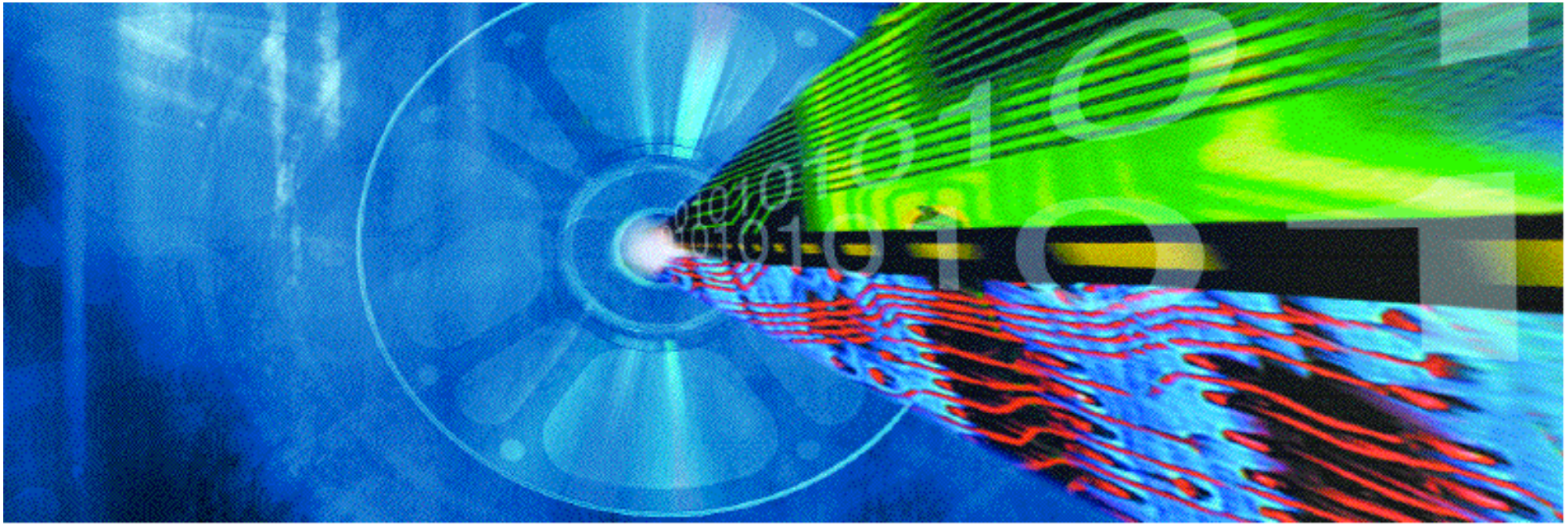


Science and Technology Council

ACADEMY OF MOTION PICTURE ARTS AND SCIENCES

THE DIGITAL DILEMMA

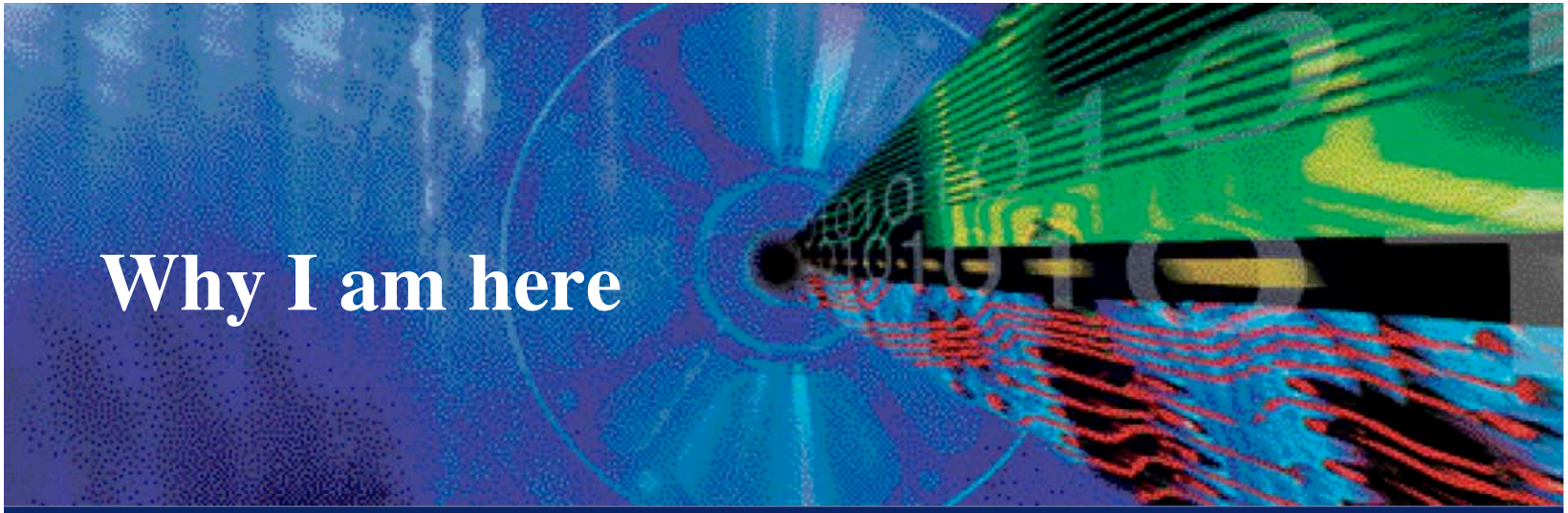
STRATEGIC ISSUES IN ARCHIVING AND ACCESSING DIGITAL MATERIALS

Andy Maltz
Director,
Science & Technology Council

Science and Technology Council

What I'll Talk About

- Why I am here
- The Academy
- The Council
- The Digital Dilemma
- Motion Picture Industry Initiatives
- A Challenge



Why I am here

Science and Technology Council

- I'm on a NARA committee
- The Motion Picture Industry has a problem:
  - It is converting from film to a fully digital infrastructure (2-10 Petabytes/movie)
  - Film lasts >100 years when properly handled
  - Bits don't last long enough for us
- We (the Motion Picture Industry) are not the only ones with this problem, and everyone needs help

“What do we do now?”

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Step 1: Define the problem

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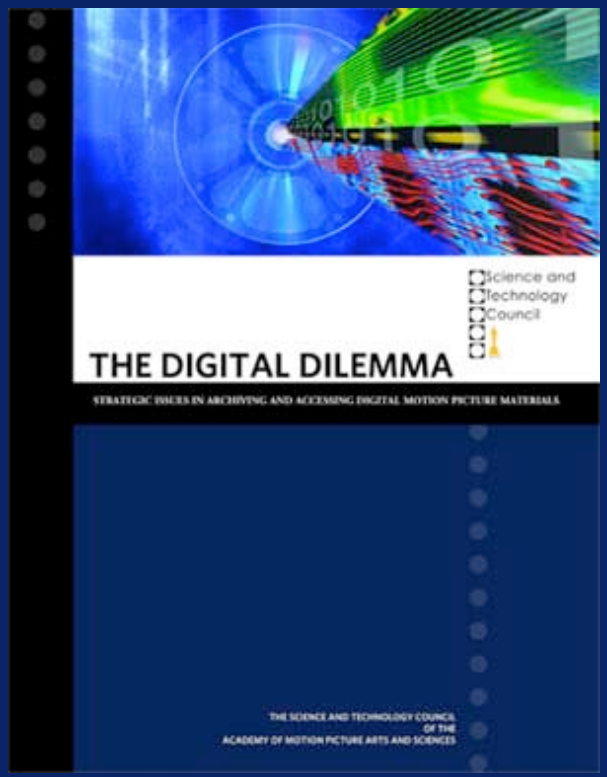

About the Academy

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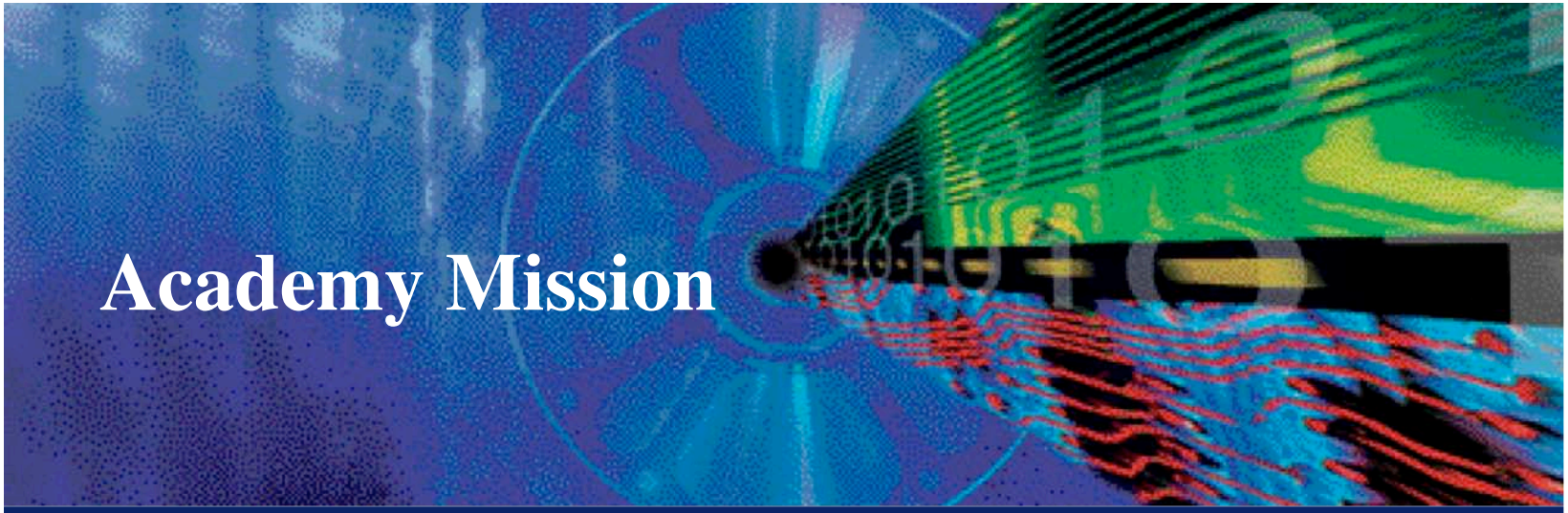
In The Beginning…

Science and Technology Council

- 1927: Industry under fire, contract issues
- Dinner at Louis B. Mayer's house: the Academy is born
- It's about the *arts & sciences*, not business
- Today:
  - >6,000 members in 33 countries
  - 15 Branches plus at-large/associates
  - Staff of 250



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Academy Mission

- To advance the art and sciences of motion pictures
- To recognize outstanding achievements
- To provide a common forum and meeting ground for branches and crafts
- To represent the viewpoint of the actual creators of the motion picture

