Developing a long-term and large scale project to digitize photographic negatives

Jeremy Moore, Megan North, Todd Peters

Albert B. Alkek Library

TEXAS STATE UNIVERSITY®

The rising STAR of Texas

TSLAC TexTreasures FY2017

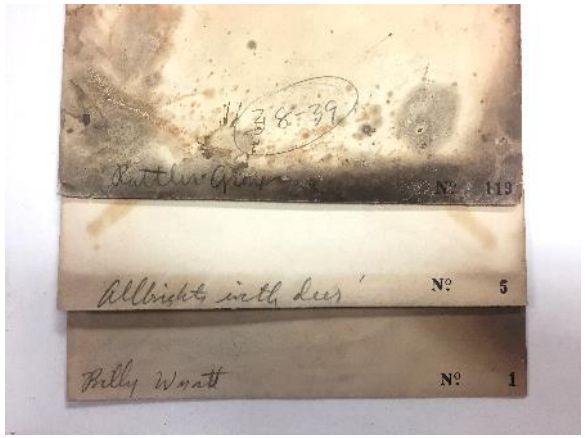
- Received 2017 TSLAC TexTreasures Grant, funded by the U.S. Institute of Museum and Library Services, to research and build 2 custom film capture stations and digitize 6,000 at-risk photographic negatives in the University Archives
- Negatives are from the San Marcos Daily Record negative collection, which spans approximately 70 years, from the mid-1930s to the 2000s
- Donated to the University Archives in January 2016

Photographs taken at San Marcos Daily Record offices, January 2016

TEXAS STATE UNIVERSITY
The rising STAR of Texas

Negative Collections in University Archives

- Approximately 1.8 million negatives in the archives
- ~800,000 from **San Marcos Daily Record** (SMDR)
  - Envelopes are labeled, but not always with useful or legible information
- ~1 million negatives from **University Marketing**
  - Limited descriptive information, some boxes marked “old” or “unidentified b&w negatives”
- Ultimate goal: digitize it all and make the vast majority of images openly accessible online
- Due to the massive size of the entire collection, this long-term project will have to be completed in stages over several years



TEXAS STATE UNIVERSITY
The rising STAR of Texas

Project Team

- **Kris Toma** – University Archivist & Records Manager
- **Megan North** – Assistant Archivist
- **Todd Peters** – Head Digital & Web Services
- **Jason Long** – Programmer Analyst
- **Jeremy Moore** – Digital Media Specialist
- **Erin Mazzei** – Digital Media Assistant

Student Imaging Technicians (Major)

Grayson Ellsworth (Photo)
Oscar Martinez (CIS)
Vicente Rangel (Photo)
*Luke Sebree (History)
*Ashton Woodward (English)

Graduate Research Assistants

Lindsey Waldenberg
Wenlan Cai

*Spring 2017 graduate

TEXAS STATE UNIVERSITY
The rising STAR of Texas

Creation metadata standards

UA-San Marcos Daily Record Stage I — SMDR Negatives Metadata Ten

	A	B	C
1	Element	Description of element	Input
2	dc.title	SMDR Photographic Negatives Collection, [writing on envelope]	SMDR Photographic Negatives Collection, [Addison and V #1]
3	dc.date	date digitized	2/1/2016
4	dc.format	b&w negatives, color negatives, nitrate, safety film	b&w negatives, nitrate
5	dc.description	brief description of what the images are of	Photograph of five people posing for the camera in front of a wooden fence, a large tree fills the background. From the left is a man standing in coveralls, a woman standing in a patterned dress with a hat, and a girl in a dress sitting on the fence next to another woman in a dress who is holding a young boy in overalls. The man and the woman on the right are pictured together in image 007_AddisonAndV_002 and identified as Addison and V, but the order of names is unknown. The woman next to the man and the children are unidentified.
6	dc.publisher.CorporateName	San Marcos Daily Record (San Marcos, Tex.)	San Marcos Daily Record (San Marcos, Tex.)
7	dc.creator	photographer if known	
8	dc.subject	keywords	children, people, portraits
9	dc.subject.LCSH	LOC subject headings	
10	dc.coverage.temporal	date or date range of original image, circa	c. 1930
11	dc.coverage.spatial	location e.g. United States - Texas - Hays County - San Marcos	United States - Texas - Hays County - San Marcos
12	dc.identifier	filename	007_AddisonAndV_001
13	dc.identifier	100.SMDR	100.SMDR
14	dc.rights.accessRights	any restrictions	
15			
16	Related?		007_AddisonAndV_002
17			

TEXAS STATE UNIVERSITY
The rising STAR of Texas

Student-Captured Keywords During Rehousing

- Billy Wyatt (SMDR_1930s-1) contains 21 negatives
  - Keywords: football, parades, The Square, banks, cars, drug stores, Memorial Hospital
- Albrights with deer (SMDR_1930s-5) contains 6 negatives
  - Keywords: deer, cars, Sunshine Laundry, guns
- Rattler groups 38-39 (SMDR_1930s-119) contains 61 negatives
  - Keywords: sports, groups, Rattler, basketball, football, tennis, majorettes, people, marching bands, San Marcos High School

TEXAS STATE UNIVERSITY
The rising STAR of Texas

Creation of database

TEXAS STATE UNIVERSITY
The rising STAR of Texas

SMDR Import Subjects Flickr Search tp09 logout

History

1930/SMDR_1930s-2/SMDR_1930s-2_001.jpg

TITLE

SMDR Photographic Negatives Collection, [Airshow]

DATE DIGITIZED

2017-04-20

FILM FORMAT

b&w negatives x nitrate x

DESCRIPTION

SUBJECTS

airplanes x crowds x people x airshows x

LOC SUBJECT HEADINGS

airplanes

- Airplanes
- Airplanes in art
- Airplanes in literature
- Airplanes in motion pictures
- Airplanes on postage stamps
- Airplanes, Company
- Airplanes, Company--Accidents
- Airplanes, Company--Accidents--Statistics
- Airplanes, Company--Accidents--Statistics--Periodicals
- Airplanes, Home-built

EMPORAL COV

1930

SPATIAL COVERAGE

United States - Texas - Hays County - San Marcos

IDENTIFIER2

100.SMDR

ACCESS RIGHTS

no rights

SMDR Import Subjects Flickr

History

TITLE

SMDR Photographic Negatives Collection, [Airshow]

DATE DIGITIZED

2017-04-20

FILM FORMAT

b&w negatives x nitrate x

DESCRIPTION

SUBJECTS

airplanes x crowds x people x airshows x

LOC SUBJECT HEADINGS

airplanes

LOC NAMES

PUBLISHER

San Marcos Daily Record (San Marcos, Tex.)

