



\ ACADEMY COLOR ENCODING SYSTEM \

A STANDARD FOR LONG-TERM ARCHIVING OF
DIGITAL MOTION PICTURE MATERIALS

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The Academy of Motion Picture Arts and Sciences



Topics

- What the Academy has been up to on this front in the last 6 years
- The erosion of motion picture standards
- ACES 1.0 – brief description, standardization, archiving impact and plan
- Your Call to Action

The Digital Dilemma



Downloads:>500 this year

Added: Korean
Marathi

Coming: Chinese
Hindi

The Digital Dilemma 2



Published in 2012

Downloads: >400
this year

Added: Korean
Brazilian Portuguese

Coming: Japanese
Chinese



Review: TDD Key Consensus Finding

8.2 Long Term Initiatives

The motion picture industry should organize itself to speak with a common voice on matters of digital archival technology and solutions.

THOSE INTERVIEWED FOR THIS REPORT AGREED THAT ACTIONS can be taken to produce better solutions for long-term digital preservation and access than we have today. The Science and Technology Council's goal is to move these notions from just being written about to being acted upon.

1 Collaborations

We stated earlier that the motion picture industry should organize itself to speak with a common voice on matters of digital archival technology and solutions, thus enabling it to effectively join forces with other industries that have similar needs with respect to digital preservation and access. This is not a problem that can be solved without great leverage – there needs to be a consortium of end-users, i.e., customers, who can economically scale their demands to make it attractive for vendors to agree to open standards. We point to the audiocassette, CD, 35mm film and for a while, the DVD, as examples of this. Many, many companies were successful in manufacturing, distributing and selling these standardized formats. They did not need proprietary “secret sauce” to be successful in creating and servicing their markets.

There are a number of examples of cross-industry collaboration, the most notable of which, for our purposes, is the National Digital Information Infrastructure Preservation Program (NDIIPP), created by the Library of Congress (discussed earlier in this report). The Library acknowledged that the scope of this problem is simply too large for any organization, even the United States government, to tackle on its own. The NDIIPP program currently funds more than 16 external partners working on digital preservation research and collections, and the Library is engaged in numerous digital preservation-related partnerships with notable institutions including the National Archives and Records Administration, the National Science Foundation, and the Digital Library Federation, as well as digital preservation initiatives abroad.

In August 2007 the Academy and the Library of Congress announced the Academy's participation in NDIIPP's Preserving Creative America project, a joint effort to address the issues of digital preservation as they relate to theatrical motion pictures. Participation in this program will bring increased visibility to the motion picture industry's needs, and it is hoped that we will also discover new ideas that will lead to better solutions for the industry. Topic areas of this joint effort include:

- a report on the Digital Dilemma from the perspective of the independent filmmaker and smaller, public film archives
- development of a digital preservation case study system to investigate various digital motion picture archival strategies
- development of requirements and specifications for digital file formats that support long-term digital preservation
- education and research activities related to digital motion picture preservation

This is just one example of the opportunities available to leverage the efforts of several organizations and industries toward a common goal.

2 Standards Development

While we have heard conflicting advice from other industries on the value of standards with respect to digital preservation, it is clear that the motion picture industry has benefited, and indeed would not exist, without worldwide standards for the interchange of motion picture content. International standards have the added

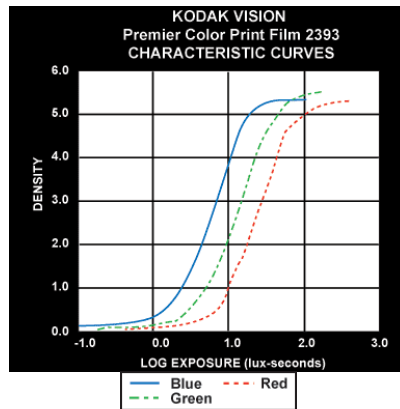
CONSENSUS



THE MOTION PICTURE INDUSTRY WAS BUILT ON STANDARDS

- The picture “container” is described by standards: 35mm film, sprockets, aperture: SMPTE ST 93, ST 139, ST 59, etc.
- The picture “metadata” is described by standards: raw stock identification, keycode: ST 184, ST 254
- Supporting system pieces are described by standards: reel cores, leader: ST 37, ST 301
- Best practices are covered by RPs and EGs: RP 53 (scene change methods for printing film), EG 3 (Projection for Technical Conferences)
- Image format technical specs and procedures: provided by a small number of leading companies within this standardized framework

Using KODAK Kit Chemicals in Motion Picture Film Laboratories

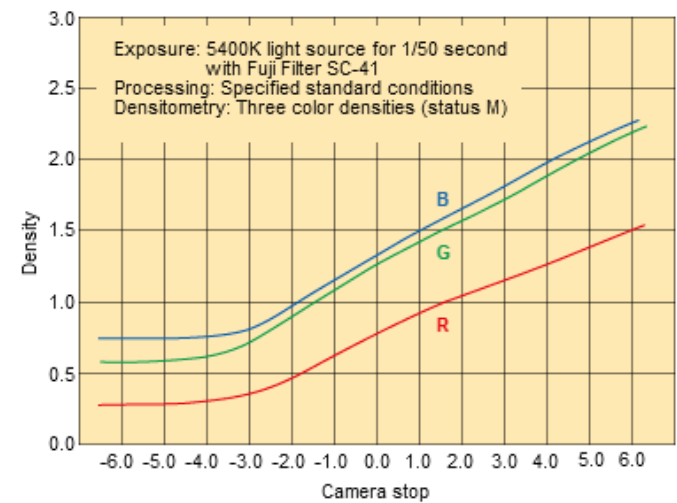


This publication is written especially for laboratory operators. It provides the most commonly used technical information about film processes for using KODAK ECN-2 Kit Chemicals and KODAK ECP-2D Kit Chemicals in your motion picture laboratory. Using KODAK Kit Chemicals will help you provide optimum results with the least environmental impact possible. This publication describes the processing cycles recommended for processing KODAK Motion Picture Negative Films and KODAK Motion Picture Print Films.

This manual is divided into five sections:

- Chemicals and Chemical Handling
- KODAK ECN-2 Kit Chemicals
- KODAK ECP-2D Kit Chemicals
- Process Monitoring and Troubleshooting
- Appendix/Index

For more detailed information on processing, see KODAK Publication No. H-24, *Processing KODAK Motion Picture Films*, or the Entertainment Imaging Internet site www.kodak.com/go/motion.



Kodak

THESE STANDARDS ENABLED MANY
DECADES OF QUALITATIVE
IMPROVEMENTS

IN THE TRANSITION TO DIGITAL, WE LOST STANDARDIZED INFRASTRUCTURE

- 1990s, 2000s - Digital VFX/Intermediate
 - film capture → process digitally → film out → archive film
- 2000s, 2010s - Digital Projection
 - film capture → process digitally → DCP → archive film-out
- 2010s - All Digital
 - digital capture (mostly) → process digitally → DCP → archive??

FOR MOTION PICTURE PRODUCTION AND ARCHIVES:

- No standard container other than DPX
- No standard metadata
- No standard image specifications other than 2K/4K
- No RPs and EGs
- Q.E.D. no standardized infrastructure in the digital world

BUT BOX OFFICE HAS NEVER BEEN HIGHER!

- True
- The industry is great at “making things work”
- The thing: digital projection at answer print quality

THE OTHER THINGS

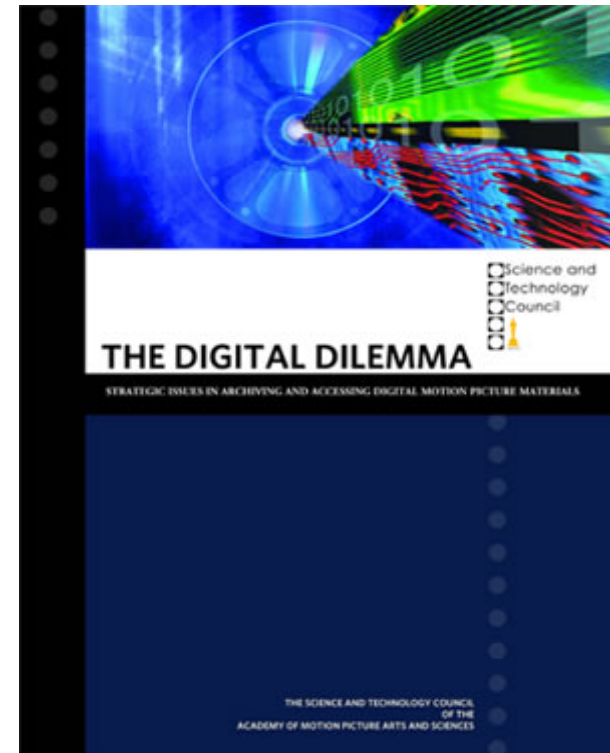
- Next Generation Cinema
 - High Dynamic Range
 - Wider color gamuts
 - VR? Computational Cinematography?