Academy Facilities

Science and Technology Council

Beverly Hills, CA

Beverly Hills, CA

Hollywood, CA

Inside the Academy

Science and Technology Council

Coming soon…

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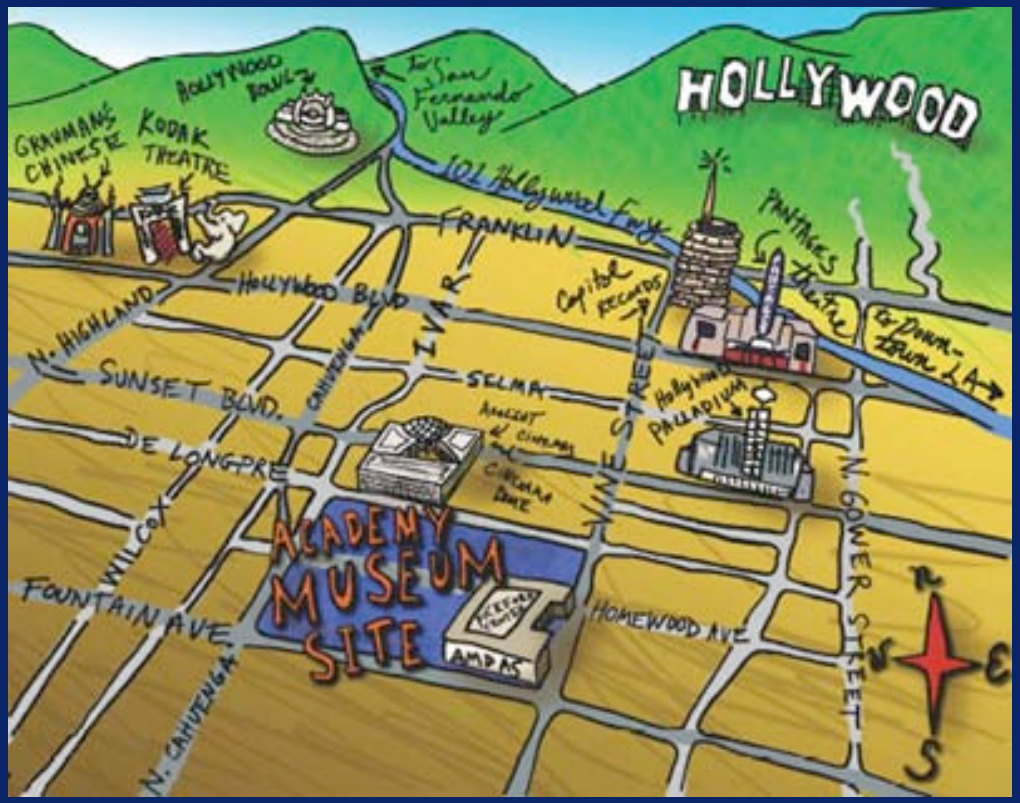

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1927: Technology work begins

- Academy technical committees:
  - Screen illumination
  - Camera aperture
  - Release prints for theaters
- 1929: Producers-Technicians Joint Committee formed
  - 36 active technical project committees
  - First sound school for studio engineers/technicians

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1932: Academy Research Council

- Reps from Academy, studios, equipment suppliers
- Reports:
  - Academy aperture, sound curve, leader
  - 3 color film process
- Public programs

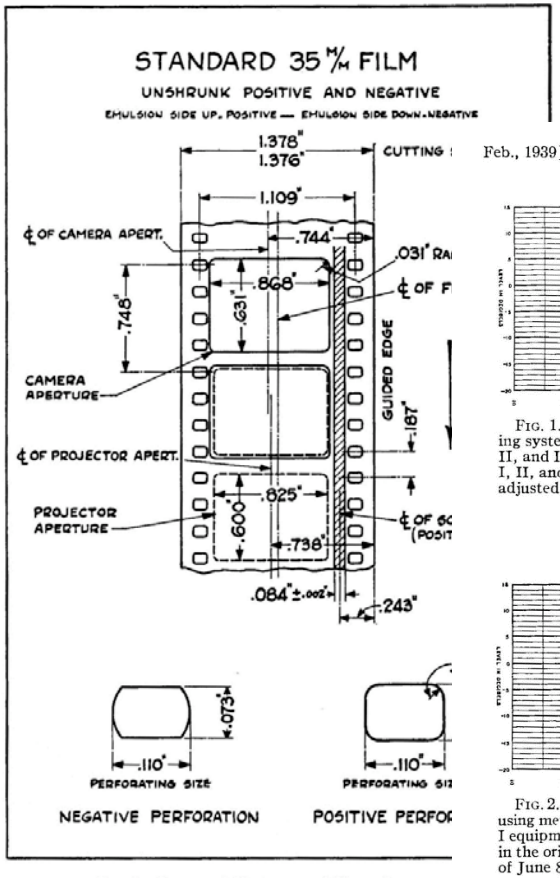


FIG. 3. Layout of 35-mm. sound film and aperture

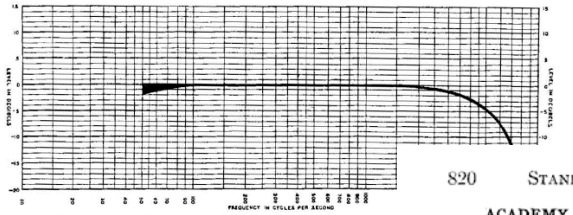


FIG. 1. Revised Standard Electrical Characteristic f
ing systems using metal diaphragms; Types I (*M-101*,
II, and III. For optimum results with current studio s
I, II, and III Systems equipped with metal diaphragr
adjusted to this Revised Standard Electrical Characte

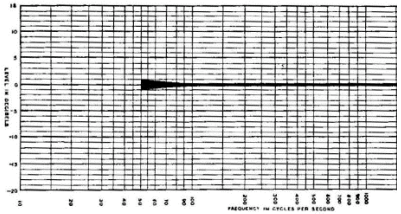


FIG. 2. Standard Electrical Characteristic for two-wa
using metal diaphragms; Type I (*M-3* Systems). This c
I equipments (*M-3* Systems) has not been changed, an
in the original publication of March 31, 1937, and the s
of June 8, 1937.

Electrical Runs, Measured at the Output of the Power Am
Equivalent to the Speaker Load Using the Academy Res
Multi-Frequency Test Reel (Corrected), Altec Test Film
RCA Test Film (Catalogue No. 265

The tolerances of ±1 db. up to 3000 cycles, increasin
quency to a maximum of ±2 db. at 7000 cycles, should
adjusting equipment to these specifications.

Electrical Runs, Measured at the Output of the P
Resistance Equivalent to the Speaker Load Using t
Council Standard Multi-Frequency Test Reel (Correc
(ED-20, Corrected), or RCA Test Film (Catalogue No.

The tolerances of ±1 db. up to 3000 cycles, increa
frequency to a maximum of ±2 db. at 7000 cycles, s
tained in adjusting equipment to these specifications.

ACADEMY SPECIFICATIONS FOR 35MM. MOTION PICTURE RELEASE PRINTS

PROTECTIVE LEADER

Either transparent or raw stock.

When the protective leader has been reduced to a length of four feet it is to be restored to a length of six feet.

IDENTIFICATION LEADER (Part Title)

Shall contain not less than 32 frames in each of which is plainly printed in black letters on white background, type of print (see nomenclature), part number (arabic numeral not less than 1/4 of frame height), and picture title.

SYNCHRONIZING LEADER

First section shall be opaque.

Start mark shall be one frame in which is printed START (inverted) in black letters on white background 1/2 of frame height.

A white line 1/32 inch wide upon which is superimposed a diamond 1/8 inch high by 3/8 inch wide shall be printed across the picture and sound track area at a point exactly 20 frames ahead of the center of the start frame.

Beginning 3 ft. from the first frame of picture, each foot is to be plainly marked by a transparent frame containing an inverted black numeral at least 1/2 frame height. Footage indicator numerals shall run consecutively from 3 to 11, inclusive.

This section shall be opaque and contain frame lines throughout entire length which do not cross sound track area.

At a point exactly 20 frames ahead of the center of each footage numeral frame there shall be a diamond (white on black background) 1/8 inch high by 3/8 inch wide.

PICTURE

It is recommended that picture action start and finish on fades wherever possible, otherwise significant sound should be kept at least five feet from the start and finish of the picture.

MOTOR CUE

Shall be circular opaque marks with transparent outline printed from the negative which has had four consecutive frames punched with a serrated edge die 0.094 inch in diameter. The center of these holes is to be halfway between the top and second sprocket holes 0.281 inch from the right-hand edge of the film with heads up and emulsion toward the observer.

CHANGE-OVER CUE

Shall be same as motor cue.

RUNOUT TRAILER

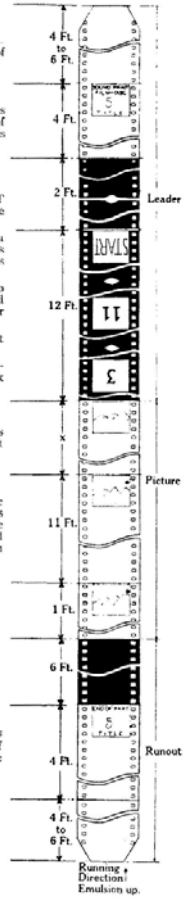
Shall be opaque.

IDENTIFICATION TRAILER (End-of-Part Title)

Shall contain not less than 32 frames in each of which is plainly printed in black letters on white background: End of part, part number (arabic numeral not less than 1/4 of frame height), and picture title.

PROTECTIVE TRAILER

Same as protective leader.



Science and Technology Council

PRESENTING HOLLYWOOD'S PREMIERE OF...

RCA's New **ULTRA-VIOLET LIGHT** Recording

SEE HOW THE sound engineer, with the latest developments, can enhance the work of the producer, writer, director and actor.

WITNESS A COMPLETE non-technical demonstration of the latest sound and laboratory technique.

EXHIBIT IN THE LOBBY of all the equipment by which the startling results you will hear on the screen will be obtained.

Under the Auspices of

the TECHNICIANS BRANCH of the

ACADEMY OF MOTION PICTURE ARTS AND SCIENCES

Tuesday Evening, April 21, at 8:30 P. M.

Music Box Theatre, Hollywood Boulevard at Gower Street

THIS DEMONSTRATION SHOULD BE OF INTEREST TO EVERY WIDE-AWAKE PERSON IN THE INDUSTRY

YOU ARE INVITED

IN ADDITION

SCIENCE'S LATEST:

THE ZWORYKIN ELECTRONIC TELESCOPE

(Not as Formidable as It Sounds)

"SEEING IN THE DARK"

YOU WILL SEE and hear new dialogue and music recording made with ultra-violet light and reproduced on the newest type sound equipment.

BROUGHT TO HOLLYWOOD from the East, especially for this demonstration, by the RCA Manufacturing Company.

BRIEF EXPLANATIONS OF the demonstrations will be given by L. M. Clement, Leo Sullivan and G. L. Dimmick, all of the RCA Manufacturing Company, Camden, New Jersey.

