alex Petukhov of Algosoft, the talented algorithmists behind RestoreIt, to develop Kinetta Viva restoration software. It's batch-processing, requiring minimal operator involvement for repairs of dirt, dust, scratches, jitter, flicker, fogging, etc. It's included with each Kinetta scanner — just add as many PCs as you'd like for processing (the software is keyed to your scanner's output). This means that digital restoration adds little to the cost — just the time needed to run through any restored material and check it, and either undo or add any fixes you'd like. (As long as you save the UNDO file with the restored material, any repair can be undone or modified in the future, meaning you can do an automated restoration pass now, and tweak it if required for more critical applications.)

Grading can be done using commonly used software. At the low end, Apple's Final Cut Studio with Color is a good choice. Adobe After Effects CS4 is useful for matching material from different sources — a common task for many restoration projects. A higher end grading system, like Iridas Speedgrade XR (designed specifically for the Cineform Codec) is a good choice for a speedy workflow. Iridas' MetaRender is useful for batch generation of all those "deliverables" everyone needs -- preview DVDs for access, screening copies with watermarks and timecode burnt in to prevent unauthorized use, web versions, iPod versions, Digital Cinema masters, HD and SD video versions, whatever you need.

The workflow is reasonably simple but potentially deep. This means operators with film handling experience but lacking computer skills can scan film — computer skills are required mostly for grading and tweaking.

There will be more information available shortly, including an updated version of The Kinetta Manifesto. Make an appointment to see us at AMIA 2008.

"I was full of silly prejudices [and] missed out
on incredible things. People who think they
have taste, me included, are idiots.
One must save everything.
Never assume you know
what's of value."

—Henri Langlois