TEMPORAL COV

1930

SPATIAL COVERAGE

United States - Texas - Hays County - San Marcos

IDENTIFIER

SMDR_1930s-2_001.jpg

IDENTIFIER2

100.SMDR

ACCESS RIGHTS

no rights

id	file	mdate	dc.title	dc.date	dc.format	dc.description	dc.publisher.CorporateName	dc.subject
166	1931/en...	2016-09-15 10:36:13	MvSMDR Phot...	2008-09-24	b&w negatives...		San Marcos Daily Record (S...	
167	1931/en...	2016-09-15 10:36:13	MvSMDR Phot...	2008-09-22	b&w negatives...		San Marcos Daily Record (S...	apples,appl...
168	1930/Ad...	2016-09-15 10:36:13	SMDR Photogr...	2016-09-09	b&w negatives...	Photograph o...	San Marcos Daily Record (S...	nature,peo...
169	1930/Ad...	2016-09-15 10:36:13	SMDR Photogr...	2016-09-09	b&w negatives...	Photograph o...	San Marcos Daily Record (S...	children,pe...
170	1931/en...	2016-09-15 10:51:01	MvSMDR Phot...	2016-04-14	b&w negatives...	test	San Marcos Daily Record (S...	
171	1931/en...	2016-09-15 10:51:01	MvSMDR Phot...	2016-04-14	b&w negatives...		San Marcos Daily Record (S...	
172	1931/en...	2016-09-15 10:51:01	MvSMDR Phot...	2016-04-14	b&w negatives		San Marcos Daily Record (S...	

dc.subject.LCSH	dc.coverage.temporal	dc.coverage.spatial	dc.identifier	dc.identifier2	dc.rights.accessRights	dc.names.LCNAF	status	flickr	flickrAlbum
	1931	United States - Te...	SWN postcar...			NULL	NULL	NULL	NULL
Apple II Plus (Com...	1931	United States - Te...	B260 f18 cd ...		test	Apple & Ampersand Press	NULL	NULL	NULL
	1930	United States - Te...	007 Addison...	100.SMDR		NULL	NULL	29978085862	72157673487473391
	1930	United States - Te...	007 Addison...	100.SMDR	no rights		NULL	30057907346	72157673487473391
	1931	United States - Te...	Reavis postc...			NULL	NULL	NULL	NULL
	1931	United States - Te...	Reavis postc...			NULL	NULL	NULL	NULL
	1931	United States - Te...	Reavis postc...			NULL	NULL	NULL	NULL
	1931	United States - Te...	Reavis postc...			NULL	NULL	NULL	NULL

Working At Scale

- Let's assume 1 million negatives
- 50,000/year for 20 years?
- 10% is 2 YEARS; 1% is 10,000 negatives
- 10 seconds * 1 million = 2,778 hours

TEXAS STATE UNIVERSITY
The rising STAR of Texas

So . . . we bought stuff

- Initial equipment list submitted with grant application based on Digital Media Specialist's experience and research
- Copy stand items purchased immediately, but research continued through October 2016 on workstation and camera equipment
- 2 major changes to equipment list: Computer and Camera
  - Desktop computers: from Dell Workstations to Alienware "gaming" towers
    - based on advice from colleagues
    - Capture One Pro's recommended specs
  - Camera system changed from Canon to Sony
    - cellphone-like LiveView
    - ease-of-use on copy stand
    - expected shutter life of 500,000 cycles (Canon 5Ds = 150,000 cycles)

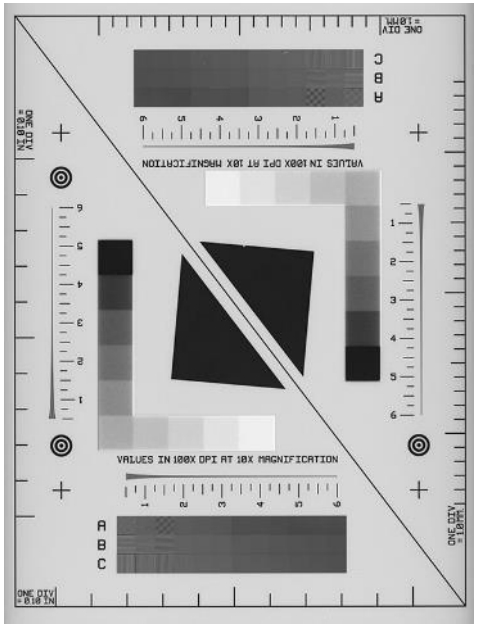
TEXAS STATE UNIVERSITY
The rising STAR of Texas

Capture Workstations

- Dell Alienware Aurora tower
  - Windows 10 Pro
  - 4+ GHz Intel i7 quad-processor
  - 32 GB of RAM
  - NVIDIA GeForce 1080 8GB GPU
  - SSD Hard drive with SATA data drive for daily local backup
- NEC PA-272 27” monitor with hood
  - Wide gamut and color-accurate monitors
  - Calibrated with Spectraview II software
- Dell 24" Ultrasharp Infinity Edge monitor
  - sRGB monitors on a swing arm next to camera
- X-Keys USB foot pedal
- Capture One Pro 9.3 software
  - On-campus Adobe CC Suite could not open Sony a7R II RAW files until update in Spring 2017
  - Capture One Pro already in use with Phase One MFDB
  - Focus Mask and Lens Cast Correction (LCC) aid in setting up and shooting