TELEVISION Will **NOT** Be Discussed

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More Council History

- 1934: Studio funding begins, Council administered by Academy
- The War Years: training films, combat photographer training

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The Research Continued…

- 1947-1960: AMPP Motion Picture Research Council
- 1967-1976: AMPTP Research Center
- 1989-1999: Technology Council of the Motion Picture-Television Industry (a.k.a. TCMPT, “Old Tech Council”)

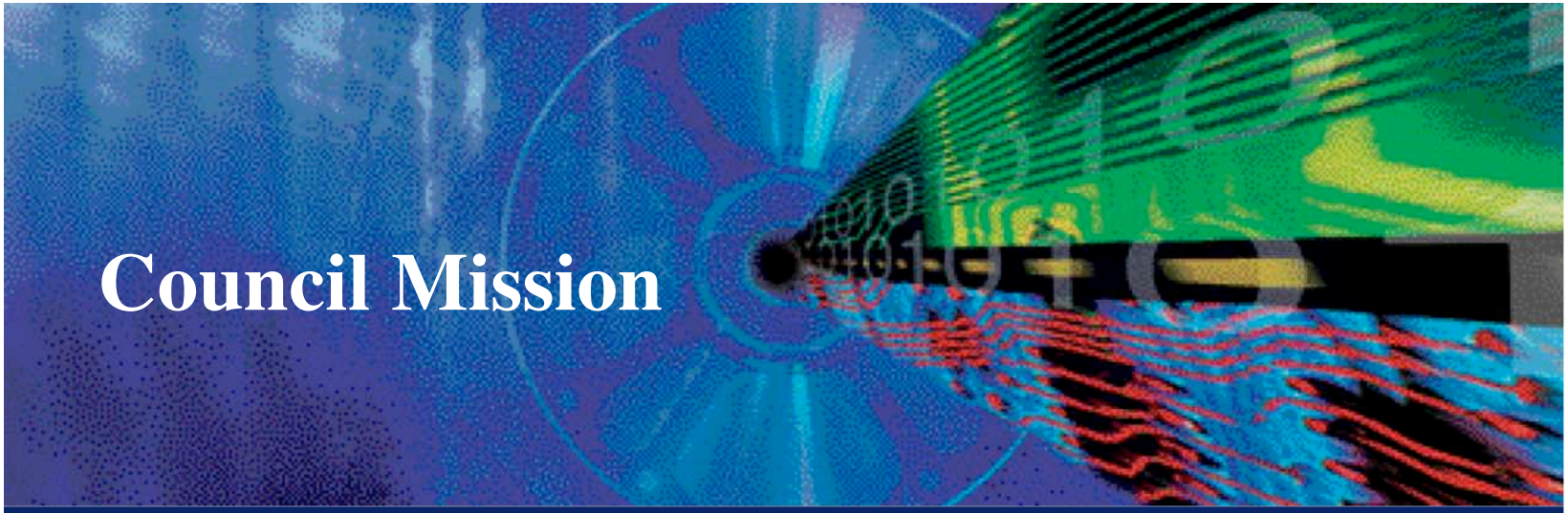
The Digital (R)evolution

Science and Technology Council

- 1980s: digital sound production recording
- 1990s: digital sound in theaters, digital tools for visual effects, animation and editing
- 1999: digital projection in theaters starts
- 2004: digital “finishing” starts
- Now: digital motion picture cameras

Science and
Technology
Council

ACADEMY
SCIENCE AND
TECHNOLOGY
COUNCIL
ACADEMY OF MOTION PICTURE ARTS AND SCIENCES



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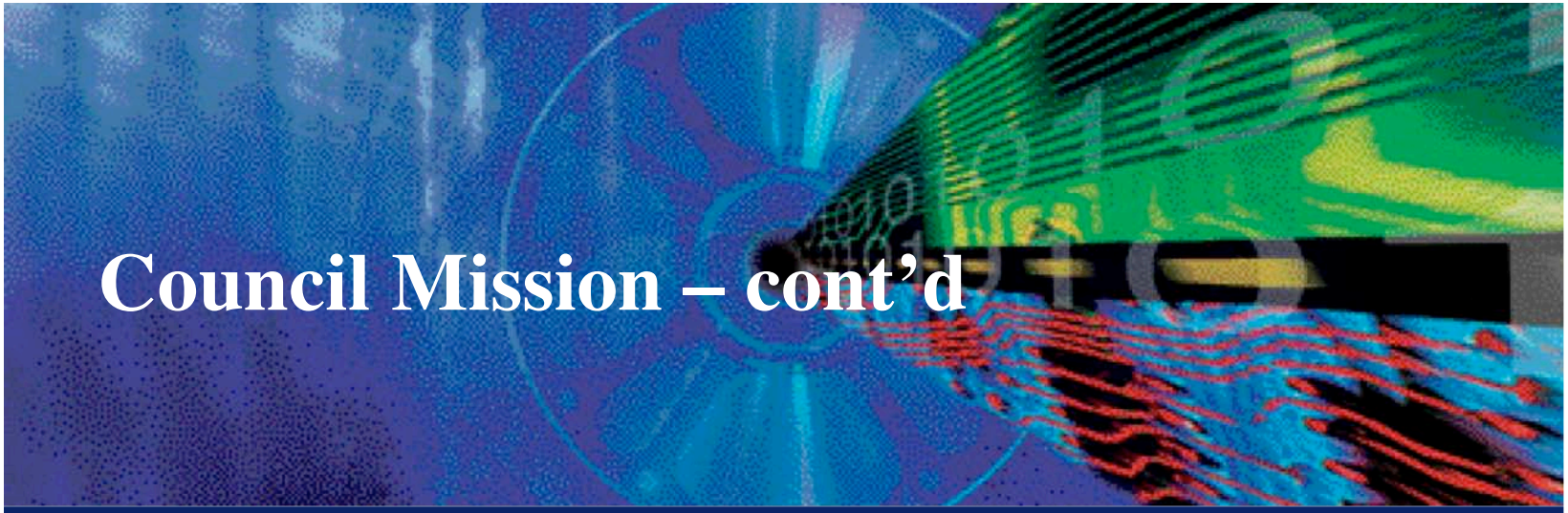
Council Mission

- To advance the science of motion pictures and foster cooperation for technological progress in support of the art
- To sponsor publications and foster educational activities
- To preserve the history of the science and technology of motion pictures



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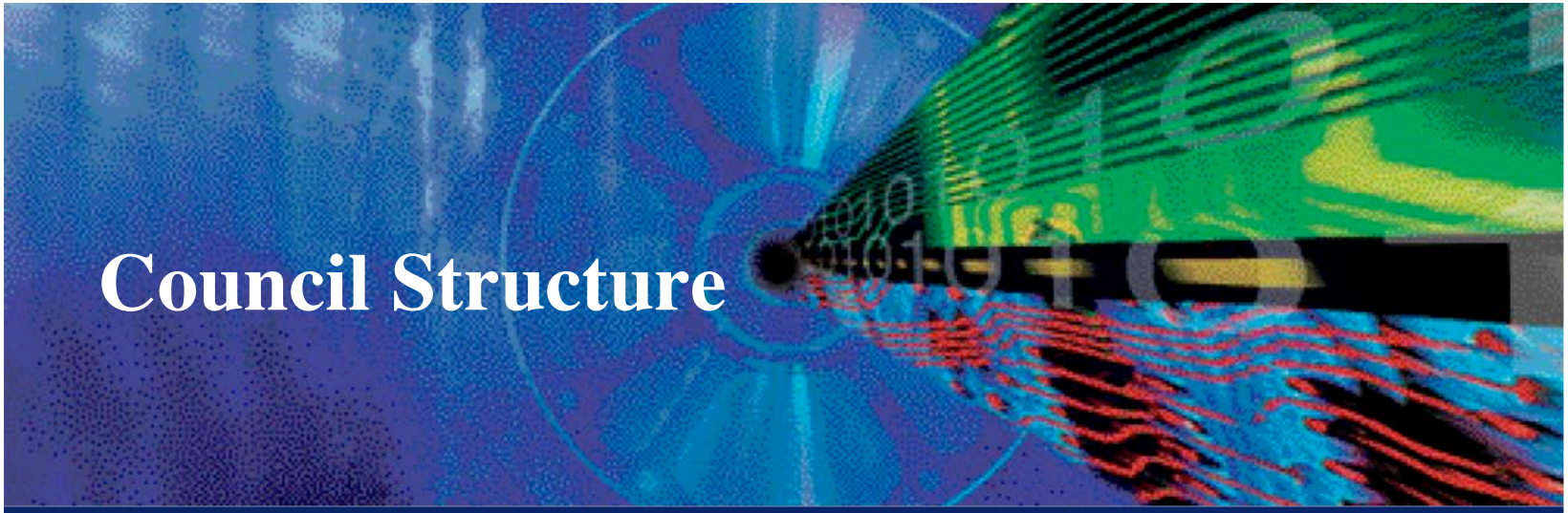
Council Mission – cont'd

- To provide a forum and common meeting ground for the exchange of information and to promote cooperation among divergent technological interests, with the objective of increasing the quality of the theatrical motion picture experience.