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ANOTHER OTHER THING

- The Digital Dilemma – Not Solved
- Standards?



A cursory survey of motion picture standards

- 800+ SMPTE standards published since 1916:
 - 398 motion picture standards:
 - 332 are film standards
 - 66 are digital standards – most cover digital projection (377, 422, 428-433 series)*
 - 18 cover Production, Mastering, and Archiving*: 2K/4K, DPX, ACES, IMF, Color Volume Metadata, HDR EOTF, MXF, AXF
 - Is digital really 1/5th as complicated as film?

*+/- depending on how you count, not including sound



Upstream in production and downstream in the archives:

- Insufficient standardized picture format technical specifications
- Insufficient standardized picture containers
- Insufficient standardized picture metadata
- Few standardized supporting pieces – packaging, labeling, RPs and EGs

Enter ACES

ACES is a free, open, device-independent color management and image interchange system that enables creation of digital masters suitable for long-term archiving

ACES IS NOT

- A software application you can download and run
- A workflow
- A “look”

ACES IS

- A suite of encoding specifications
- Transform definitions and guidelines
- Metadata definitions
- Archive-ready image data and metadata container specifications
- Developer tools
- Standardized by SMPTE, soon by ISO

ACES IS IN PRODUCTS FROM THESE COMPANIES

ARRI

Assimilate

Autodesk

Canon

Codex

ColorFront

Deluxe

Digital Vision

Dolby Laboratories

FilmLight

FotoKem

The Foundry

Fujifilm North America

Light Illusion

MTI Film

Panasonic

Pomfort

Quantel

RED DIGITAL CINEMA

SGO

Shotgun Digital

Sony Electronics, Inc.

Technicolor



Look for this Logo



ACES Benefits

- Maintains maximum image fidelity throughout the workflow
- Enables consistent color reproduction across all phases of production and post-production
- Clearer communication of creative intent from Set to VFX, Editorial and DI
- Puts an end to “snowflake workflows”
- Enables high dynamic range and wide color gamut deliverables
- Provides a path to an archive-ready digital source master
- Defines an archival source master



ACES has a substantial development history

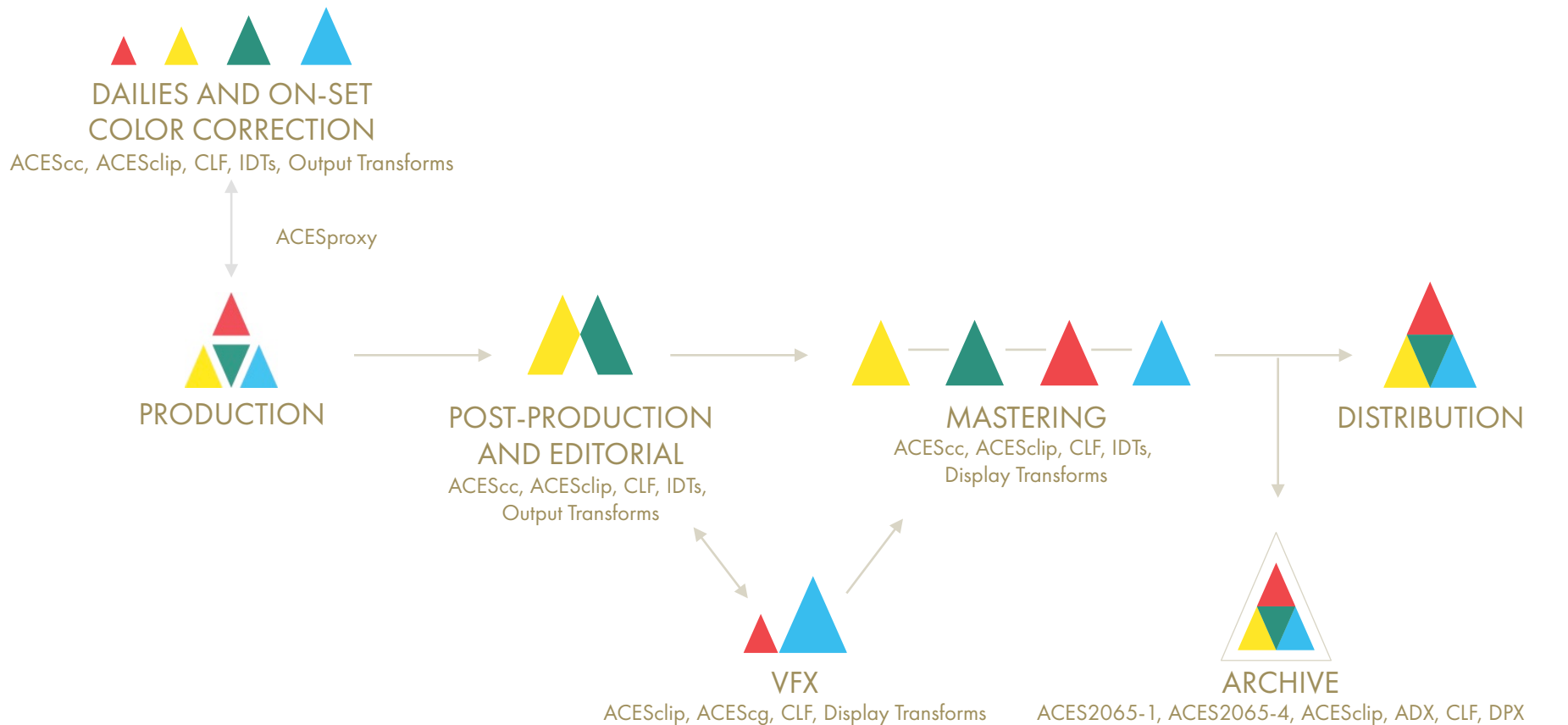
- Architecture development began in 2004
- Early focus: color management, future-proof design
- Field trials began in 2011
- Iterative architecture refinements based on field experience
- First SMPTE standards published in 2012 and 2013
- ACES 1.0 released in December, 2014