TEXAS STATE UNIVERSITY
The rising STAR of Texas

Copy Stand Equipment



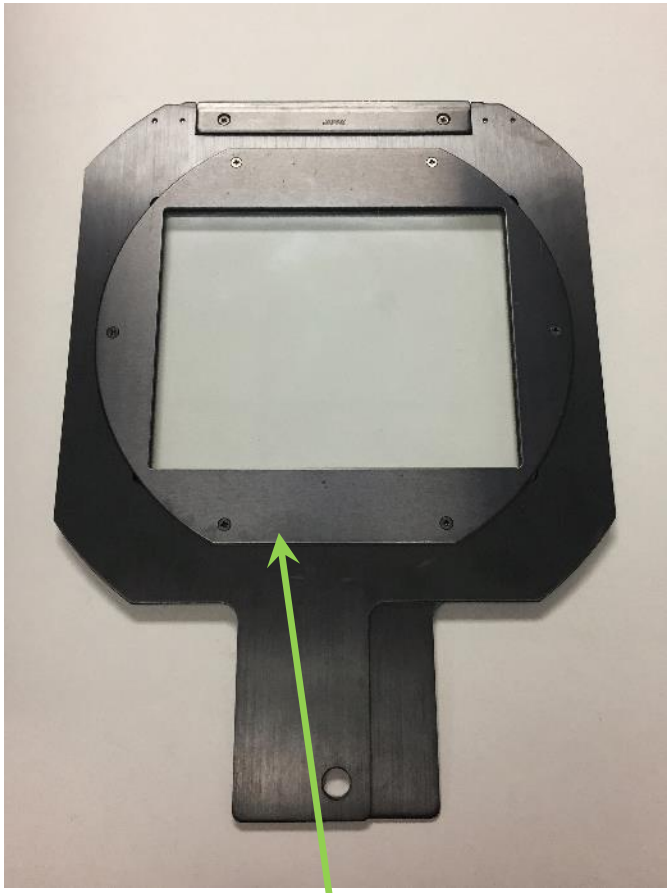
- Kaiser RSD Motorized Copy Stand
  - *** Rated for 17.5 pounds***
- Omega 4x5” universal glass negative carrier
  - Anti-Newton glass to reduce Newton rings
- Omega 4-bladed masking attachment
- Omega 35mm glass rapid shift negative carrier
  - Anti-Newton glass to reduce Newton rings
- Artograph LED lightpad with tempered glass
- Kinetronic anti-static brush
- Image Science Associates’ Preservation Microfilm Scanner Target PMT-1 with MScan software

- Items already on hand: rocket blowers, Kinetronic anti-static gloves, and Versalab Parallel Alignment Gauge (laser alignment)

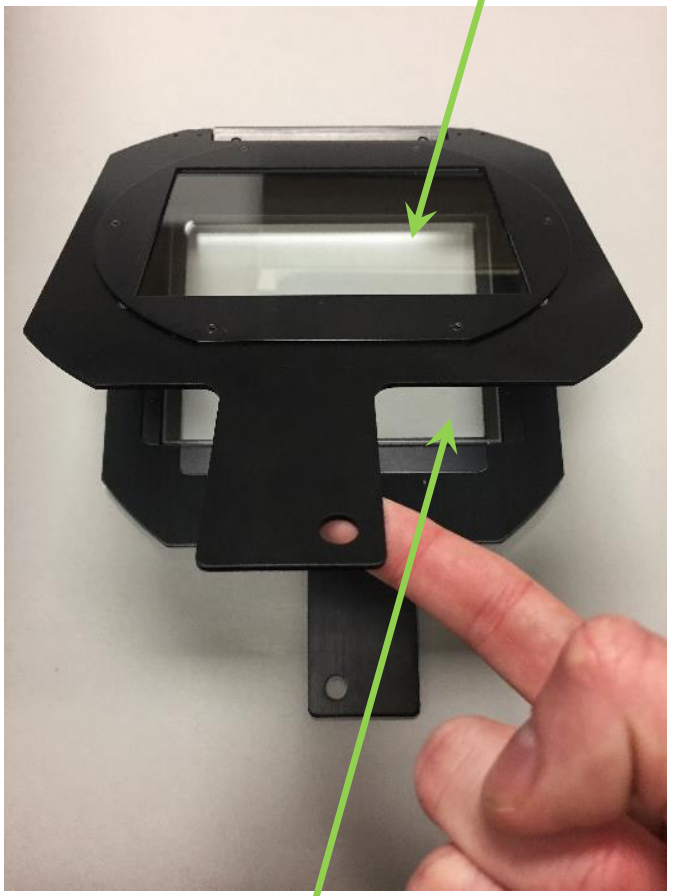
TEXAS STATE UNIVERSITY
The rising STAR of Texas

Negative carriers?

Clear plate glass on the “top”



Raised circular area mates up with 4-bladed masking attachment



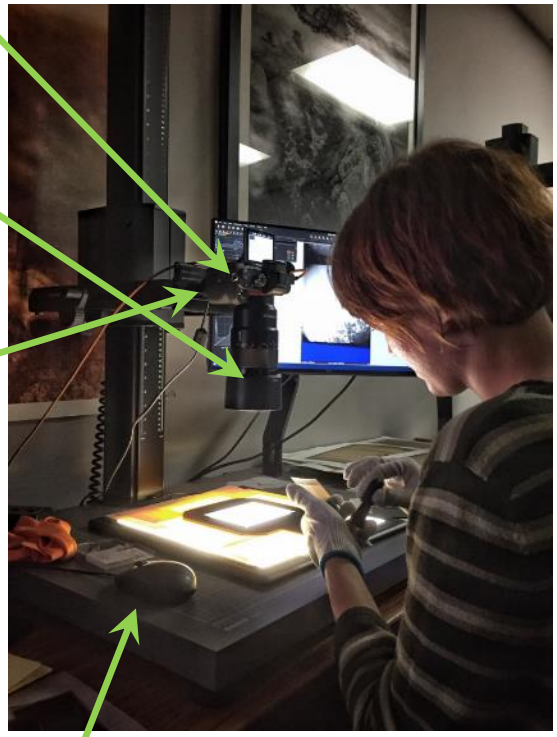
Anti-Newton glass on “bottom”
(we use the holders upside down)

TEXAS STATE UNIVERSITY
The rising STAR of Texas

TEXAS STATE UNIVERSITY
The rising STAR of Texas

Camera Equipment

- Sony Alpha a7R II Mirrorless Digital Camera
  - 42MP Full-Frame Exmor R BSI CMOS Sensor
    - Very low noise and rapid Live View update
- Sony FE 90mm f/2.8 Macro G OSS Lens
  - Aspherical, ED, and Super ED Elements to correctly focus colors in a flat-field
  - Manual focus ring + electronic motor = zero focus creep in vertical position
  - Nano AR lens coating for dramatically reduced flare
- Sony AC Adapter
  - Because constantly charging and swapping batteries is NOT acceptable



We mouse left-handed due to setup; it's good for your brain!