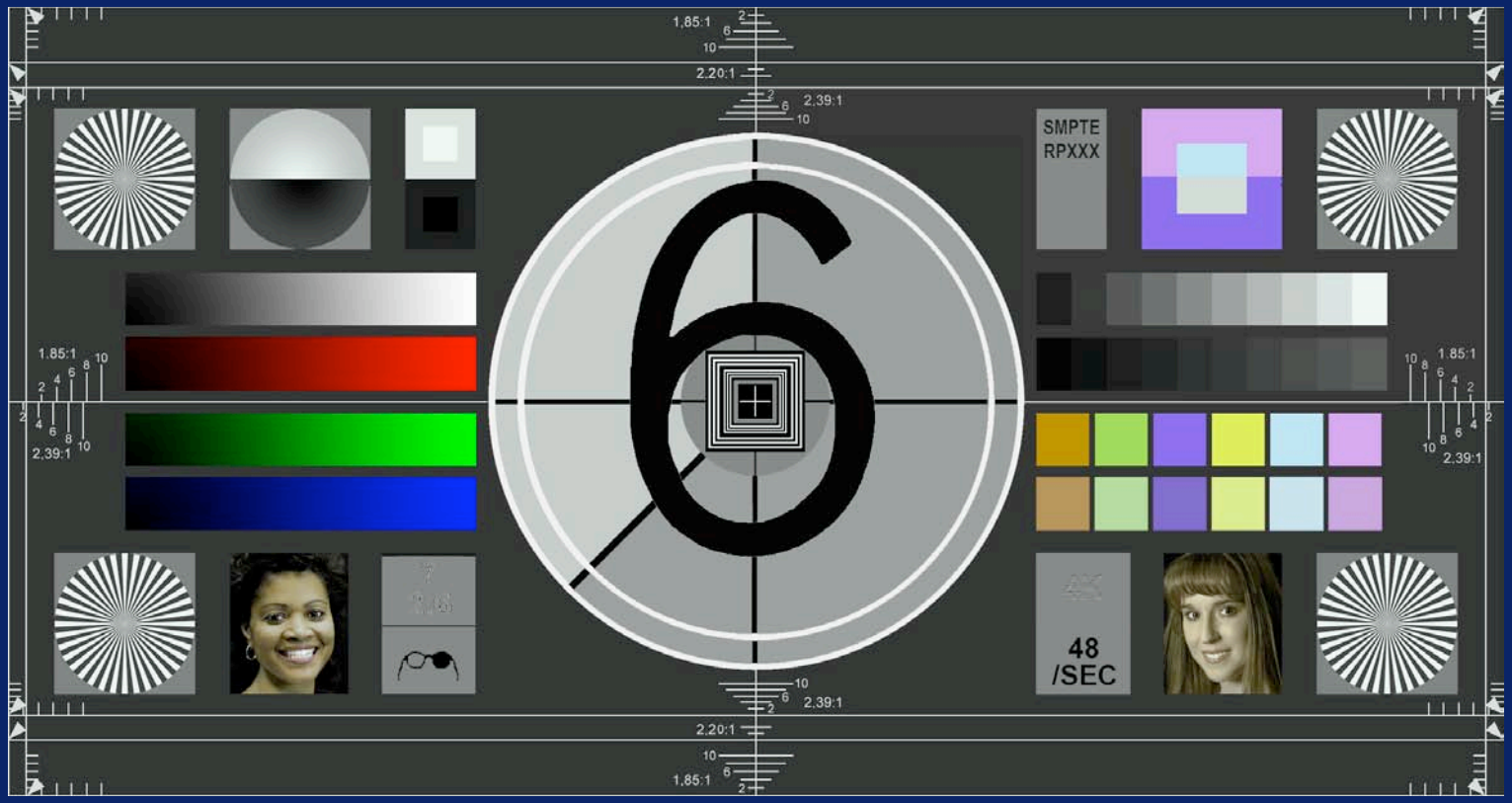
Council Structure

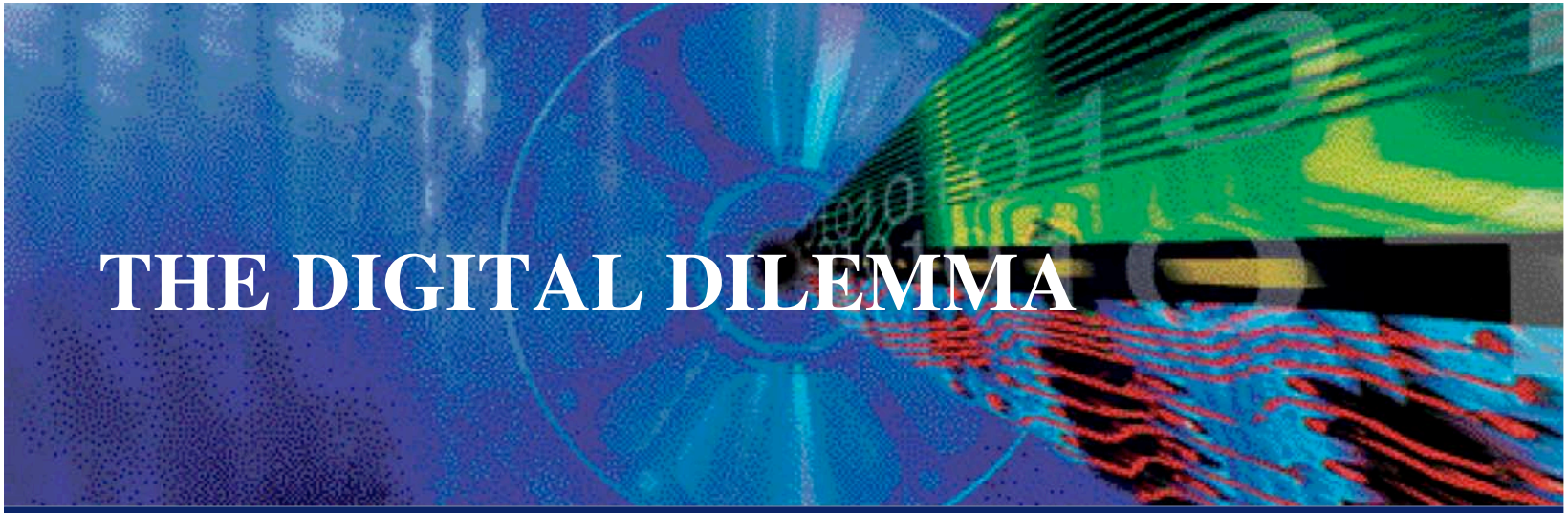
Science and Technology Council

- The Council: 25 Academy members
- Four standing subcommittees:
  - Technology History
  - Public Programs & Education
  - Advanced Technology Programs
  - Research
- Council Advisory Group: Studio CTOs
- Staff of 8 plus interns
- Project committees: over 150 volunteers

SMPTE RP 428-6 Digital Leader

Science and Technology Council





THE DIGITAL DILEMMA

Science and Technology Council

- 2005 Digital Motion Picture Archival Summit
  - Issue: digital archiving is not
  - Issue: digital does not get “cheaper”
  - Issue: not the prime market for storage vendors
  - What are other industries doing?
  - What should the Motion Picture Industry do?
- Academy project to “define the problem” and key requirements for solution(s)

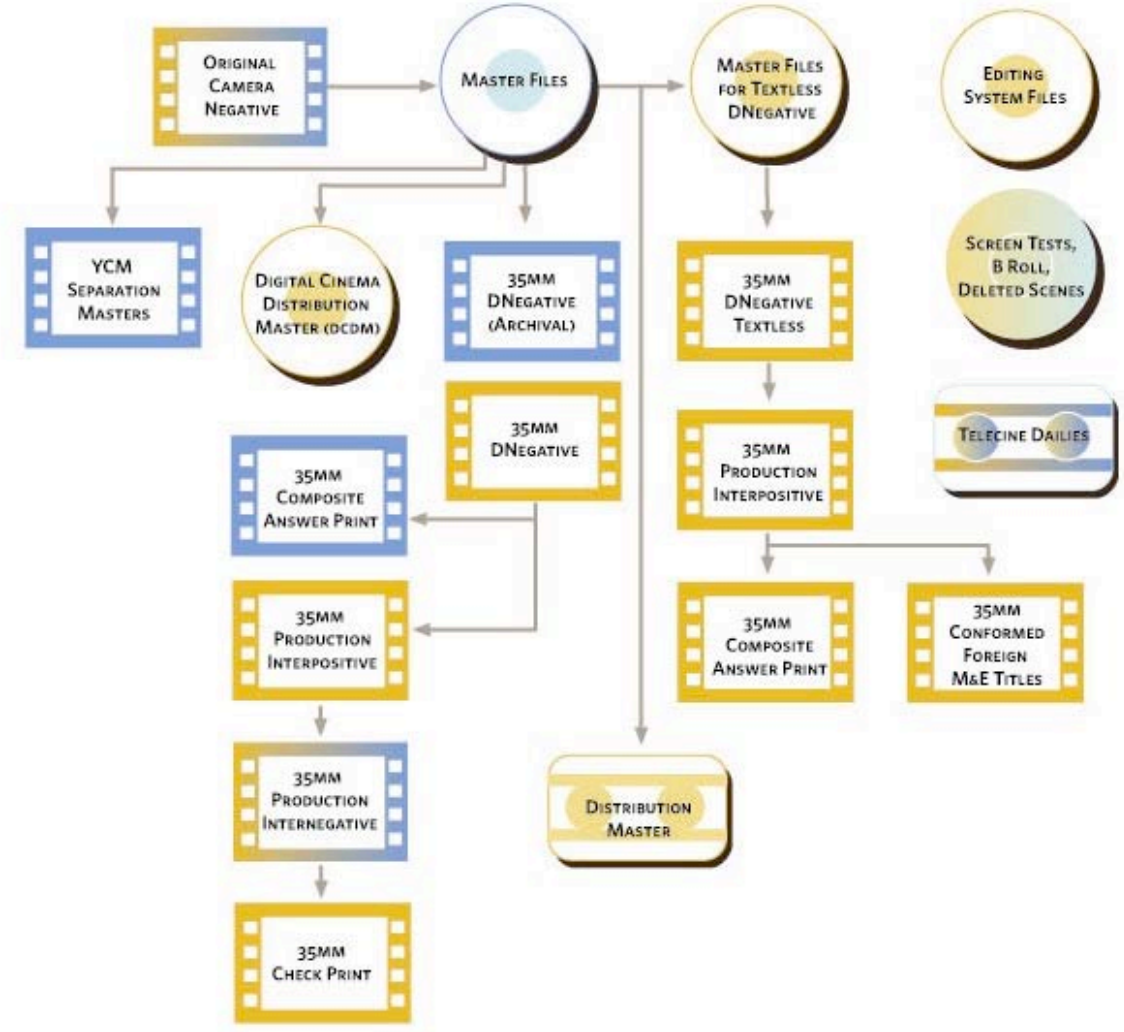
Science and Technology Council

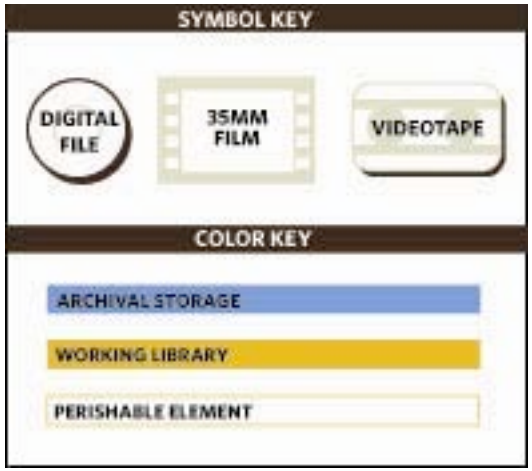
But first, some definitions

- Archives and Libraries are not the same thing
- Archive:
  - preservation without errors: access without end
  - access model: WORSE (Write Once, Read Seldom if Ever)
- Library:
  - temporary storage site
  - access model: online or nearline