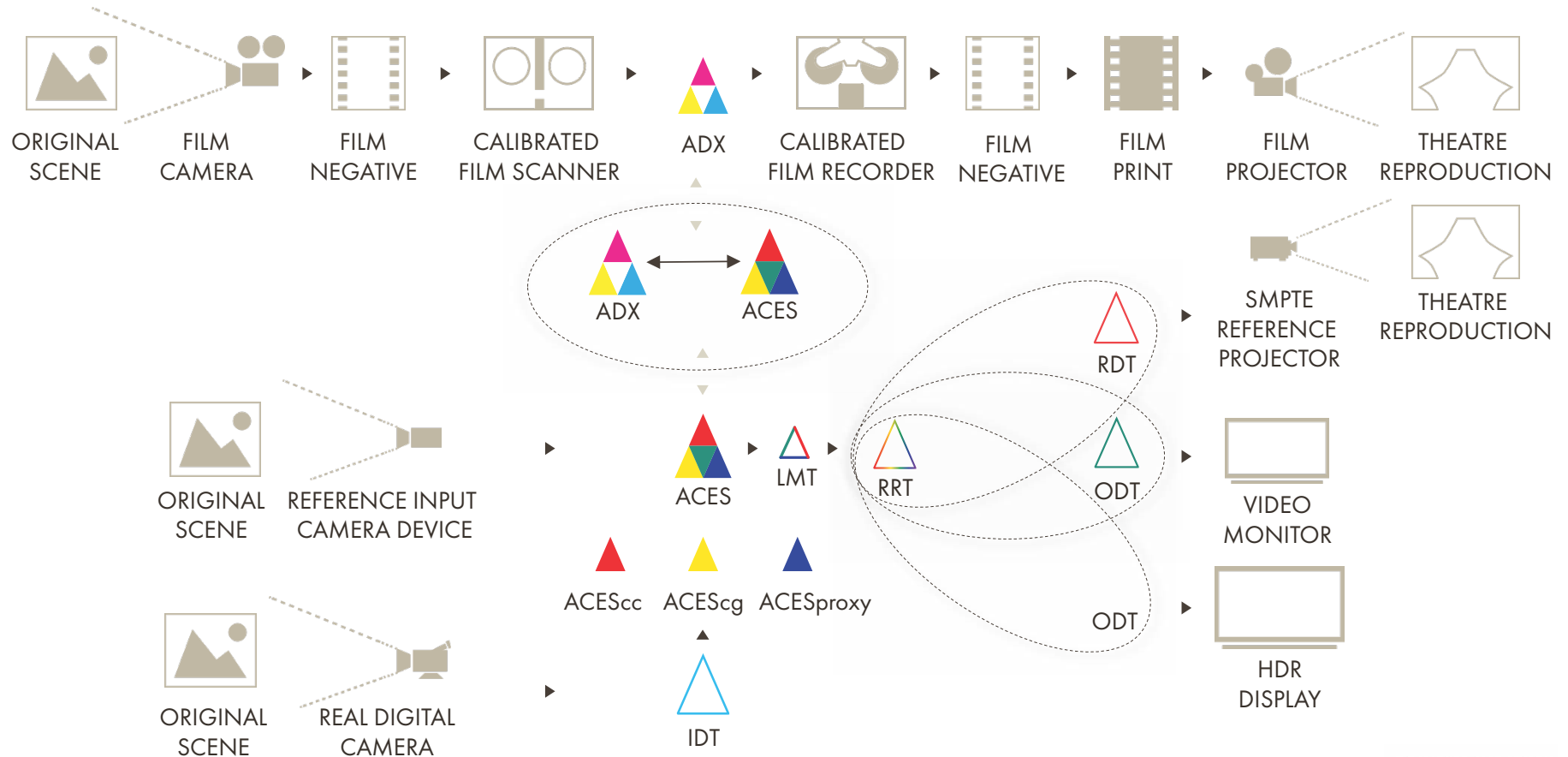
ACES in Production

- Many movies, television shows and commercials
- See IMDb.com and ShotOnWhat.com for a list of ACES productions (search instructions at oscars.org/aces)

ACES: A PRODUCTION-CENTRIC VIEW



ACES: AN ENGINEERING-CENTRIC VIEW



ACES 1.0 Key Components

- Image Encodings:
 - Colorimetric Encoding, aka “ACES 2065-1”
 - Covers the entire spectrum locus (all visible colors)
 - 16-bit floating point (high precision)
 - Encodes 30 stops of dynamic range
 - RGB not XYZ (better suited for many color operations, easier to see if an image is “right”)
 - Suitable for archiving