TEXAS STATE UNIVERSITY
The rising STAR of Texas

The a7R II is GREAT on a copy stand 1 of 7

- Mirrorless + electronic front curtain shutter = ZERO shutter shock
- High-Res LCD screen on back of camera flips up
- Can zoom from 1x to 5x to 12.5x on the LCD screen for focusing
  - Slides 2 – 4 of 7
- Adjustable setting in menu for “zebras” to appear when highlights approach or exceed 255 (max white) by a chosen percentage
  - Slides 5 - 7
  - Used to determine capture settings due to density variability in negatives

TEXAS STATE UNIVERSITY
The rising STAR of Texas

The a7R II is GREAT on a copy stand 2 of 7

Zooming in here . . .

Zoom level changed by pushing custom button C3

TEXAS STATE UNIVERSITY
The rising STAR of Texas

The a7R II is GREAT on a copy stand 3 of 7

Zoomed location area on negative

Magnification

TEXAS STATE UNIVERSITY
The rising STAR of Texas

The a7R II is GREAT on a copy stand
4 of 7

SMDR_1930s-1_003
1936 Armistice Day parade on San Marcos square

TEXAS STATE UNIVERSITY
The rising STAR of Texas

The a7R II is GREAT on a copy stand 5 of 7

Histogram collapsed to the right (upside-down LCD = left in picture)

Too many zebras, can't see the image

Shutter speed too slow letting in too much light

TEXAS STATE UNIVERSITY
The rising STAR of Texas

The a7R II is GREAT on a copy stand
6 of 7

Histogram collapsed to the left (upside-down LCD = right in picture)

No zebras anywhere; clear film rebate has too much tone

Shutter speed too fast, not letting in enough light

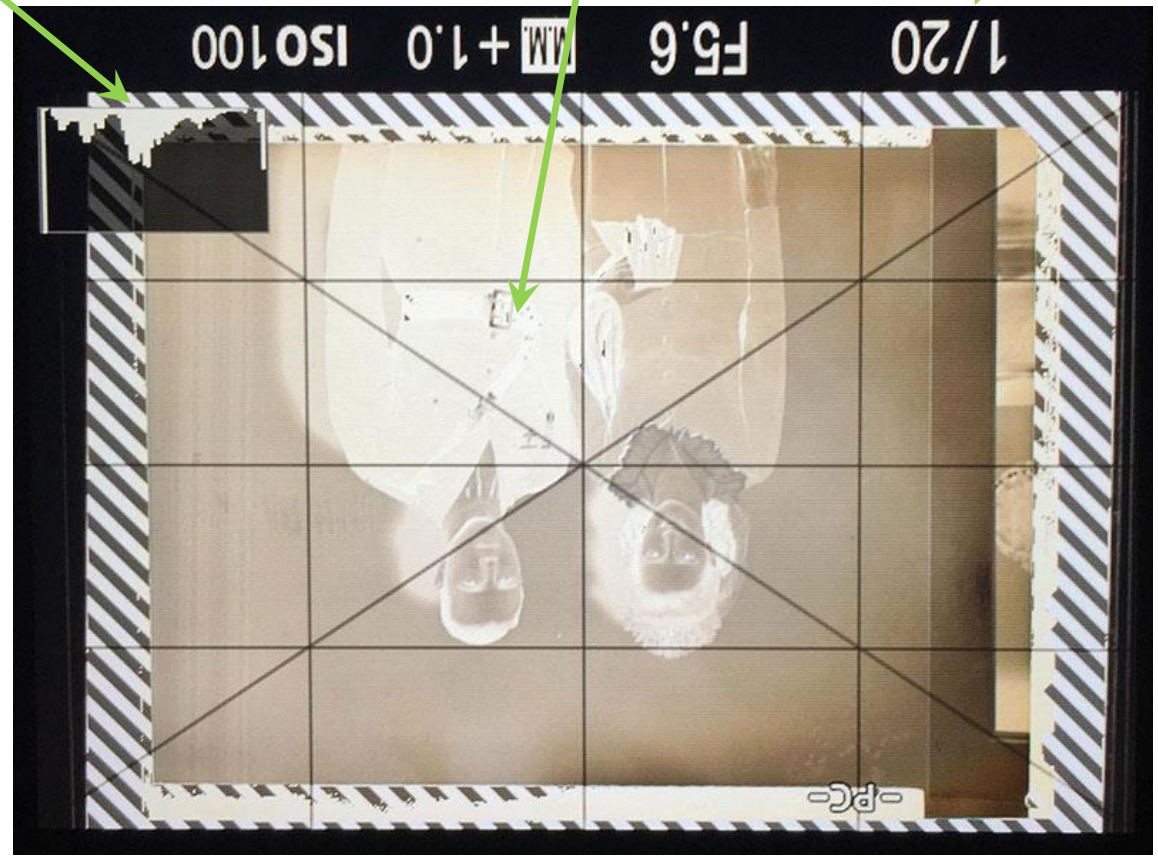
TEXAS STATE UNIVERSITY
The rising STAR of Texas

The a7R II is GREAT on a copy stand 7 of 7

Full histogram!

Just beginning to zebra in image area

Acceptable exposure for this negative



TEXAS STATE UNIVERSITY
The rising STAR of Texas

Standards from Grant Application

- Based on UNT's Digital Projects Lab's standards for film negative digitization

Final output	Color space	Resolution	File type
Positive image	Grayscale	Minimum of 5,000 pixels on long side	TIFF or JPEG2000

Original storage boxes on their way to Digital Media Lab.

Student imaging techs rehoused negatives into acid-free folders and sleeves to prepare for digitization.

TEXAS STATE UNIVERSITY
The rising STAR of Texas

Initial Goals

- Digitize at-risk nitrate and cellulose acetate film negatives
  - Nitrate film is "highly flammable, cannot be extinguished once ignited, and is therefore a serious fire hazard."
    - http://www.loc.gov/preservation/care/film.html#Nitrate
  - "Cellulose acetate film, also known as "safety" film, is not flammable like cellulose nitrate film, but it is also unstable and undergoes an autocatalytic degradation mechanism that results in embrittlement, shrinkage, and eventual total loss of the image."
    - http://www.loc.gov/preservation/care/film.html#Acetate
- Make the digitization process more active to increase job satisfaction
- Break the process into discrete steps to maximize focus on what is important
  - Prioritize safe handling of film during capture
  - Adjust tones or digitally remove dirt/scratches separately
- Scan more quickly and capture a higher resolution image at the same PPI when compared to Legacy Equipment