GENERIC MOTION PICTURE ELEMENT TREE:
Picture only, film capture

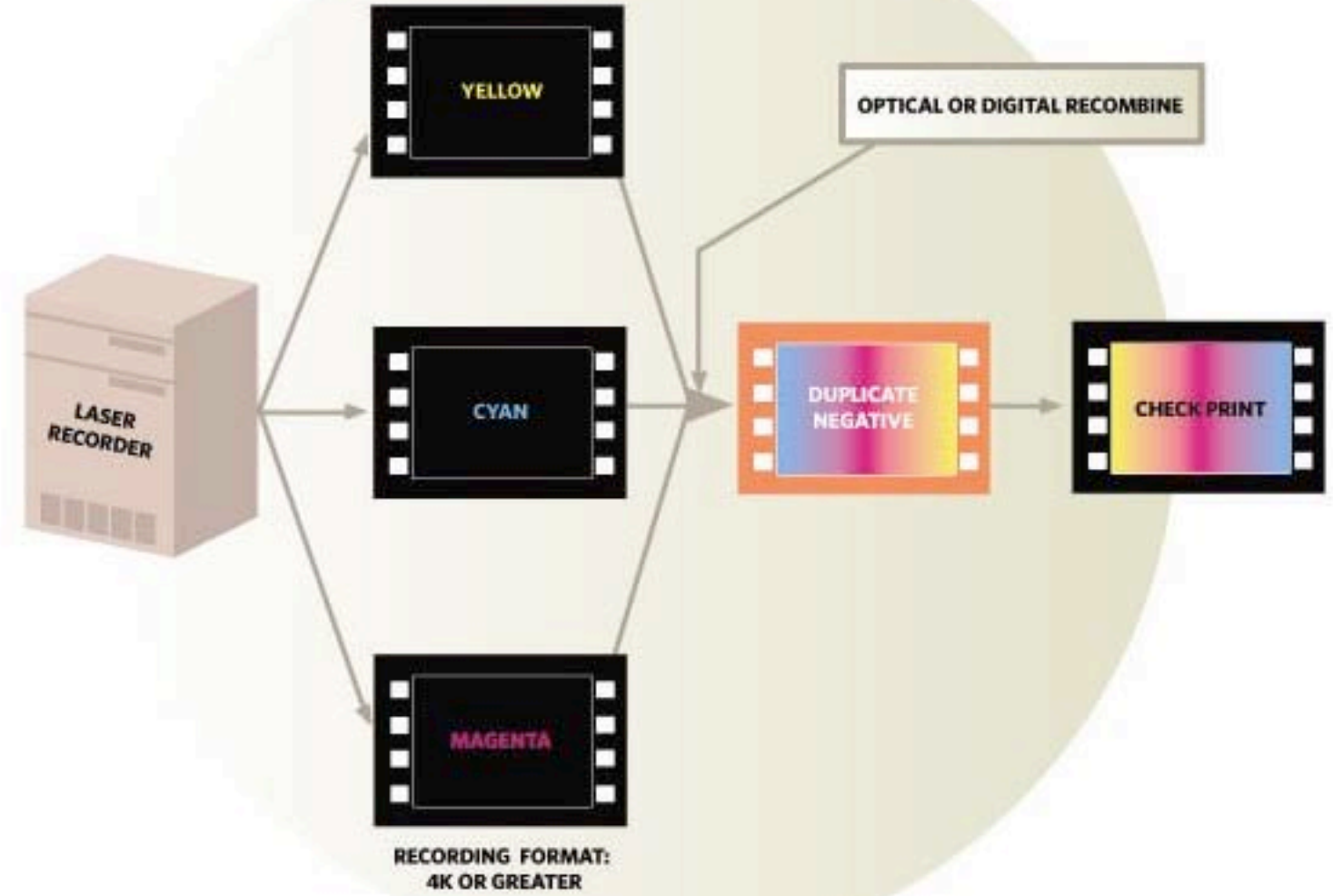
Science and Technology Council





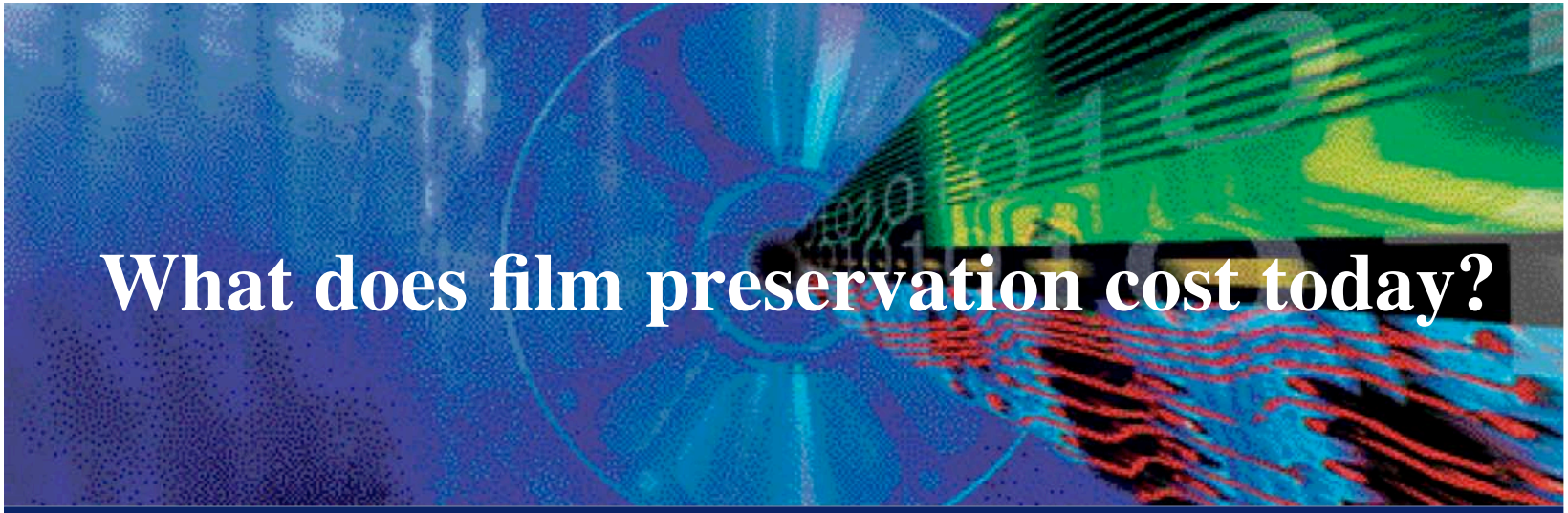
MAKING A DIGITAL YCM SEPARATION ARCHIVAL MASTER
On Black-and-White Polyester Film Stock

Science and Technology Council



How does film preservation in a film archive work today?

Science and Technology Council



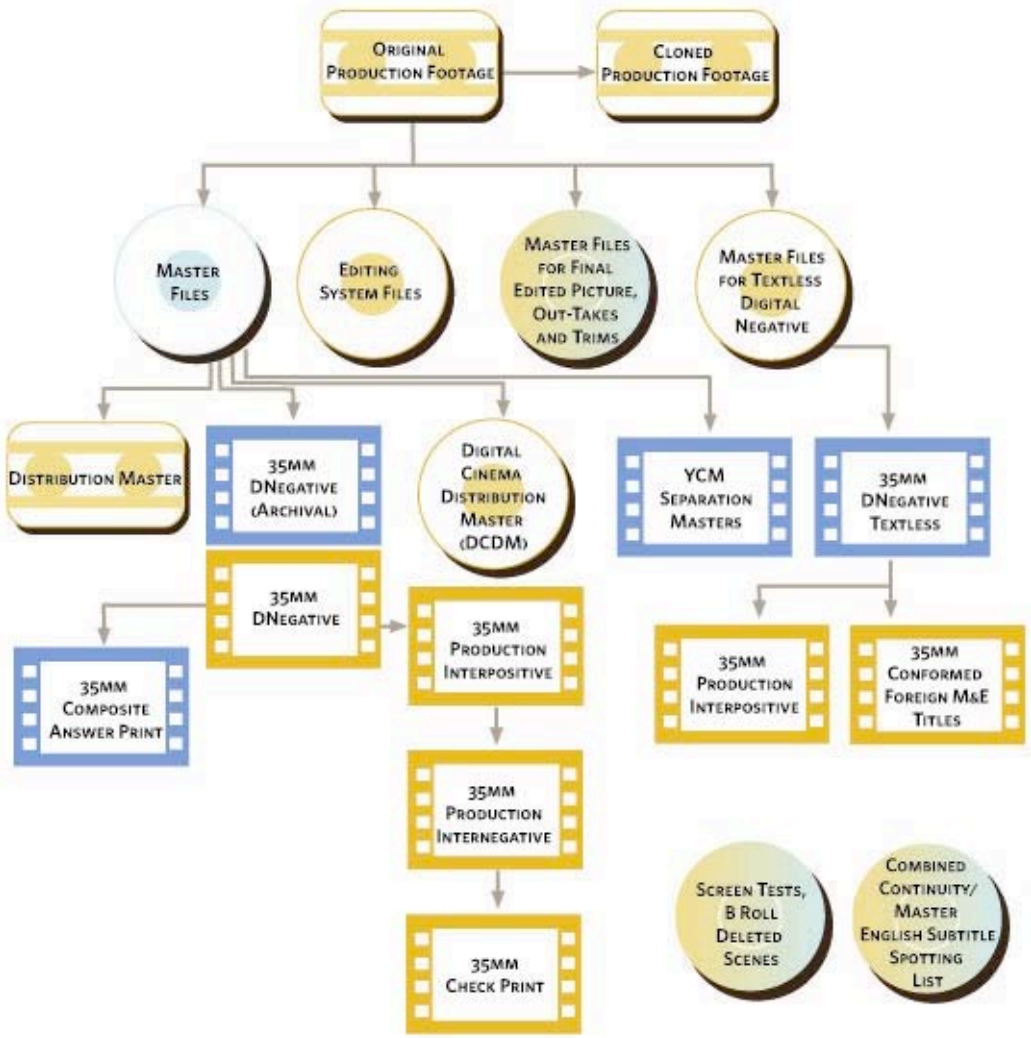
Science and Technology Council

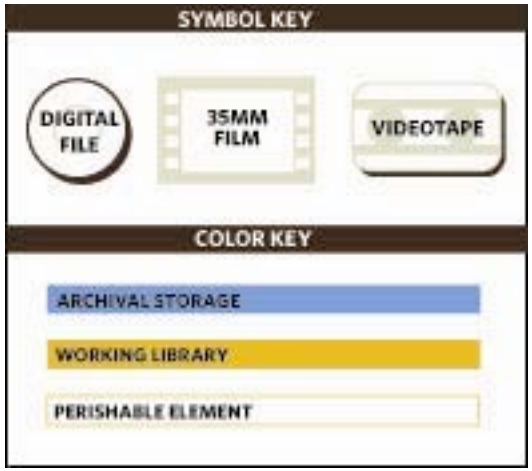
What does film preservation cost today?

- "Store and Ignore" costs ~$1,000/year for the master, ~$500 for the rest
  - $.40/reel in archive conditions
  - $.15/reel in "warehouse" conditions
  - ~260 reels/movie on average (25:1 shooting ratio)
  - Includes $80K mfg cost of film masters