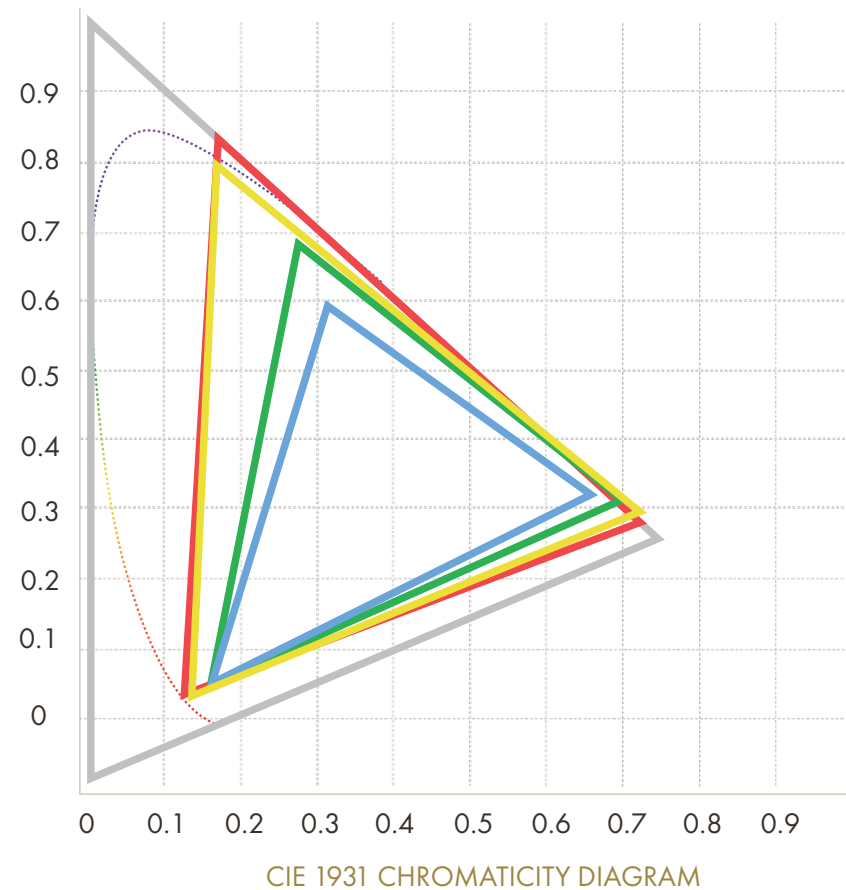
ACES Image Encodings

NEW: AP1 Primaries

ACEScc

ACEScg

ACESproxy

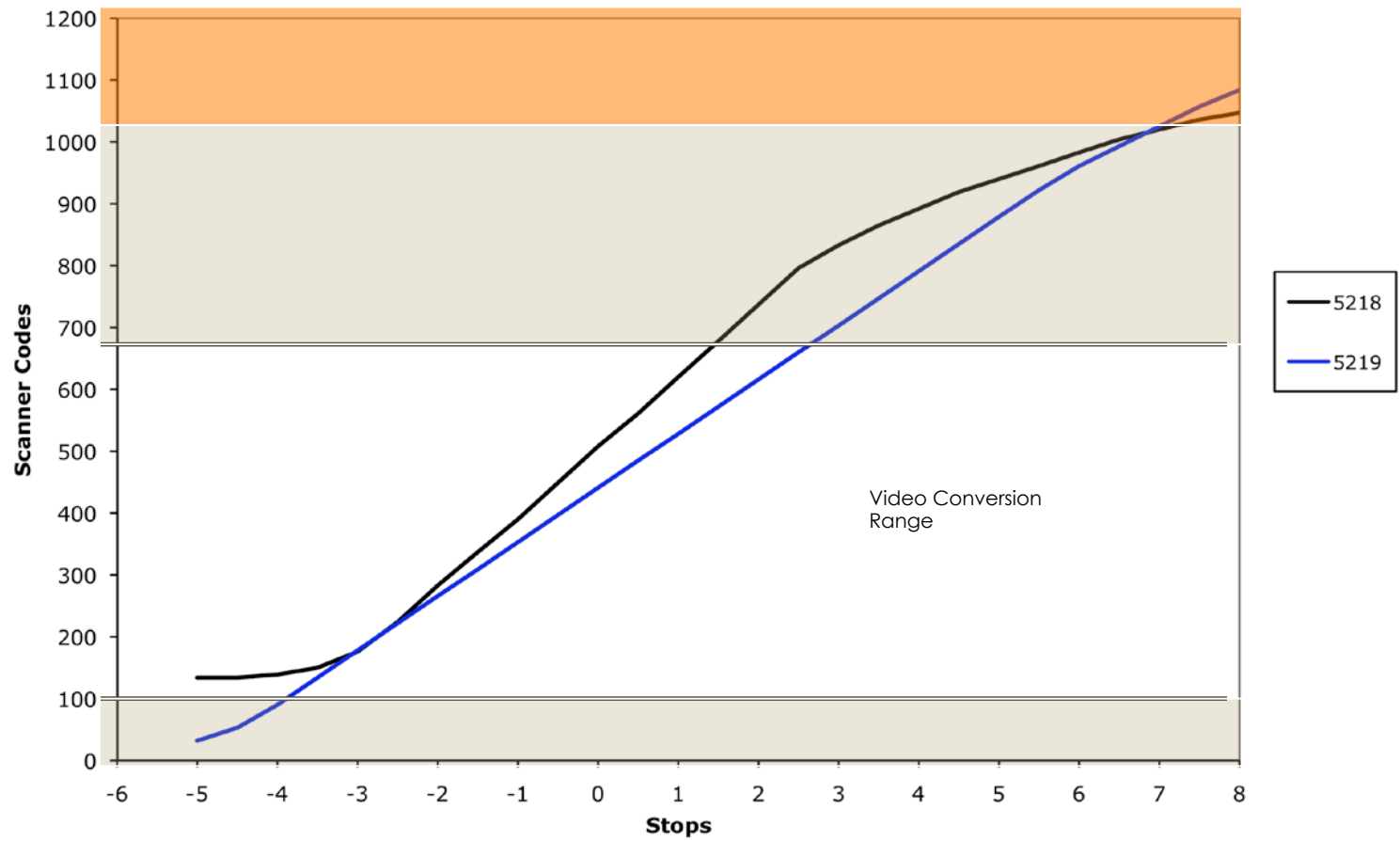


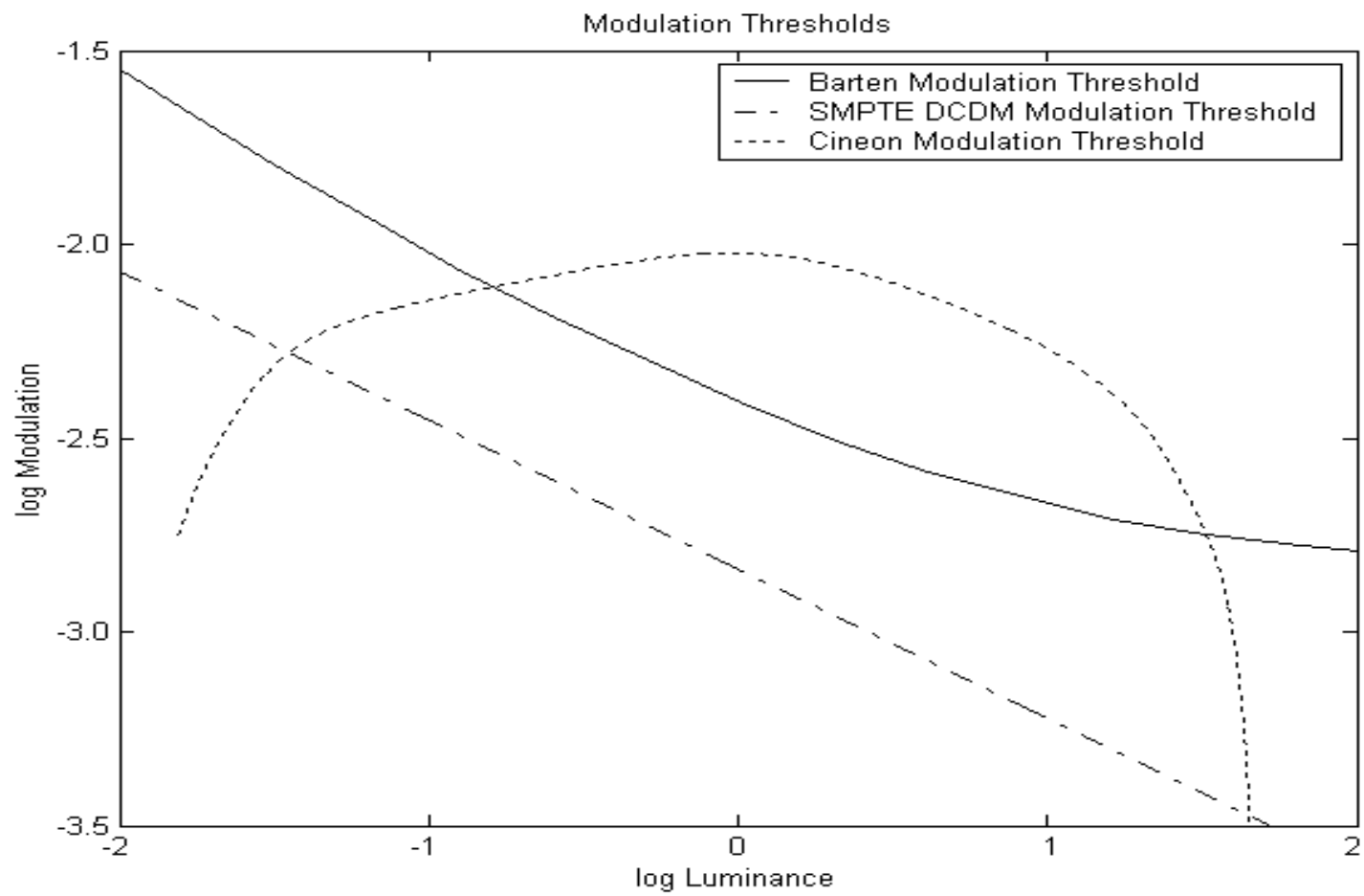
- ▲ ACES2065-1
- ▲ AP1
- ▲ REC. 2020
- ▲ DCI-P3
- ▲ REC. 709

ACES 1.0 Key Components

- Image Encodings:
 - Densitometric Encoding, aka “ADX”, ACES 2065-3
 - There’s still plenty of film being shot, and a LOT that will be re-scanned for HDR release
 - 10-bit Cineon is insufficiently defined and insufficiently precise

Film Characteristic Curves





ACES 1.0 Key Components

- Image Data Containers
 - Container for ACES2065-1 data, aka “ACES2065-4 files”
 - Constrained OpenEXR: widely used in VFX, open source software toolkit
 - Yes, the files are bigger than 10-bit DPX (and disk drives get bigger and networks get faster every year)
 - ACES2065-4 files are not passed around on-set or in editorial

ACES 1.0 Key Components

- Image Data Containers
 - Container for ADX data, aka “DPX”
 - Again, no reason to invent a new file format
 - Added flags to SMPTE ST 268 for 16-bit ADX-encoded data

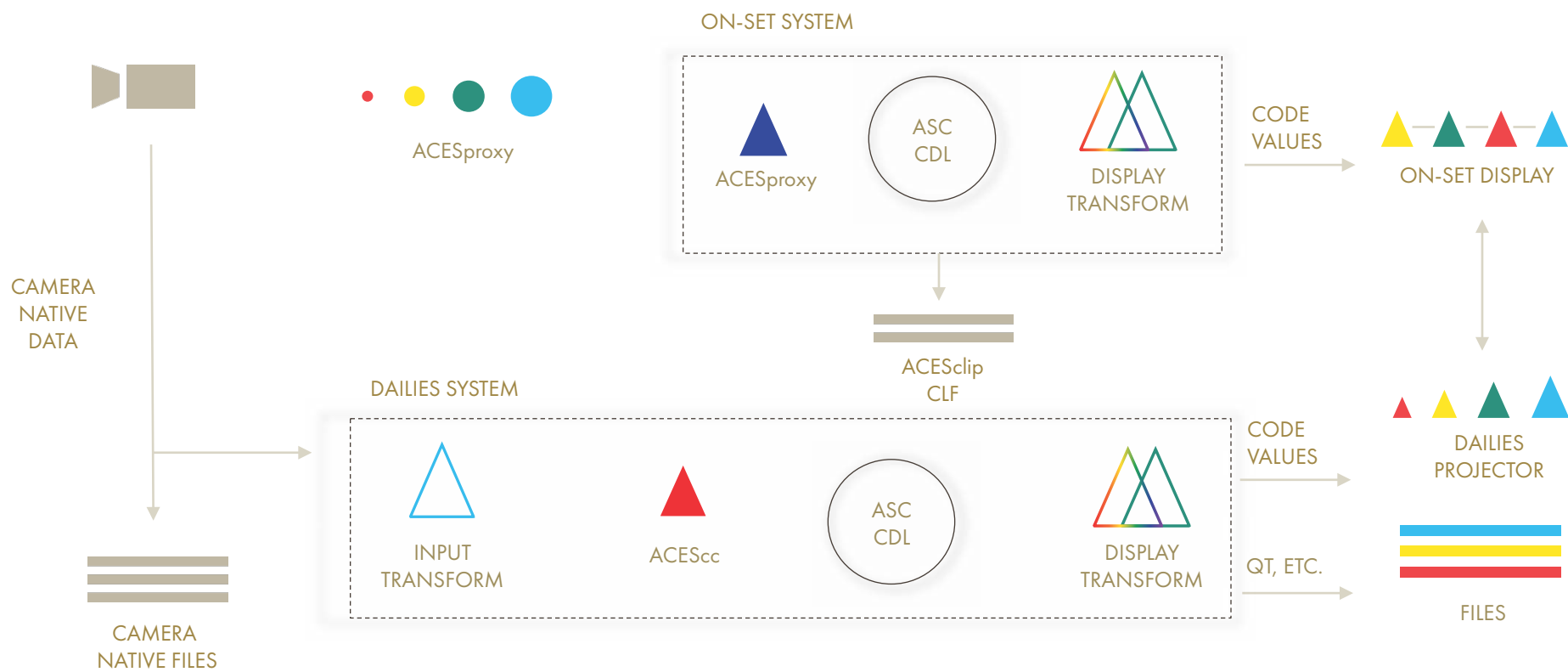
ACES 1.0 Key Components

- Essential Metadata
 - Color pipeline metadata: ACESclip XML file
 - Required: ACES System Version, ACES Display Transform
 - A lot of optional elements
 - Full ACES metadata specification in Academy TB-2014-009 ACES Clip-level Metadata File Format Definition and Usage
 - Common LookUp Table (LUT) Format
 - There will always be image transforms of one kind or another
 - Academy Specification S-2014-006 A Common File Format for Look-Up Tables (DRAFT)