TEXAS STATE UNIVERSITY
The rising STAR of Texas

PPI is not Resolution

- **Sampling frequency**, calculated as pixels per inch (ppi), specifies the amount of data collected, but NOT the quality, sharpness, or fineness of said data – Merriam-Webster.com gets this half correct
- Quantity is only part of the data needed to gauge resolution
- Sampling frequency is measured both horizontally and vertically
  - Sony a7R II sampling frequency: 7952 x 5304 pixels
- ISO 12233:2017 and ISO 16067-2:2004 define MTF/SFR measurement for calculating resolution as it relates to sampling frequency for photographic film digitization

TEXAS STATE UNIVERSITY
The rising STAR of Texas

MTF/SFR

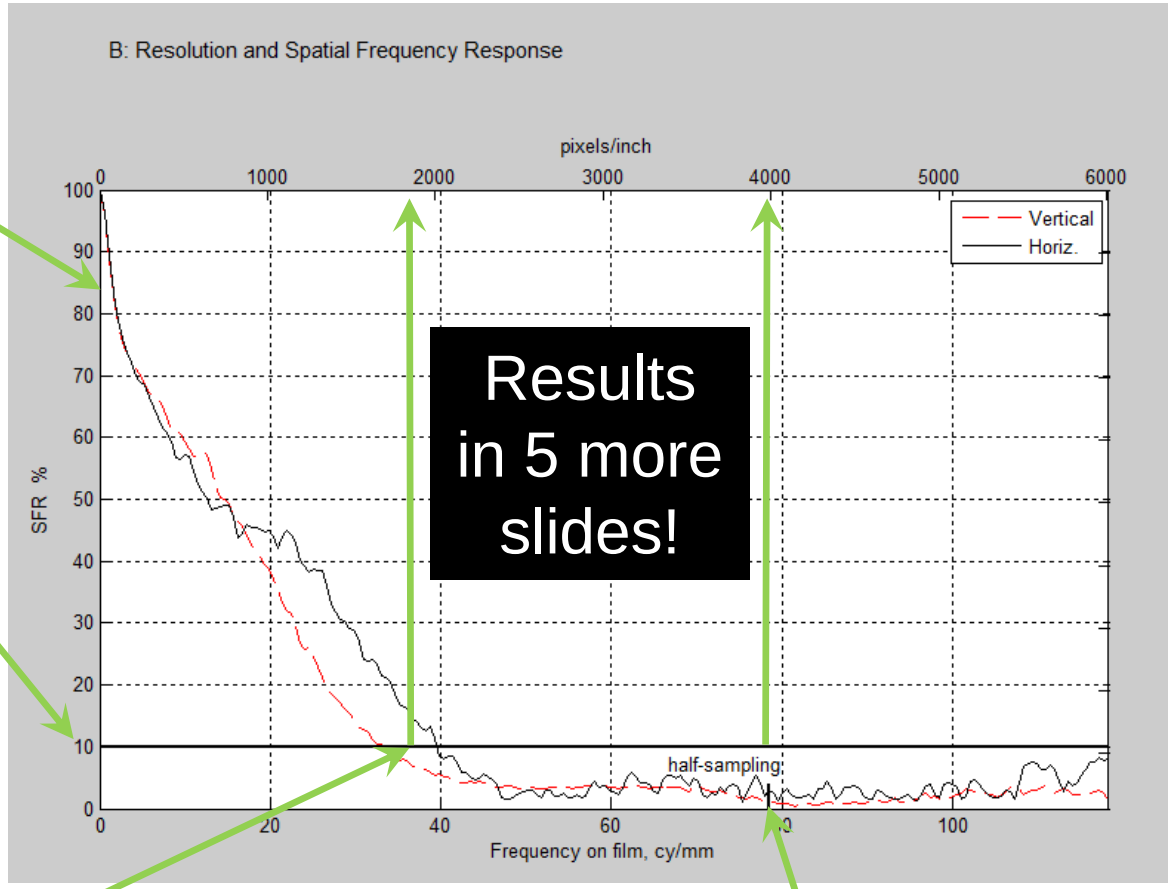
- "Modulation Transfer Function (MTF) is a measurement of the contrast difference between the original and the digital image."
  - (FADGI:2016, p. 11)

- "Spatial Frequency Response (SFR) measures the imaging systems ability to maintain contrast between increasingly smaller image details."
  - (FADGI:2016, p. 11)

- Sampling Efficiency: ratio of 10% SFR (MTF10) to the sampling frequency
  - User Guide for MScan software
    - http://losburns.com/imaging/software/mscan/Preservation%20Microfilm%20User%20Guide2.pdf

TEXAS STATE UNIVERSITY
The rising STAR of Texas

Resolution and Spatial Frequency Response



Rapid drop in Y-axis = low contrast

10% SFR, MTF10

Avg of H/V 10% SFR

Half-sampling of cy/mm = sampling frequency

TEXAS STATE UNIVERSITY
The rising STAR of Texas

Negative Scanning - Legacy Equipment

- Epson 10000XL flatbed with transparency adapter
  - Holders for 35mm, 120, and 4x5 inch negatives
  - Anti-Newton glass can be used with off-sizes on the scanner platen or with 3rd party holders
  - Stated optical resolution: 2400 ppi
  - Autofocus/manual focus
  - Later models still in production (Epson 12000XL) with continued software and hardware support
- Nikon Super Coolscan 5000 ED film scanner
  - Limited to 35mm film
  - Stated optical resolution: 4000 ppi
  - Autofocus
  - Requires 3rd party software (Vuescan or Silverfast)
  - Discontinued hardware – Nikon will no longer repair or support
    - "We recommend that the scanner and adapters be taken to an authorized Nikon service representative once every one to two years for inspection, and once every three to five years for servicing (fees are charged for these services)." - Nikon 5000 Manual, page 52
  - Collimated light source exacerbates dust and grain in B&W negatives

TEXAS STATE UNIVERSITY
The rising STAR of Texas

35mm Scans Compared
1 of 4

- Average time to begin loading film in scanner and saved to network
  - Nikon: ~2 minutes per 35mm frame
  - Epson: ~6 minutes per 35mm frame
  - Sony: still collecting data, but the Sony averaged 1.8 images for each Nikon frame scanned and saved locally in a test using modern 35mm film
- Red boxes below denote cropped area compared in next 2 slides