GENERIC MOTION PICTURE ELEMENT TREE:
Picture only, data capture

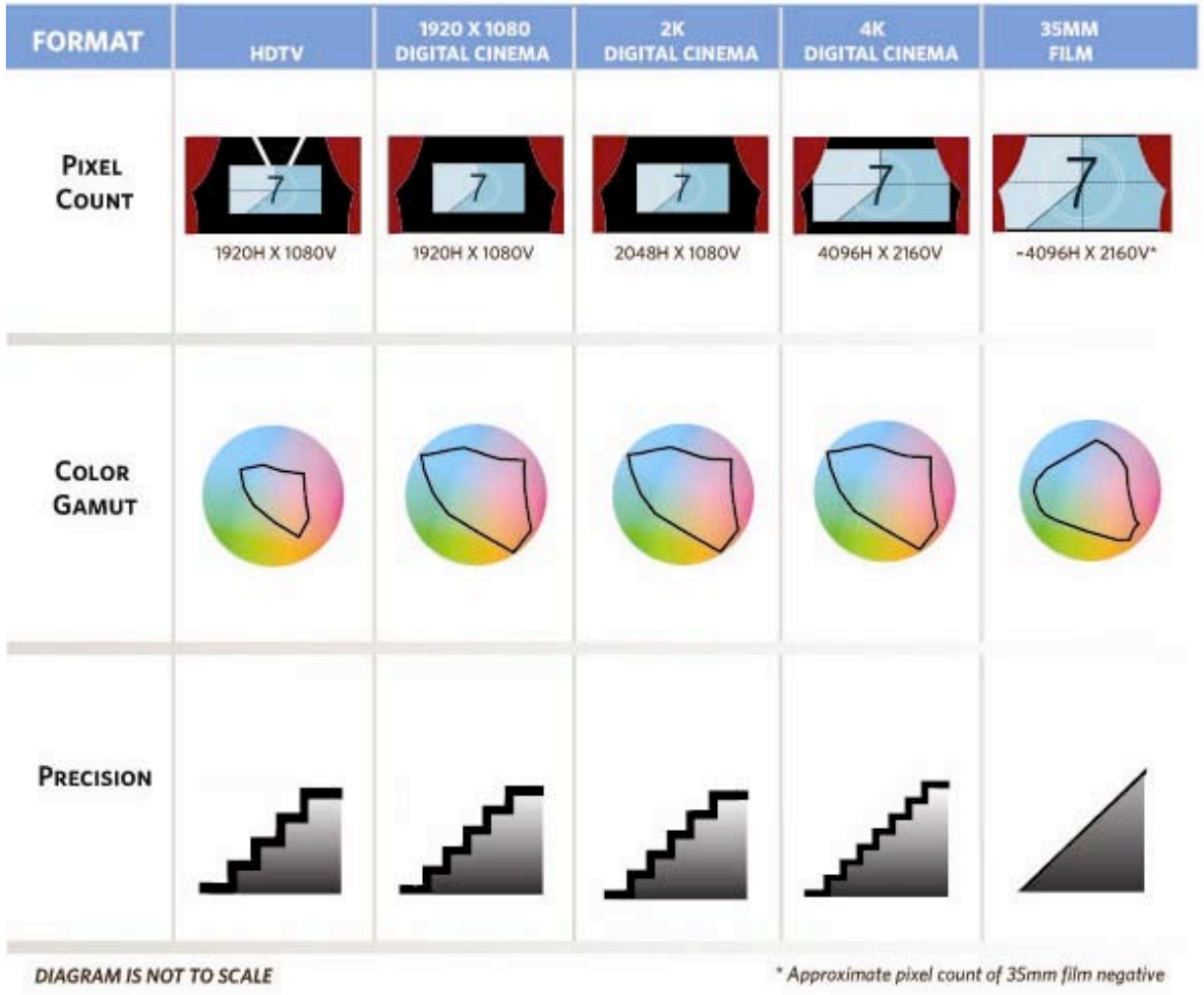
Science and Technology Council





VISUAL ATTRIBUTES
OF MOTION PICTURE IMAGE FORMATS

Science and Technology Council

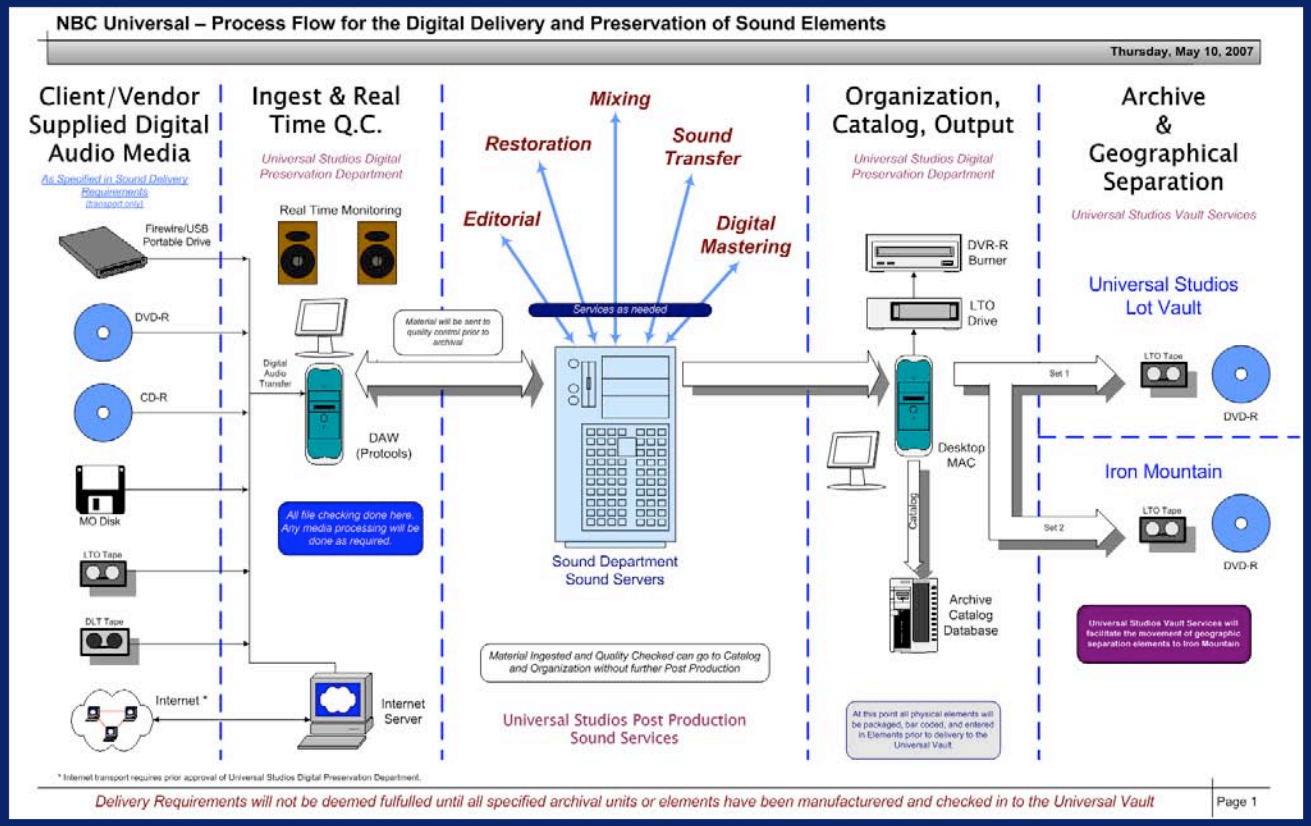


How does digital preservation in a film archive work today?

Science and Technology Council

Science and Technology Council

The industry is waking up: NBC/Universal Studios Sound Archive



Other Efforts in the Motion Picture Industry

Science and Technology Council

- Disney: 7 year metadata case study
  - 9 different ways to spell one property
    - CHIP ‘N DALE
    - CHIP ‘N’ DALE
    - CHIP ‘AN’ DALE
    - Chip n Dale
    - Chip ‘an’ Dale
    - Chip n Dale…
- Academy efforts (more later…)

Science and Technology Council

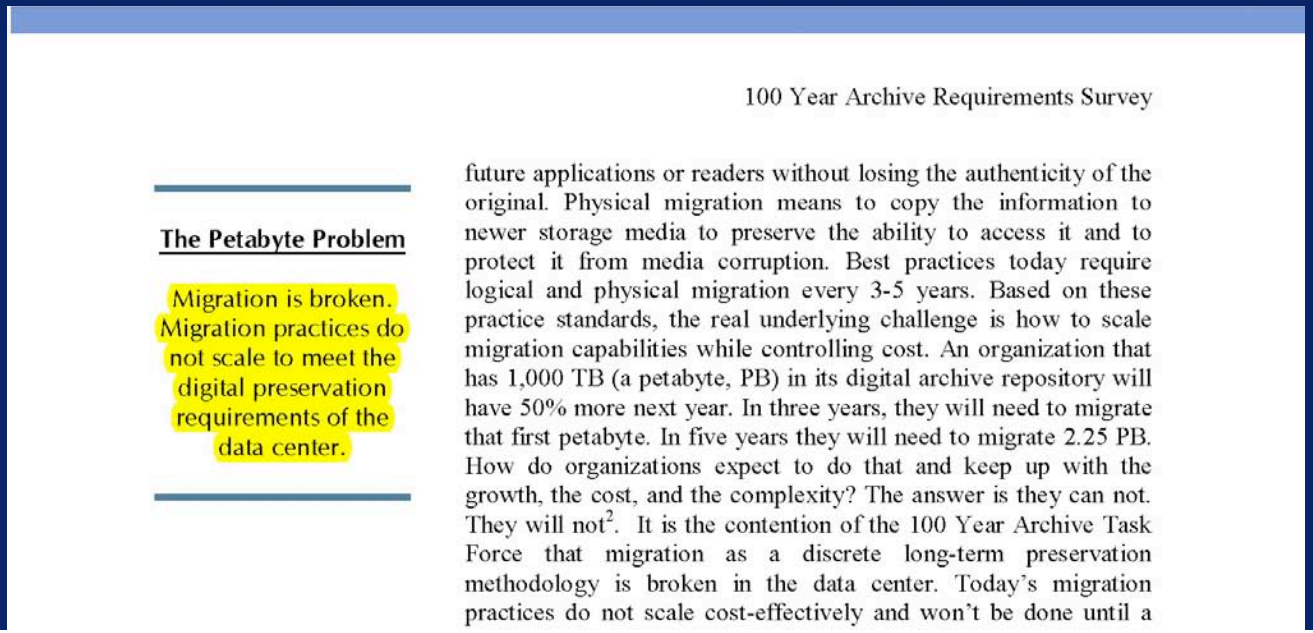
Digital Motion Picture Storage Costs

- 1 movie "master" at 4K = 8.4 TB
  - 53 MB/frame, 24 fps, 120 minutes/movie
- Managed digital tape storage: $500/TB/yr
  - 2006 SDSC study, single copy
- 1 copy of 1 master: $4,171/yr
- 3 copies: $12,514/yr
- Masters + Source: >$200,000/yr (!)

Science and Technology Council

Current technologies and practice are inadequate for motion pictures

- Several instances of nearly unrecoverable data
- SNIA 2007 Report: "Migration is Broken"



100 Year Archive Requirements Survey

The Petabyte Problem

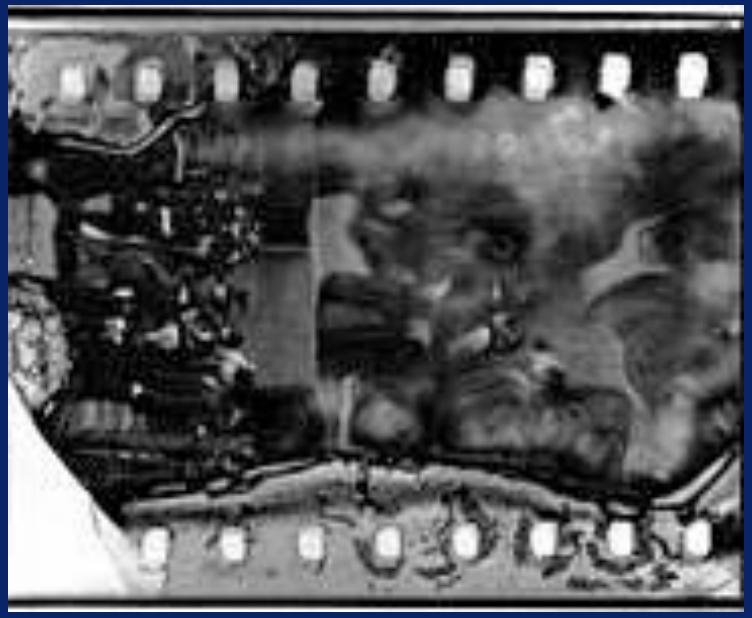
Migration is broken. Migration practices do not scale to meet the digital preservation requirements of the data center.

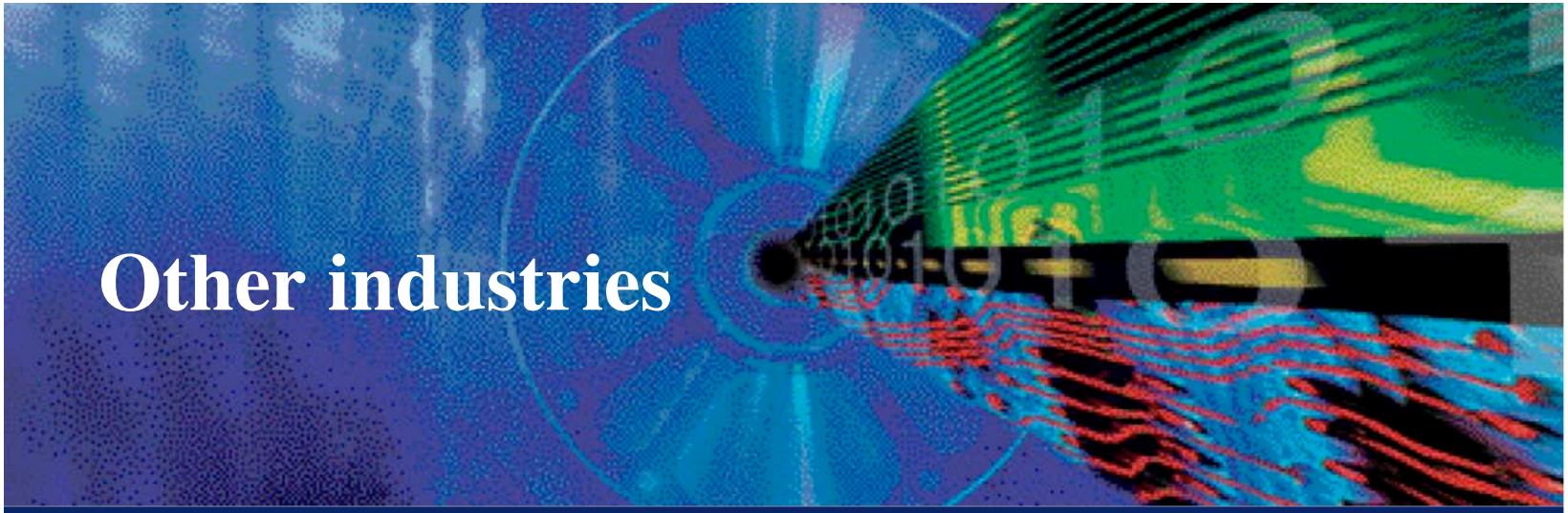
future applications or readers without losing the authenticity of the original. Physical migration means to copy the information to newer storage media to preserve the ability to access it and to protect it from media corruption. Best practices today require logical and physical migration every 3-5 years. Based on these practice standards, the real underlying challenge is how to scale migration capabilities while controlling cost. An organization that has 1,000 TB (a petabyte, PB) in its digital archive repository will have 50% more next year. In three years, they will need to migrate that first petabyte. In five years they will need to migrate 2.25 PB. How do organizations expect to do that and keep up with the growth, the cost, and the complexity? The answer is they can not. They will not[2]. It is the contention of the 100 Year Archive Task Force that migration as a discrete long-term preservation methodology is broken in the data center. Today's migration practices do not scale cost-effectively and won't be done until a

If nothing changes….