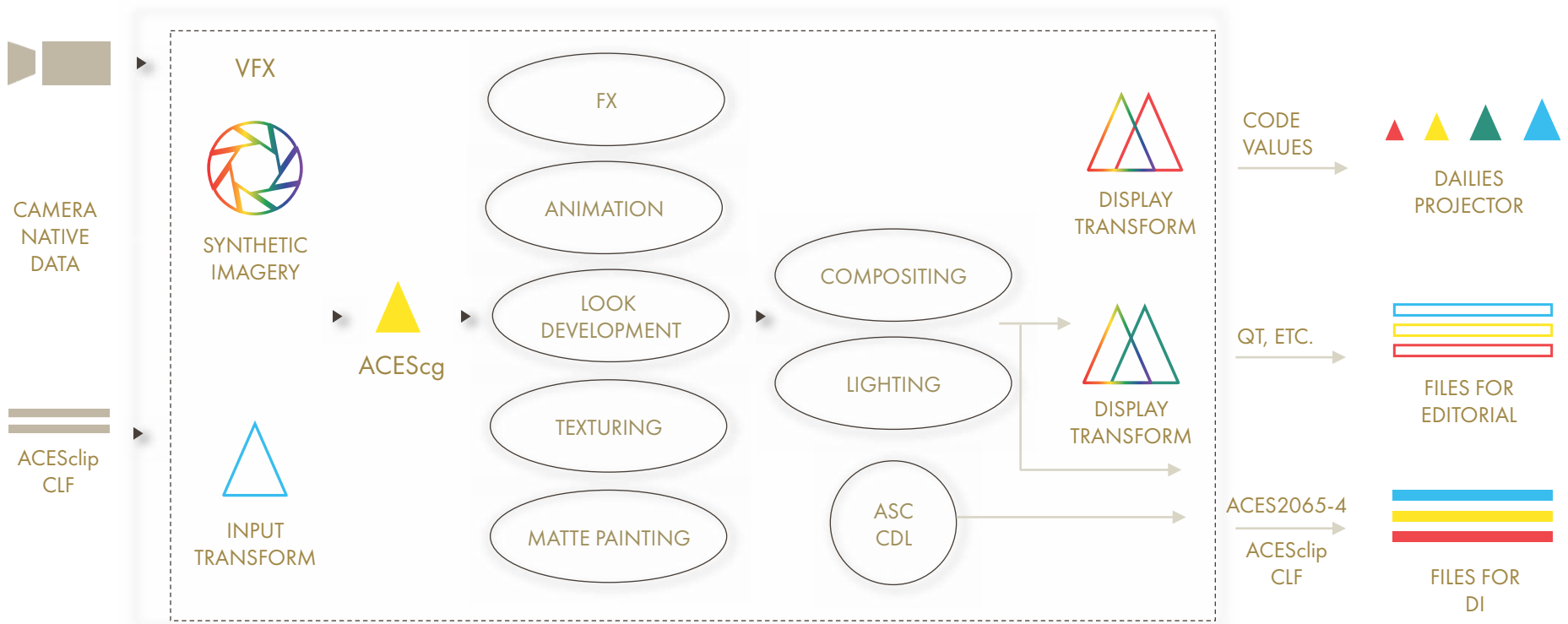
ACES 1.0 Key Components

- Developer Tool
 - RDD 15 Software Scripting Language for Pixel-based Color Transformations, aka “CTL”
 - Mechanism to specify and test ACES color transforms
 - Implemented as a software interpreter
 - Includes an image processing application that writes **ACES2065-4** *and* DPX files!