SMDR_1940s50s-NoEnvelope_001

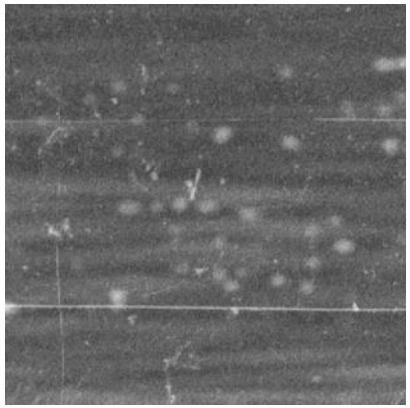
SMDR_1940s50s-NoEnvelope_002

TEXAS STATE UNIVERSITY
The rising STAR of Texas

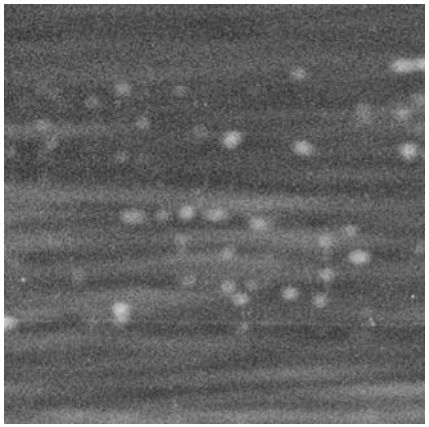
35mm Scans Compared
2 of 4

- 0.1 in square crops sized down 50%
- Nikon shows all of the dirt and scratches
- Sony image is larger due to 4213 ppi capture vs. 4000 ppi for others
- Epson's optical limitations are obvious in comparison

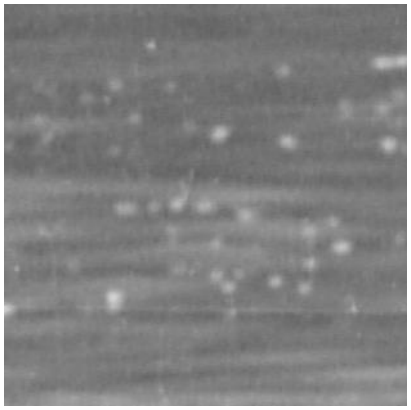
Nikon



Sony A7r II



Epson



SMDR_1940s50s-NoEnvelope_001

TEXAS STATE UNIVERSITY
The rising STAR of Texas

35mm Scans Compared
3 of 4

- 0.05 in square crops at 100%
- Nikon shows banding running vertically due to motion of scanner
- Epson shows banding across image horizontally due to motion of scanner

Nikon

Sony A7r II

Epson

SMDR_1940s50s-NoEnvelope_002

TEXAS STATE UNIVERSITY
The rising STAR of Texas

35mm Scans Compared
4 of 4

Nikon

```
Sampling on film:  3987.2 ppi

Resolution (ppi)

                        Film
    horizontal:     2600.2
    vertical:        3401.1
    average:        3000.6

Sampling Efficiency:  75.0 %
```

Sony A7r II

```
Sampling on film:  4213.0 ppi

Resolution (ppi)

                        Film
    horizontal:     4100.4
    vertical:        4123.6
    average:        4112.0

Sampling Efficiency:  96.5 %
```

Epson

```
Sampling on film:  3996.3 ppi

Resolution (ppi)

                        Film
    horizontal:     2000.4
    vertical:        1679.8
    average:        1840.1

Sampling Efficiency:  46.0 %
```

Effective horizontal resolution drops due to vertical banding seen in last slide (PMT target is analyzed perpendicular to the orientation of example negative on last slide)

Same as the Nikon, effective vertical resolution drops due to banding in the scan

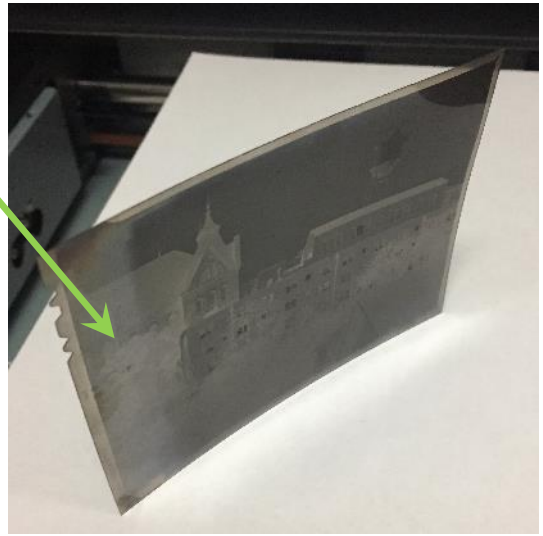
TEXAS STATE UNIVERSITY
The rising STAR of Texas

3.25” x 4.25” Scans Compared 1 of 4

- Epson scan time for this size: 3 minutes
  - JUST the scan time, does not include pre-scanning, autofocusing, etc.
- Sony capture time: 2.5 minutes from loading to unloading
- Red box below denotes cropped area compared

Band of lighter tone matching silver mirroring on negative

Silver mirroring on negative from oxidation

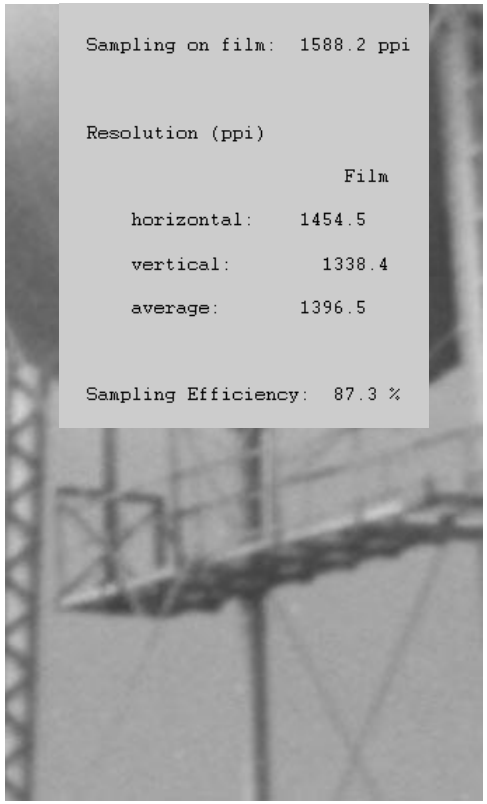


SMDR_1940s50s-SF-25
“College Class of 1906, 7-1946”