Science and Technology Council

- This could be a period of “Digital Nitrate”





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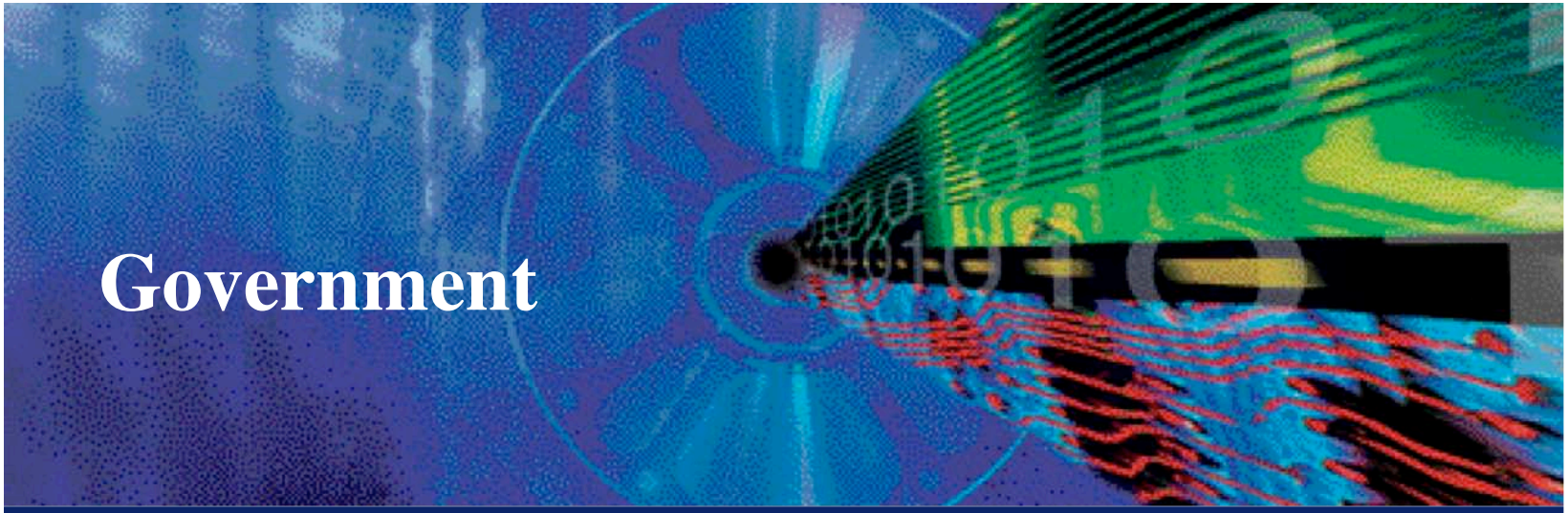
Other industries

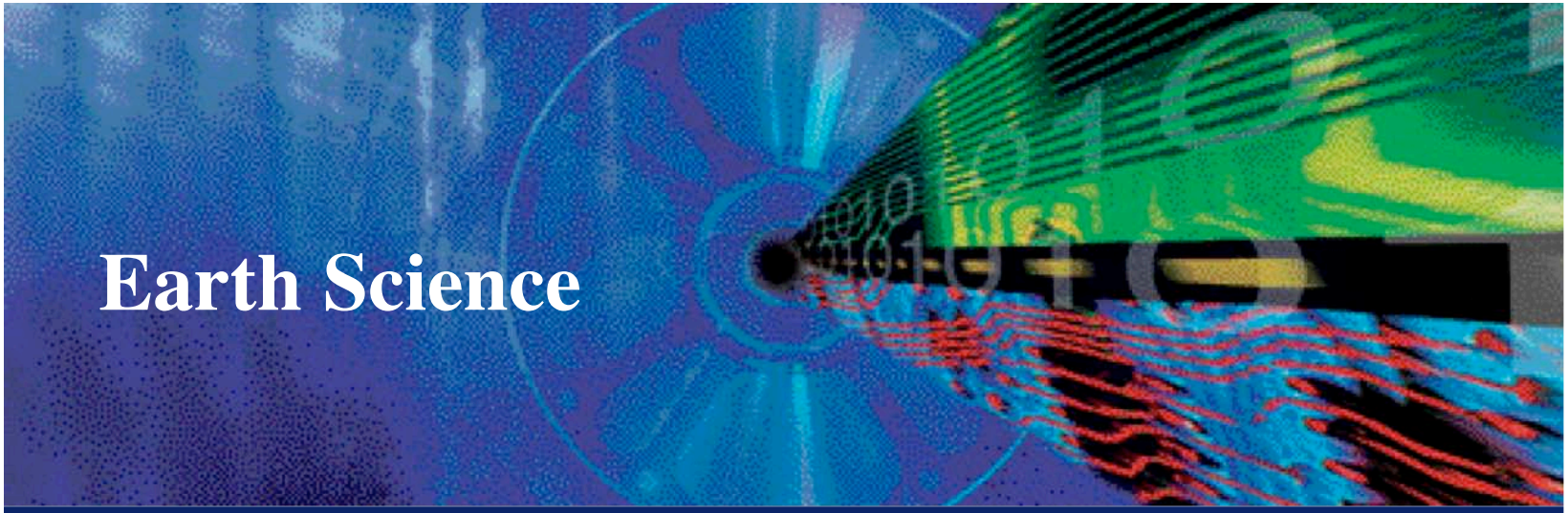
- Corporate
- Government
- Medical
- Earth Science
- Supercomputing



Government

Science and Technology Council

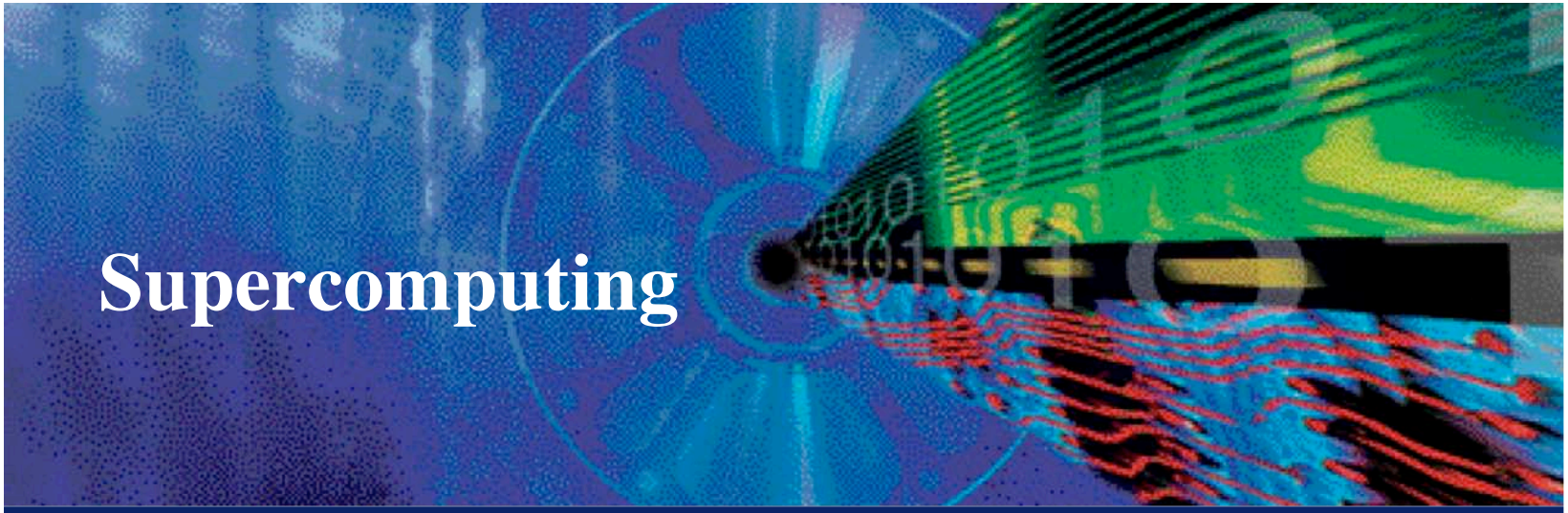
- NARA
  - Preserves some government records “for the life of the Republic”
  - 800 million presidential emails to be processed starting January 22, 2009
  - 1000s of FOIA lawsuits to respond to after January 22, 2009
  - 8 archivists to process ALL of the presidential records



Earth Science

Science and Technology Council

- Oil and gas exploration
  - Similar to motion pictures:
    - Large data sets (many 200 TB data sets per survey)
    - New value from old data
  - Experiencing difficulties with archiving data
    - Migration is problematic
    - No standards
    - Locked in to vendor-specific solutions



Supercomputing

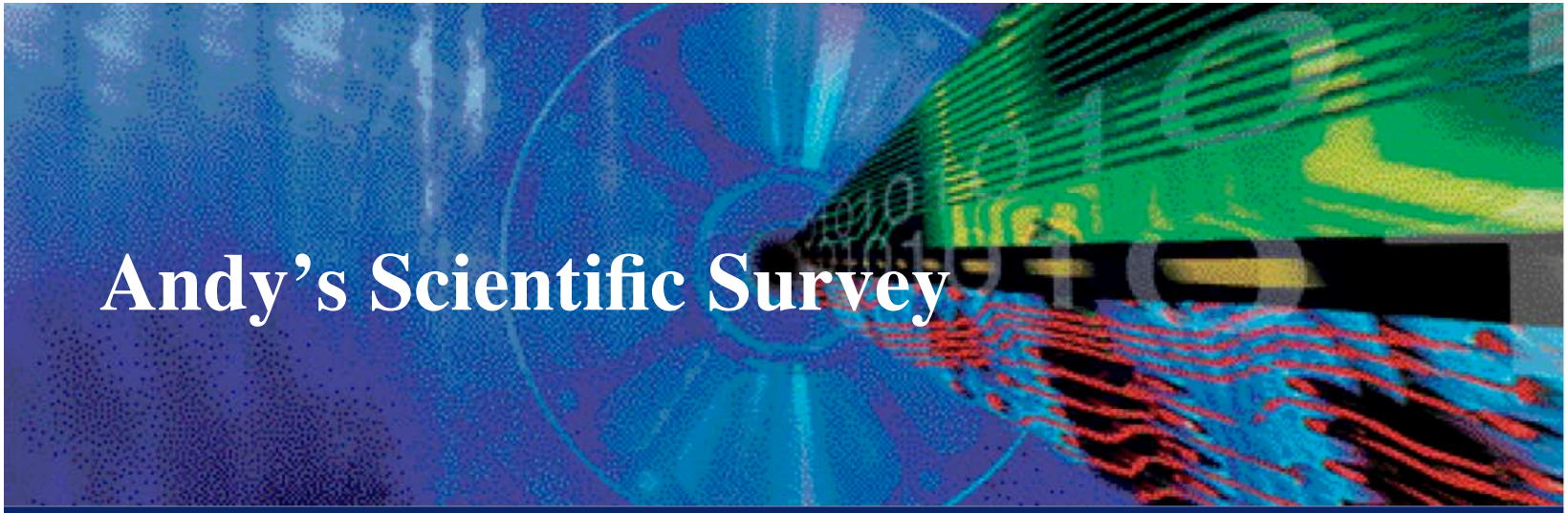
Science and Technology Council

- San Diego Supercomputer Center
  - Thorough cost analysis
  - Dealing with migration
  - Exploring distributed storage strategies
  - Biggest risk: uninterrupted funding

Two major findings

Science and Technology Council

- Every enterprise we spoke with has similar problems and issues with digital preservation
- No enterprise yet has a long term strategy or solution that does not require significant and ongoing capital investment and operational expense



Andy's Scientific Survey

Science and Technology Council

- How many of you use a digital still or video camera?
- How many of you:
  - back up your image data?
  - make multiple copies?
  - practice biodiversity?
  - geographic separation?
- Any of this in the last 3 months?