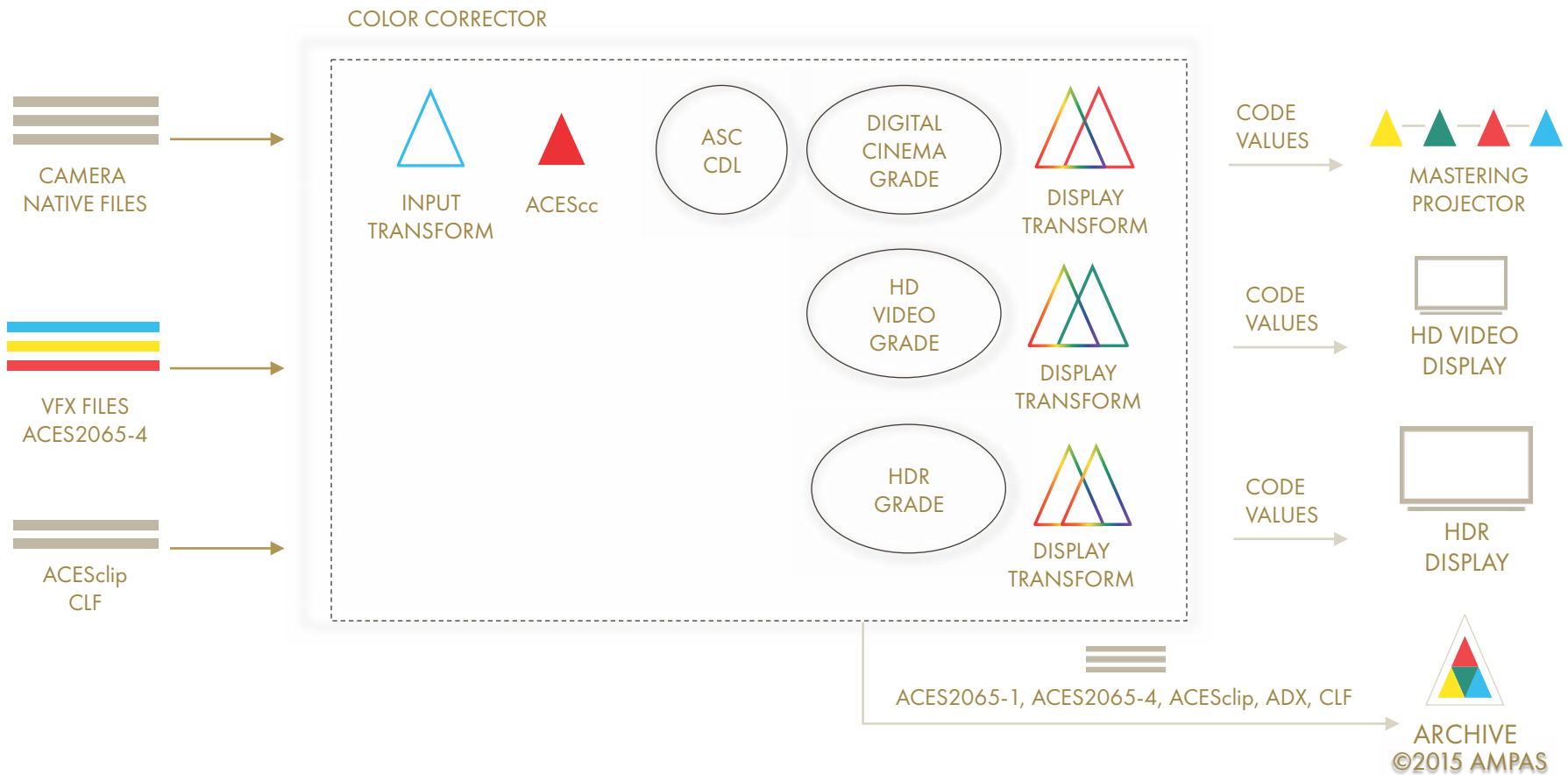
ACES On-Set/Dailies



ACES In VFX



ACES In Mastering and the Archive

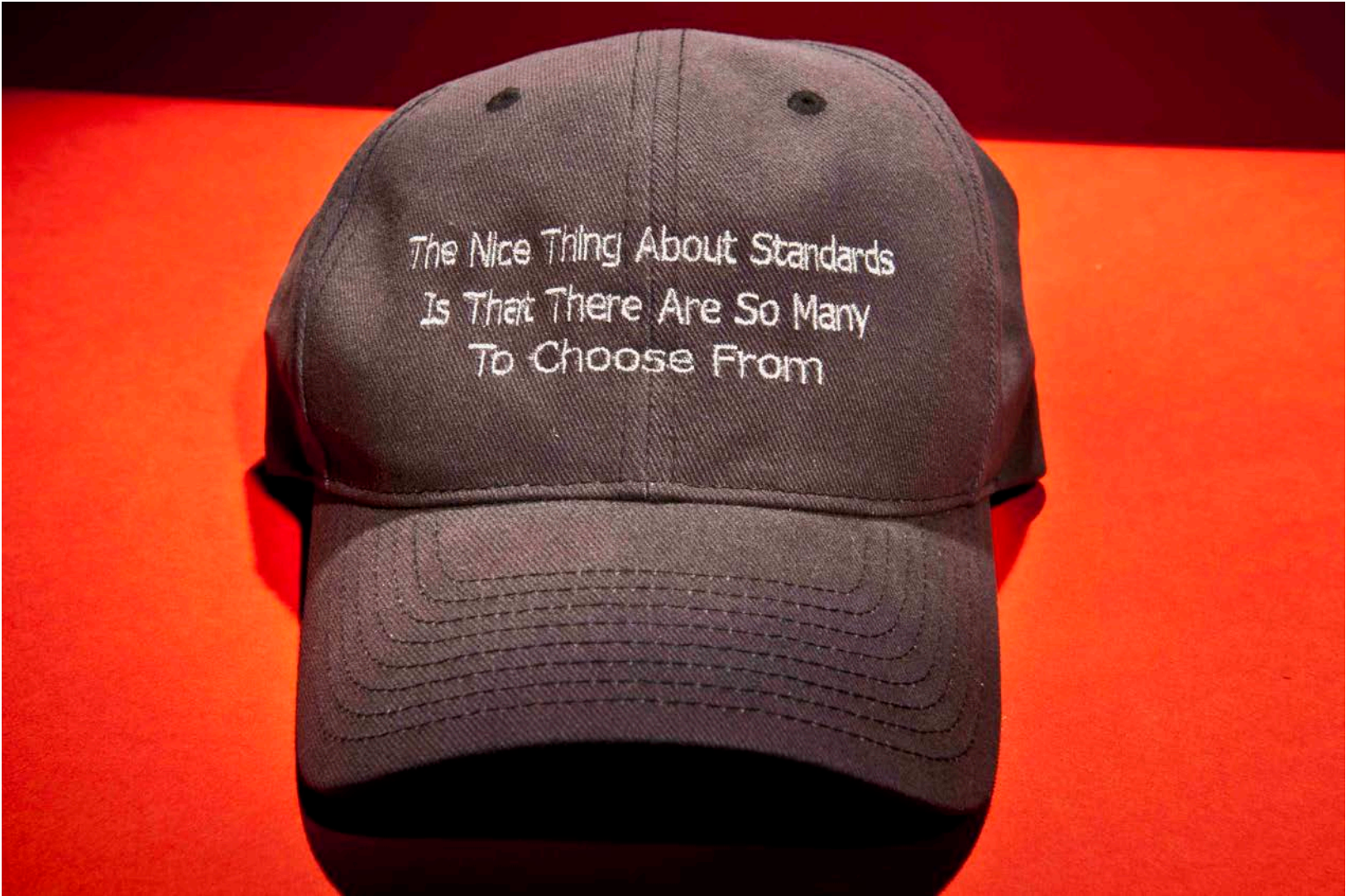


Archiving Digital Movies Today: Choices

- Camera RAW Files – Proprietary, unprocessed camera files. Require specialized software to open and process.
- MXF – Just a wrapper for varying essence
- DPX – What encoding standards? Knowledge of viewing transform required to reproduce the final image.
- DCDM – The digital print master
- DCP – The digital print under lock and key (compressed)
- AXF – Packaging for data tape? What does it package?
- ProRes? QTs?
- Which files are the “Finished Movie?”

Archiving with ACES: a simpler approach

- The digital equivalent of the finished film negative for the archive
- Uncompressed, full dynamic range, color gamut and precision
- Fully specified encoding and intended display conditions
- Not a playable DCP
- Use existing standards where possible, add where needed

A grey baseball cap is centered against a vibrant red background. The cap features white embroidered text on its front panel. The text is arranged in four lines, reading: "The Nice Thing About Standards", "Is That There Are So Many", "To Choose From". The cap has a curved brim and two dark buttons on top.

The Nice Thing About Standards
Is That There Are So Many
To Choose From

AMPAS

Archiving with ACES: existing standards

- Use standards to make archived elements unambiguous
 - SMPTE ST 2065-1 – ACES Color Encoding
 - SMPTE ST 2065-4 – ACES File Container
 - SMPTE ST 2065-3 – ACES Densitometric Encoding (ADX)
 - SMPTE ST 268 – DPX File Container for ADX data

Archiving with ACES: round out the standards

- New standards in process
 - Packaging for the digital master: ACES2065-4 files with sound and text
- After that
 - Display Transforms: how to view ACES data
 - RPs and EGs

Archiving with ACES: current standards work

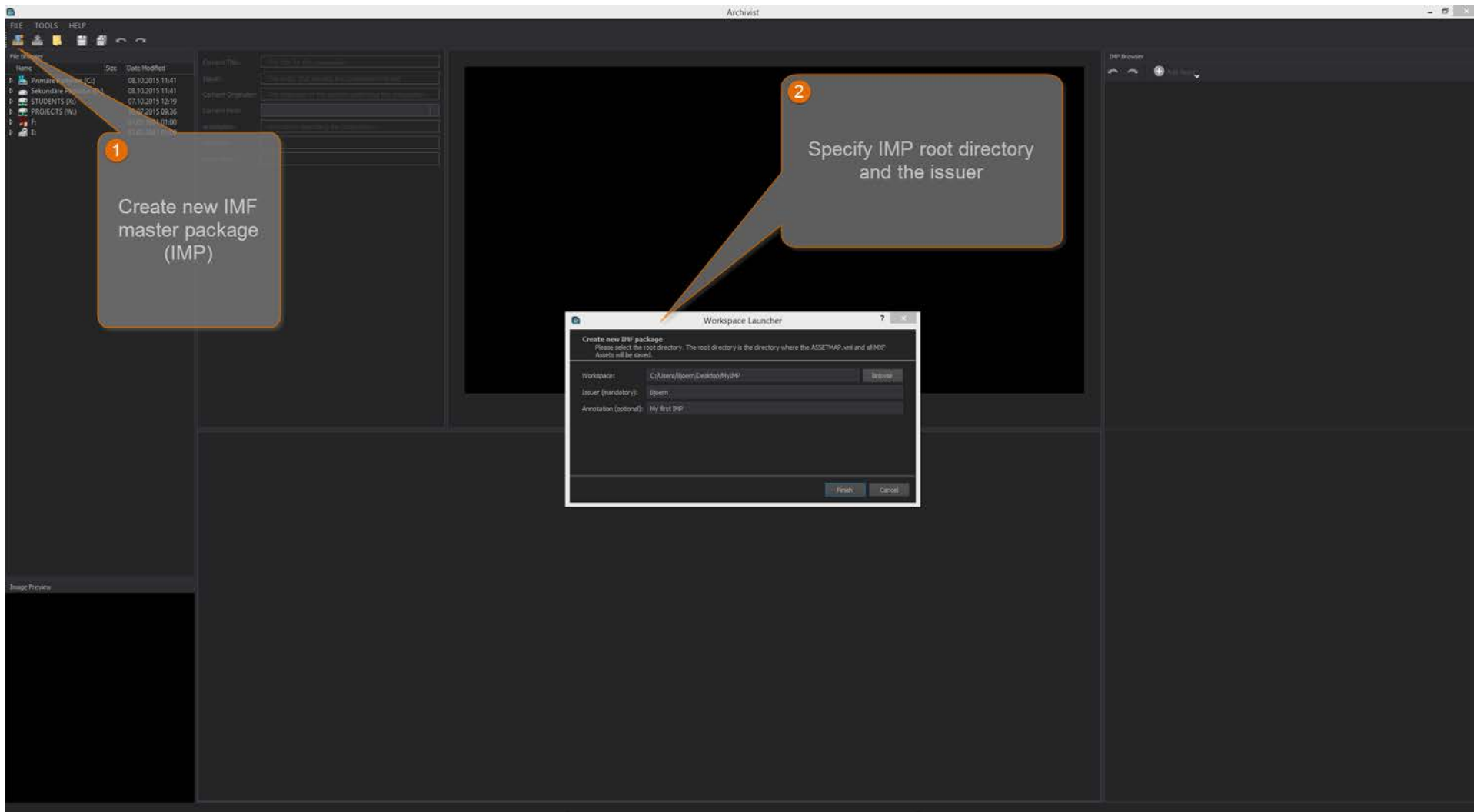
- The approach
 - Interoperable Master Package (IMP)
 - Interoperable Master Format (IMF) Application #1
 - Uncompressed image data wrapped in MXF
 - Requires MXF wrapper for ACES2065-4 files
 - Requires ACES color pipeline metadata definition