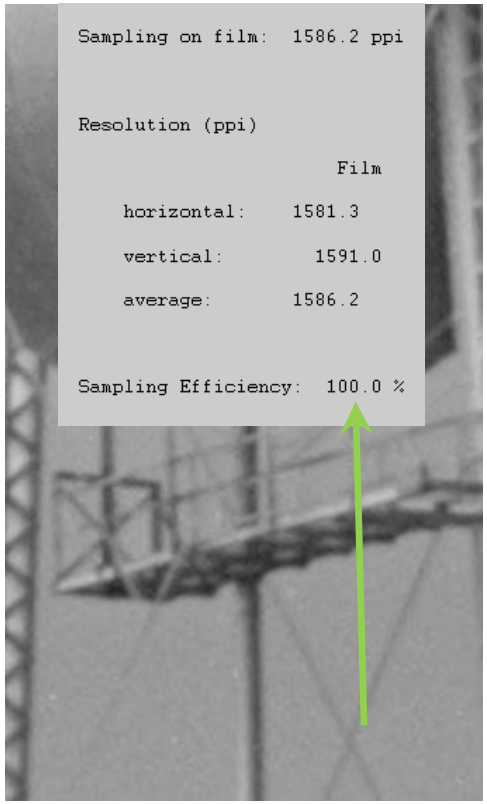
TEXAS STATE UNIVERSITY
The rising STAR of Texas

3.25” x 4.25” Scans Compared
2 of 4

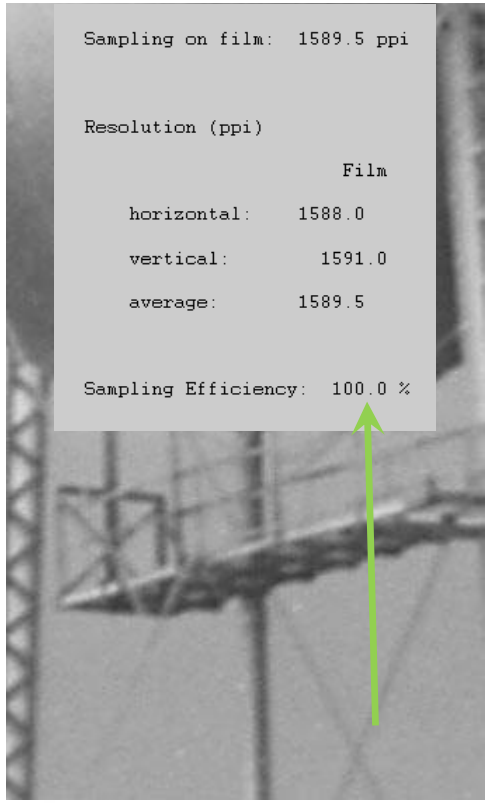
Epson



Sony A7r II



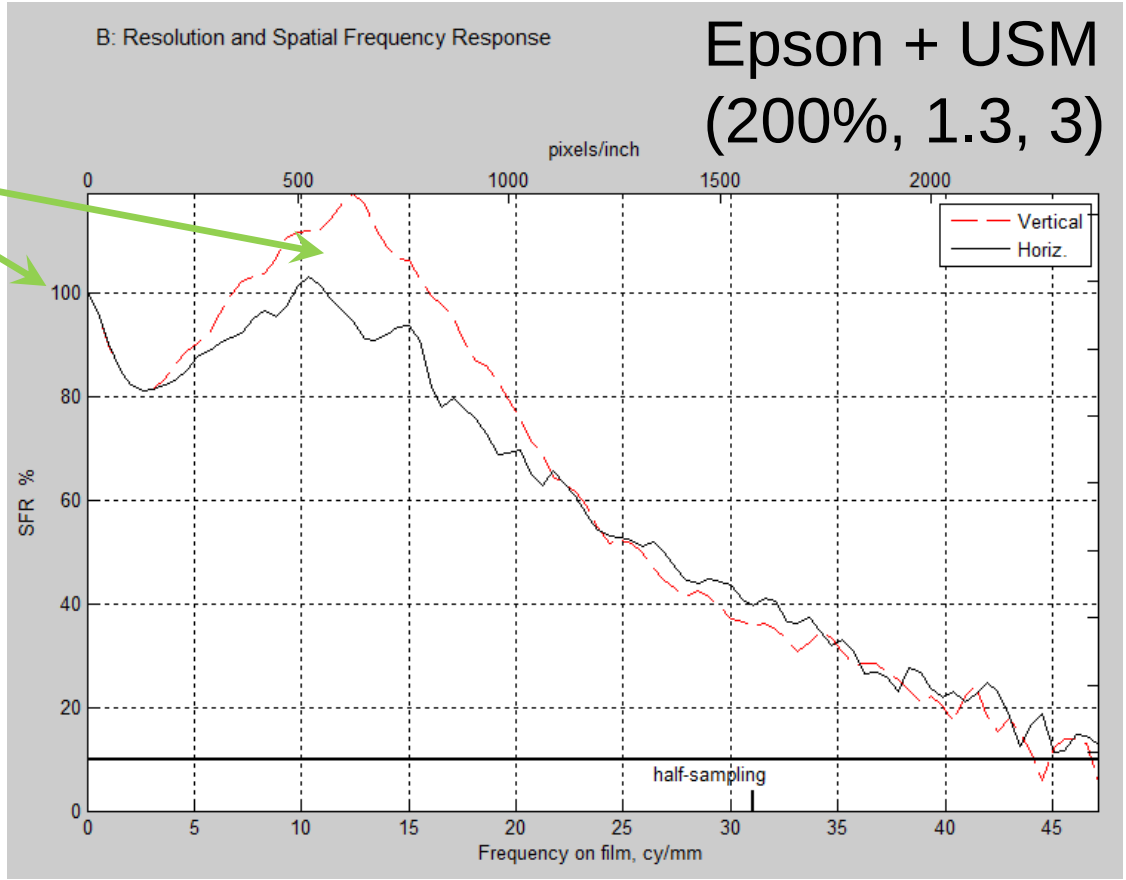
Epson + USM (200%, 1.3, 3)