Step 2: Define the requirements for Digital Motion Picture Preservation

Science and Technology Council

- Access guaranteed for at least 100 years
- Assets survive periods of benign neglect
- The digital system should be at least as good as the photochemical system it replaces
- We don’t know what we’re willing to pay, but $500/TB/yr is too much

Step 3: Academy Digital Motion Picture Archival Framework Project

Science and Technology Council

- Participating in LC NDIIPP Preserving Creative America effort
- Digital preservation case study: StEM collection
- File format development/standardization: Acquisition, Mastering, Archive
- The devil is in the metadata/registry details

Academy Digital Motion Picture Archival Framework Project – cont'd

Science and Technology Council

- A follow-on report: independent film-makers, public archives
- Education efforts and seminars
- Directed research (proposed):
  - Early warning of data deterioration
  - Alternate image recording techniques and media
  - Data compression for motion picture archives
  - Preservation of digital content creation tools

Step 3A: Engage core technology providers

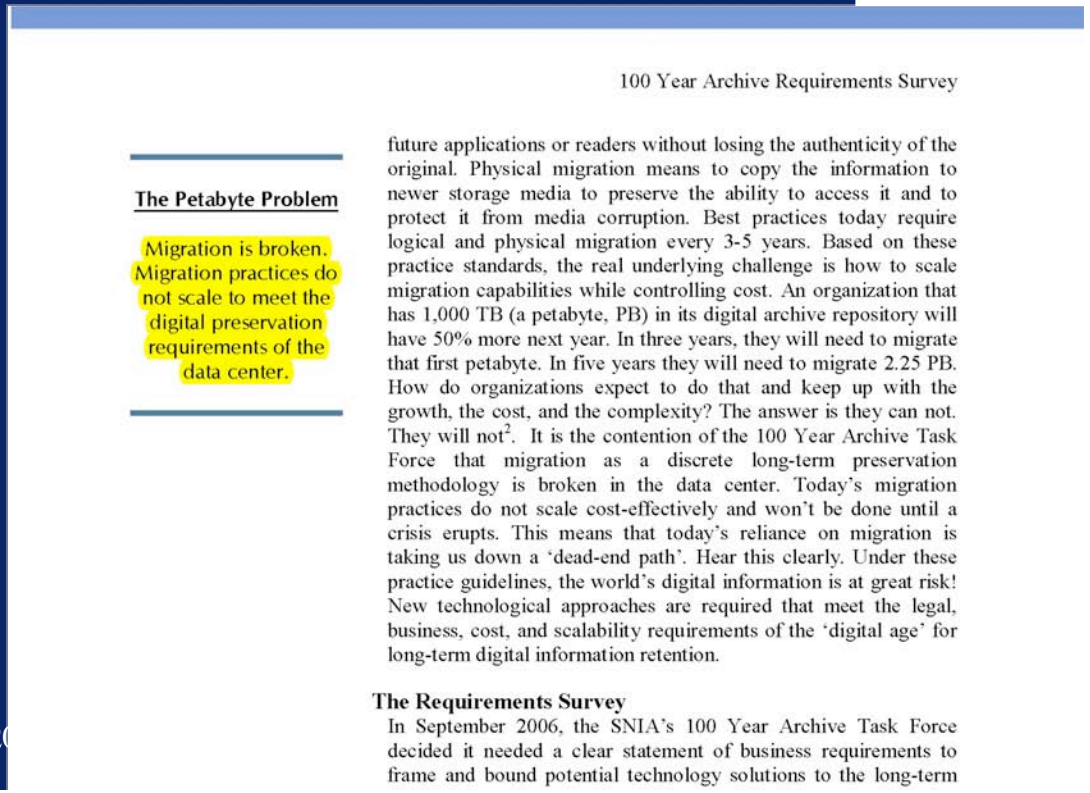
Science and Technology Council

- There are technical issues the end users can't solve:
  - Storage TCO does not decline over time
    - Labor, energy, system "stack"
  - Network and device bandwidth is not keeping up with increased storage demands
    - Time to migrate can exceed data lifetime

Challenge (and opportunity)

Science and Technology Council

- Look at the problem in a different way
- Take migration off the table



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The Petabyte Problem

Migration is broken. Migration practices do not scale to meet the digital preservation requirements of the data center.

future applications or readers without losing the authenticity of the original. Physical migration means to copy the information to newer storage media to preserve the ability to access it and to protect it from media corruption. Best practices today require logical and physical migration every 3-5 years. Based on these practice standards, the real underlying challenge is how to scale migration capabilities while controlling cost. An organization that has 1,000 TB (a petabyte, PB) in its digital archive repository will have 50% more next year. In three years, they will need to migrate that first petabyte. In five years they will need to migrate 2.25 PB. How do organizations expect to do that and keep up with the growth, the cost, and the complexity? The answer is they can not. They will not[2]. It is the contention of the 100 Year Archive Task Force that migration as a discrete long-term preservation methodology is broken in the data center. Today's migration practices do not scale cost-effectively and won't be done until a crisis erupts. This means that today's reliance on migration is taking us down a 'dead-end path'. Hear this clearly. Under these practice guidelines, the world's digital information is at great risk! New technological approaches are required that meet the legal, business, cost, and scalability requirements of the 'digital age' for long-term digital information retention.

The Requirements Survey

In September 2006, the SNIA's 100 Year Archive Task Force decided it needed a clear statement of business requirements to frame and bound potential technology solutions to the long-term

Challenge/opportunity - 2

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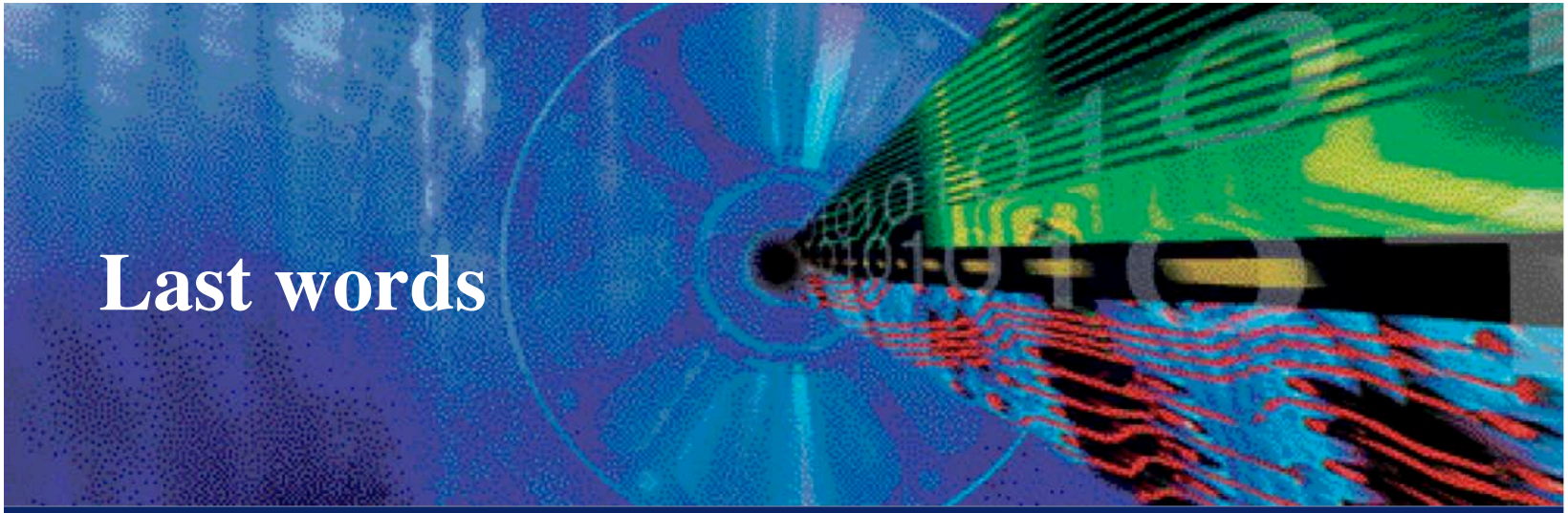
- Consider “true” Total Cost of Ownership in your thinking
- Define “digital archiving” for each market
  - Corporate: 7 years
  - Medical: patient lifetime (pediatrics)
  - Earth Science, Government, Motion Pictures: 100 years
- New product category(?) - Digital Archive (not asset) Management System



Last words

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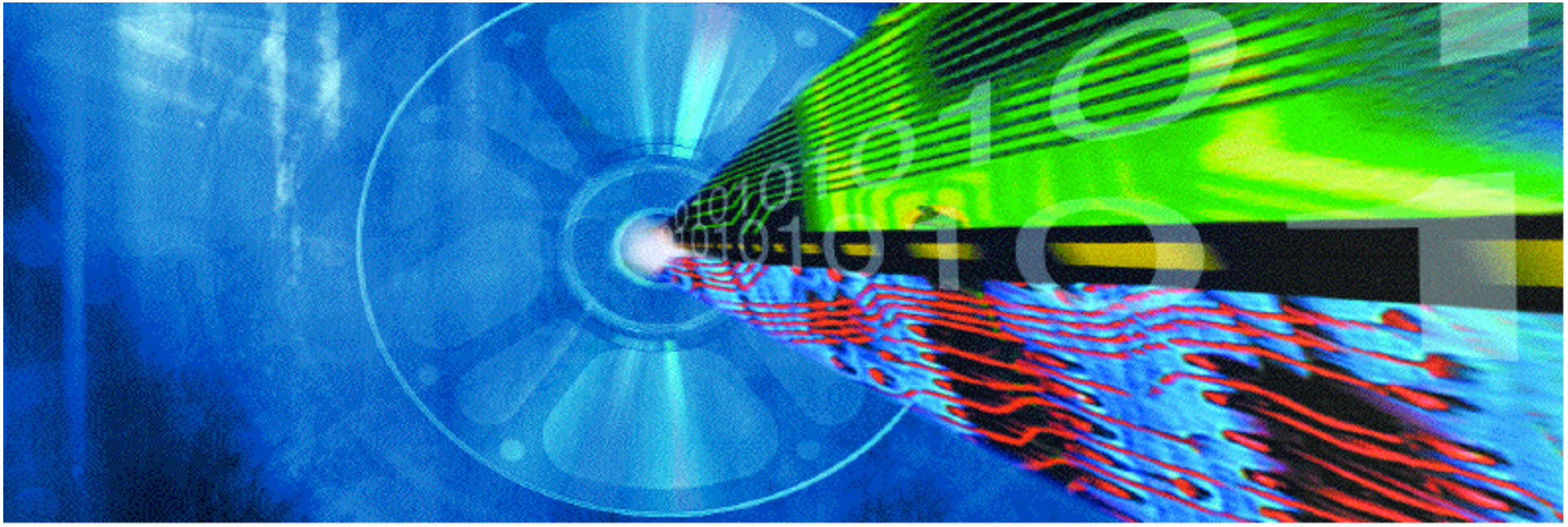
"We can't solve problems by using the same kind of thinking we used when we created them"

*Albert Einstein



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ACADEMY OF MOTION PICTURE ARTS AND SCIENCES

THE DIGITAL DILEMMA

STRATEGIC ISSUES IN ARCHIVING AND ACCESSING DIGITAL MATERIALS

Thank you!