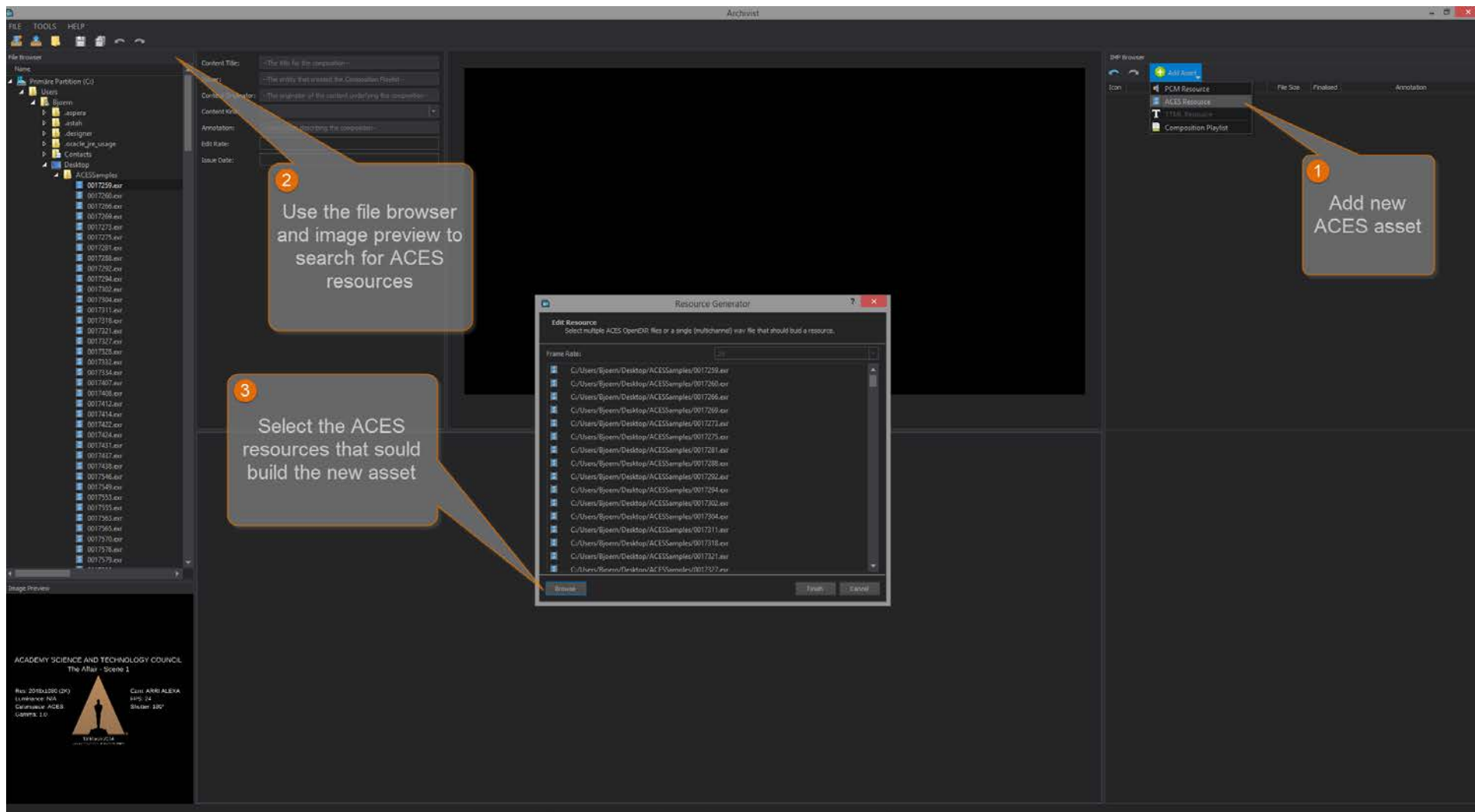
Where standards are made

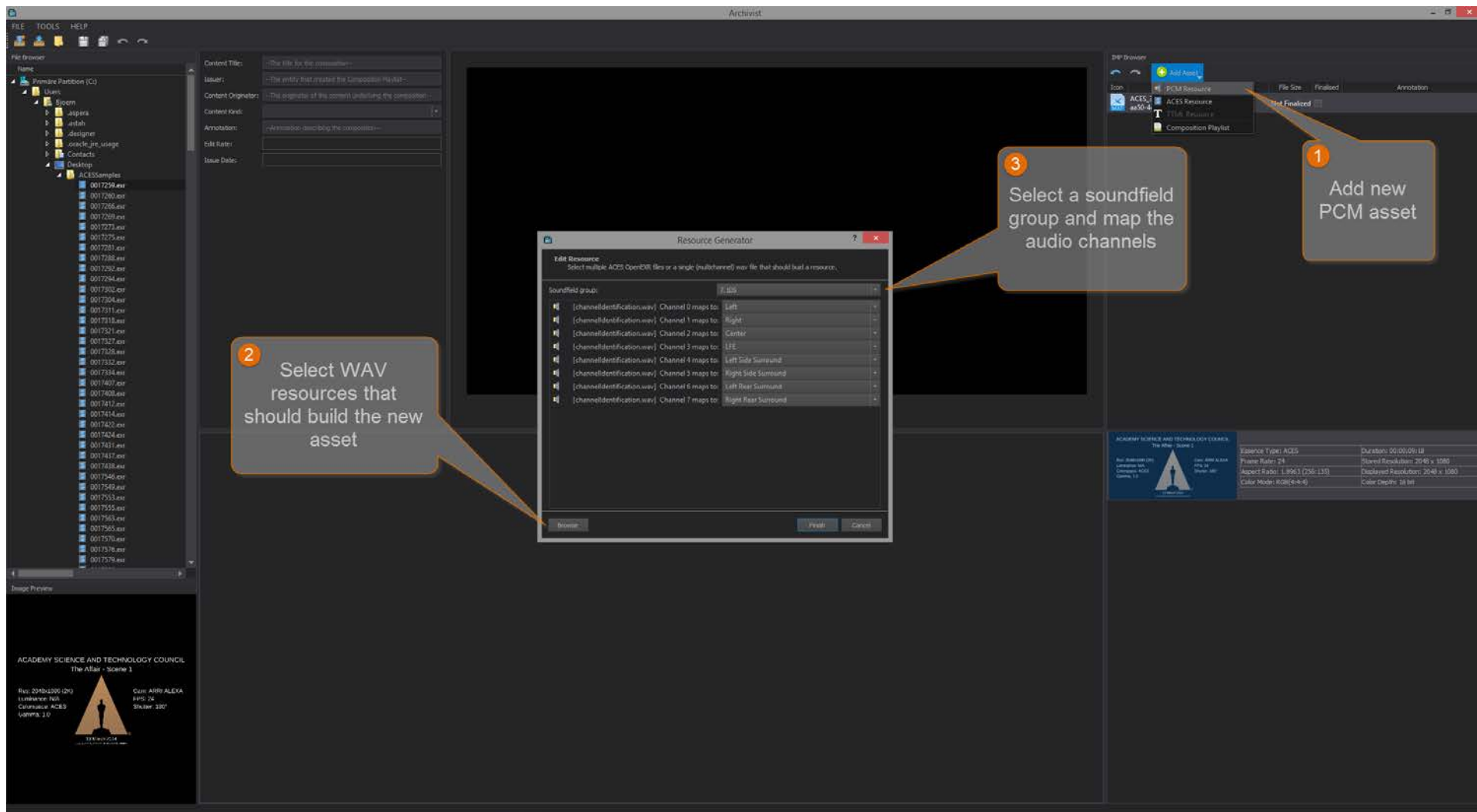
- MXF Wrapper: SMPTE 31FS
- IMF Application: SMPTE 35PM
- Proponents: Most (perhaps all) major Studios, key equipment manufacturers and the Academy
- ACES is at ISO, too
 - Introduced at 2015 TC36 plenary in Beijing