TEXAS STATE UNIVERSITY
The rising STAR of Texas

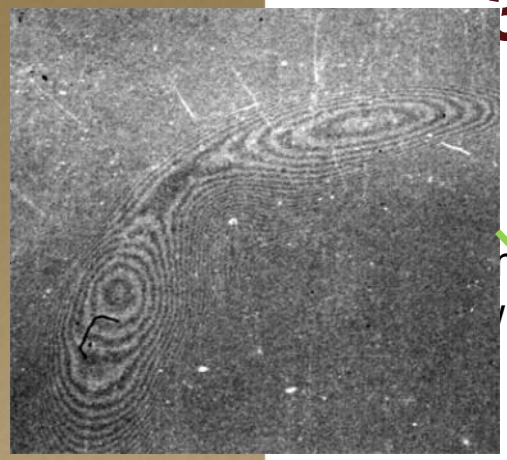
3.25” x 4.25” Scans Compared
3 of 4

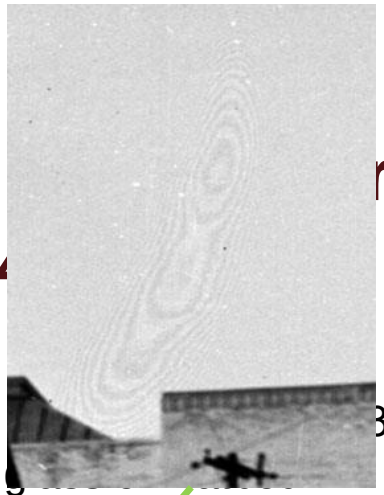
Maximum MTF greater than 100% SFR = excessive sharpening that leads to haloes at dark/light transitions



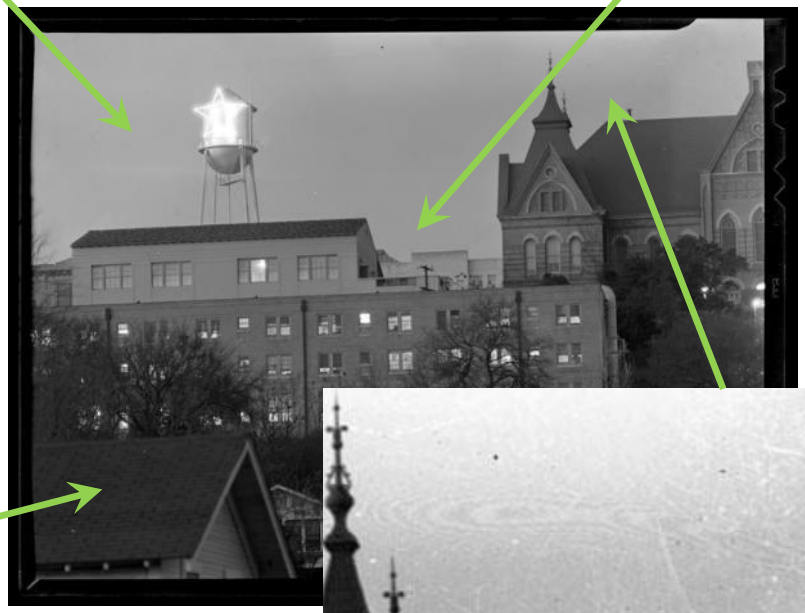
TEXAS STATE UNIVERSITY
The rising STAR of Texas

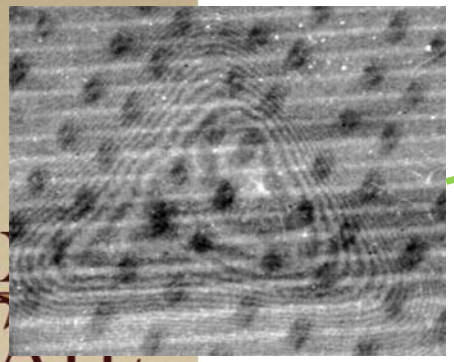
3.25” x 4.25” Sca red
4 of 4

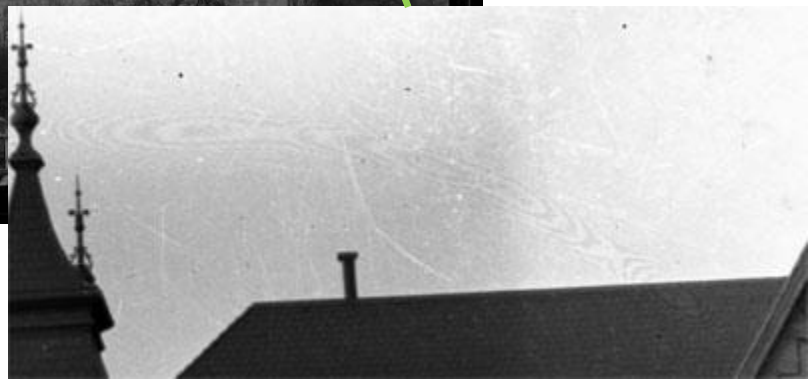




n scanner producing significant 3.25x4.25”
when flattened with Anti-newton







TE
STATE
UNIVERSITY
The rising STAR *of Texas*

Ongoing Project Standards

- Informed by FADGI:2016
- Sampling frequency: > 5,000 pixels on long side of image
- Sampling efficiency: > 90%
- Sharpening (Maximum MTF): < 1.0
- Bit-depth: 16-bit
- File type: uncompressed TIFF
  - Currently keeping Sony RAW file – allows for future manipulation
- Colorspace: Positive image in Grayscale (gamma 2.2)
- Tones: between 5 – 250 in 8-bit equivalent colors in gamma 2.2 (unless heavily stained or damaged)

TEXAS STATE UNIVERSITY
The rising STAR of Texas

Production

- Grant target: 6,000 negatives online by August 31, 2017
- Began production scanning on April 10, 2017
  - Delays in receiving equipment due to special order darkroom items and . . .
- All production work completed on 1 station
  - Alienware Aurora Revision 5 on its way back to Dell (again!)
  - Only 1 Sony 90mm lens within specifications (< 75% sampling efficiency)
- Average negatives captured per workday: 91
  - 4 days with 0 negatives
  - Average time digitizing negatives per day: < 4 hours
  - 3.25x4.25” film takes longer to clean and load in holder due to size and curl
  - Average negatives captured on workdays shooting 6x6 cm: 188
- Captured negatives as of May 12, 2017: 2,277 (37.95%)
  - 3,723 negatives to digitize (62.05%)
  - All 28 frames of 35mm already captured
  - All remaining 3.25x4.25” film expected to be digitized by TCDL presentation
  - Vast majority of film still to digitize for the grant is 6x6 cm

TEXAS STATE UNIVERSITY
The rising STAR of Texas

Summary

- 1 student imaging tech scanned 6,000 negatives in 1 year with Legacy Equipment
- First 21 days with one capture station in service (including training, finals, and troubleshooting): 2,277 negatives
- Imaging quality and capture speed exceeds all Legacy Equipment in our lab
- This presentation has been a quick introduction to our on-going research building and evaluating custom film capture stations
- Thank you.

TEXAS STATE UNIVERSITY
The rising STAR of Texas

Questions?

TEXAS STATE UNIVERSITY
The rising STAR of Texas