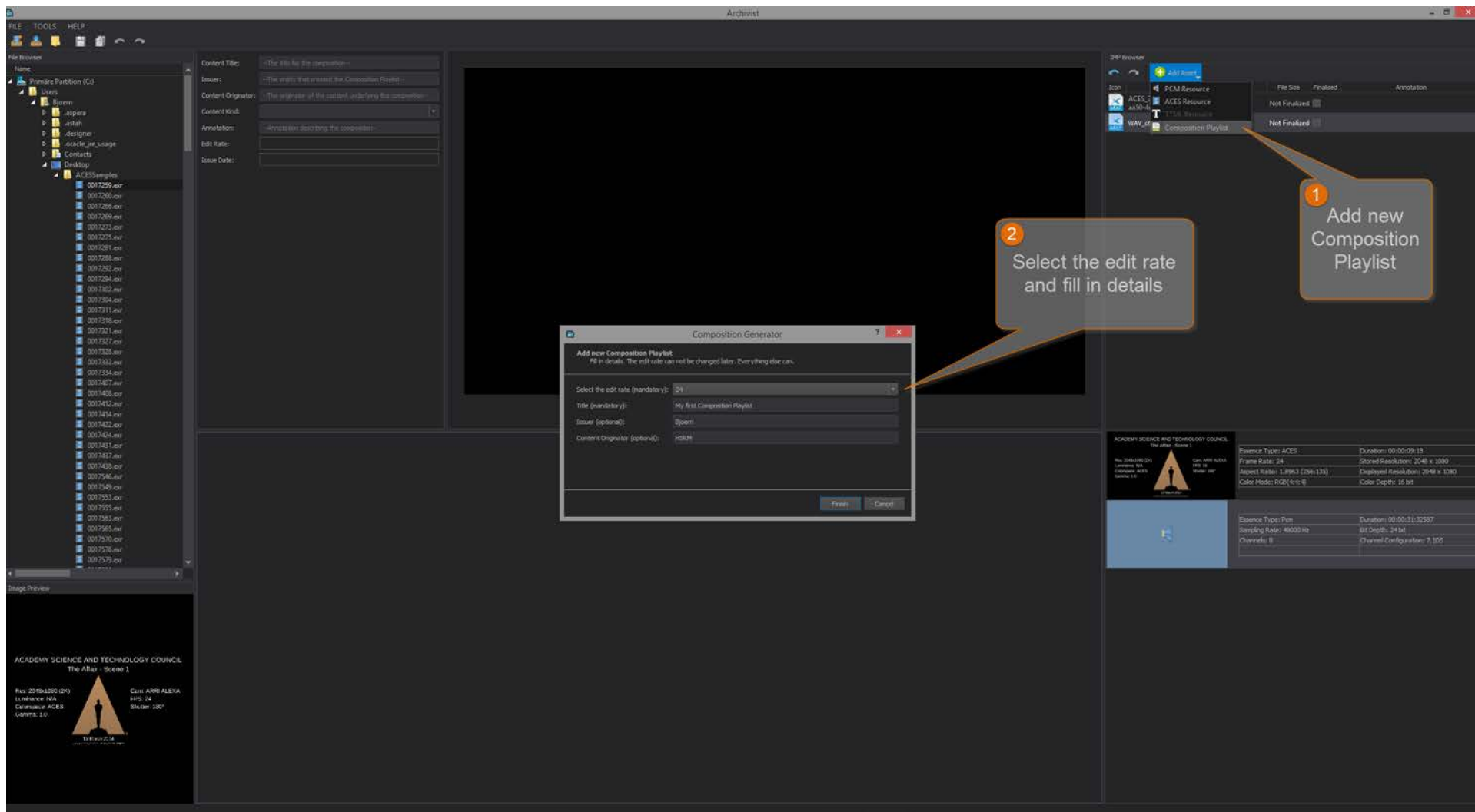
Proof-of-concept software

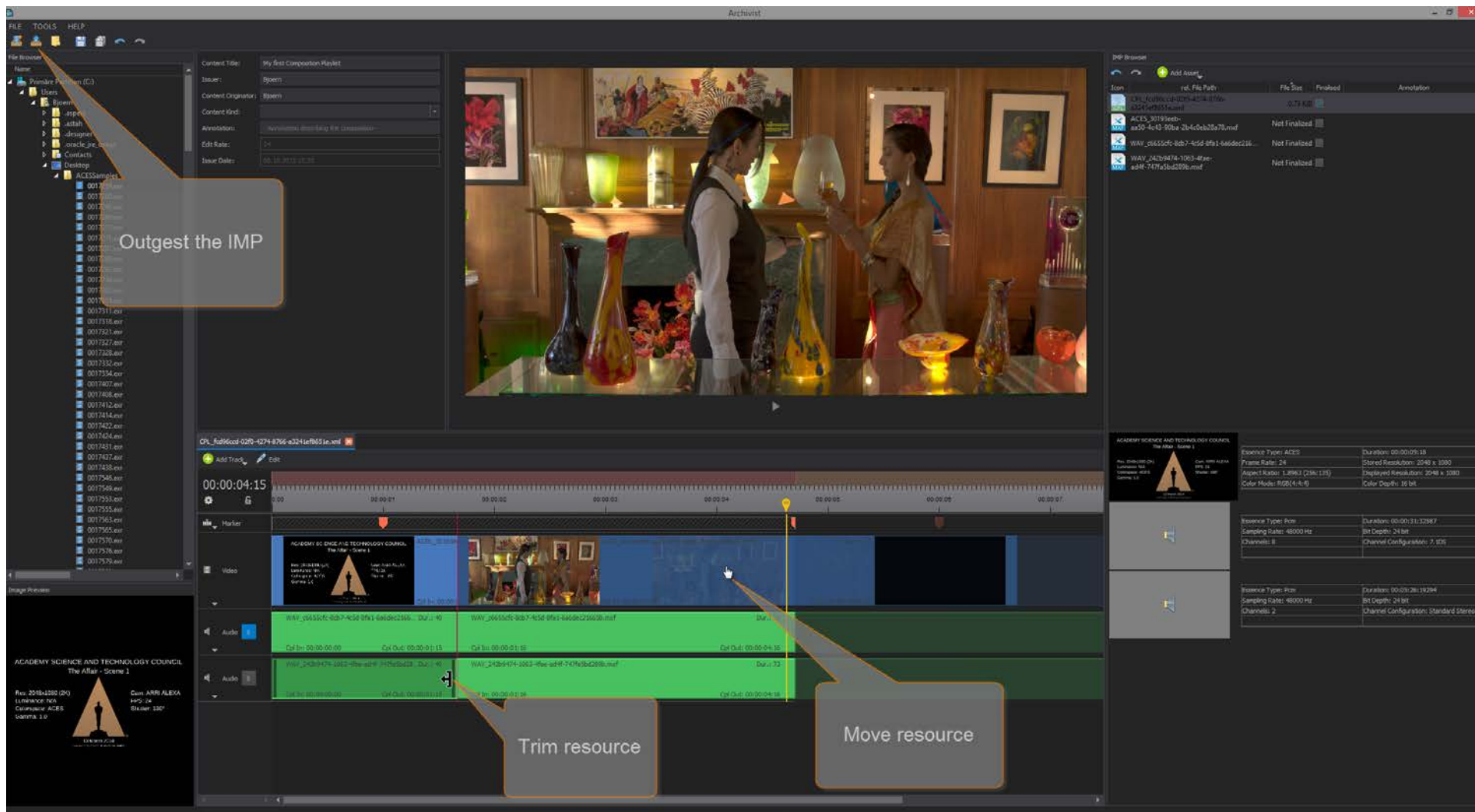
- Laboratory of Prof. Dr. Wolfgang Ruppel, RheinMain University, Wiesbaden, Germany (wolfgang.ruppel@hs-rm.de)
- Software development: Björn Stresing, cand. M. Eng.











Phase 3 standards

- Common LUT Format: Academy Specification S-2014-006
- Working Spaces: Academy Specifications S-2013-001, S-2014-003, S-2014-004
- Core Transforms: see CTL code at github.com/ampas/aces-dev/tree/v1.0.1
- ASC-CDL
- RPs and EGs for vendor-supplied transforms

ACES components, documentation
and educational materials
(case studies, videos)
are available here:

Oscars.org/aces

(for free)



A Call to Action

Participate in
SMPTE 31FS and 35PM



A Call to Action

I WANT MY



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Join the Community!

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