

ACES Leadership response to “ACES – Retrospectives and Enhancements”

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I. INTRODUCTION

In March of 2017 a group of interested individuals submitted feedback to the Academy of Motion Picture Arts and Sciences on the Academy Color Encoding System (ACES) 1.0 release [1] in the form a paper entitled “ACES Retrospectives and Enhancements” (RAE) [2]. This clear and well-thought-out feedback from the ACES user community is greatly appreciated and the Academy’s ACES leadership team encourages others to submit such carefully crafted critiques.

For historical context, the primary intention of the ACES 1.0 release was to provide the motion picture industry with a stable, production-ready digital production, image interchange and archiving platform after many years of continually evolving beta releases. The expectation for the 1.0 release was that the user community would widely adopt it and provide meaningful feedback on how the system might be improved in future releases. When ACES 1.0 was released, it was well understood that various system components might need additional refinement based on community feedback. This was particularly true for components of the system that had not gone through extended field-testing cycles during the beta period. Examples of such components include the Common LUT Format (CLF) [3], the ACESclip metadata sidecar file format [4], and Look Modification Transforms [5]. The RAE document is an excellent example of the type of feedback that ACES Leadership hoped to receive.

This document is intended to directly respond to the topics raised in the RAE document, to contribute to the developing roadmap for future versions of ACES, and to encourage a greater level of participation in the ACES development process from the entire ACES community.

II. RAE REQUESTS

For easy reference, the RAE requests and Academy replies in this section are ordered as they appear in the Summary section (Section IV.A) of the RAE document.

RAE Request 1

The past, current, and future of ACES development will be more open to peer-review and academic discourse.

ACES Leadership Reply 1

The ACES Leadership team is committed to peer review and academic discourse. Since shortly after the release of ACES 1.0, ACESCentral.com [6] has served as the primary public forum in which to discuss user experiences with ACES and the development of future versions. ACES Leadership is referring to the process of determining the future of ACES as “ACESnext.” Participation in this process by the ACES community is critical for success and will directly influence any changes to ACES, the scope of those changes, and the schedule by which those changes are introduced. Peer-review is a key tenant of the ACES roadmap development. All proposed changes will be discussed and vetted by the ACES community in the ACESCentral forum before they are incorporated in future versions of the framework. This process is already underway: a “virtual working group” (the new mechanism to enable global participation in ACES development) was recently established to discuss, improve, and supplement where necessary the ODTs included in ACES 1.0. The virtual working group discussions and meetings have all been posted to ACESCentral to encourage community participation. [7], [8], [9] ACESCentral was designed, in part, to serve as the industry-wide forum in which to discuss proposed refinements and enhancements to ACES. When appropriate, we may choose to publish articles in peer-reviewed journals and present at established technical conferences. We believe an open, academic discussion of the issues ACES aims to solve and the means by which it solves them will imbue confidence in the various ACES user communities. Likewise, we encourage those using ACES to vet current and future versions of the system and to publish their findings to foster a productive and on-going dialog.

RAE Request 2

A public record of any experimentation, analysis, and implementations, along with useful data (image datasets, viewing conditions, display attributes and observer physiological characteristics) will be initiated.

ACES Leadership Reply 2

As part of our efforts to be open, documented, and peer-reviewed, we have moved ACES development discussions to ACESCentral.com, a public forum. Relevant (and unrestricted)

datasets, implementations, documentation, analysis, etc. will be published to ACESCentral and DOIs minted as appropriate. That practice is already in place.

RAE Request 3

The CTL codebase documentation, especially the unexplained constants will be revised.

ACES Leadership Reply 3

ACES Leadership agrees that documentation of the codebase and the underlying algorithms are important in helping users understand how ACES works, how it should be used, and how it was developed. Many of the "unexplained" constants in the ACES 1.0 transforms are the result of visual assessment by expert users. As we develop future versions of ACES together, more rigorous descriptions will be provided of the core algorithms including details of experiments from which various constants were derived and how viewer preferences were decided upon.

RAE Request 4

A document on ODT creation akin to P-2013-001 will be written.

ACES Leadership Reply 4

As the current development work is focused on the Output Device Transforms (ODTs), one of the outcomes of this work will be an ODT document similar in scope to that of P-2013-001. [10] Work items currently include reconciling differences between the various ODTs, providing an algorithm to compute ODT tone scales for devices with various luminance dynamic ranges, and providing both practical end-user focused and engineering documentation. We have invited anyone from the ACES community, through the ACESCentral virtual working group, with expertise or interest in this topic to participate in the development process. [8] We have started a public discussion area on the topic on ACESCentral.com to share our assessment of the ACES 1.0 ODT shortcomings and our thoughts on potential solutions. [7] In the short term, we will be providing end-user focused documentation intended to help filmmakers understand which ODTs should be used to support their productions. [11] Engineering-level documentation will be provided with future versions of ACES as part of the community-driven development process.

RAE Request 5

The CTL codebase and the official ACES OpenColorIO configurations, along with relevant documents, e.g. technical bulletins, will be stamped with DOIs.

ACES Leadership Reply 5

We have begun to upload the ACES codebase and various ACES related materials to a digital archive [12] to ensure permanent accessibility and proper citation. Each of the items uploaded will be minted with a DOI and organized in an ACES Zenodo community. [13] We encourage anyone writing or presenting on ACES to upload their documents for inclusion

in the ACES community. This enables others to reference prior work on ACES and to create a body of open research on the topic.

RAE Request 6

The CTL codebase reference implementation will adopt a solid unit tests suite while checking the ACES OpenColorIO configuration state against it.

ACES Leadership Reply 6

We agree that a unit test suite for the ACES CTL codebase is both helpful and desirable. At present, CTL does not support unit testing directly. We are exploring mechanisms to provide unit testing via another language such as Python. A Python binding for CTL may be helpful in accomplishing this goal. We are happy to accept pull requests to the aces-dev [14] or CTL [15] repositories from the anyone in the ACES community with programming experience who is willing to help build the unit testing framework or any necessary hooks that might make it easier to put such a framework in place. Once a suite of unit tests has been built, we hope to maintain code quality using continuous integration (CI and subsequently make it easier for developers creating their own implementations of ACES to verify that those implementations match the reference CTL.

RAE Request 7

The Academy will promote a system for vetting and integrating IDTs with user feedback.

ACES Leadership Reply 7

A mechanism currently exists for submitting, discussing, and vetting end-user supplied IDTs on ACESCentral. [16], although it is unused. We would appreciate hearing from the ACES community as to why that is, e.g., the community is unaware of the mechanism, lack of familiarity with IDT development methodologies, etc., and will make adjustments to improve adoption of the mechanism if needed.

RAE Request 8

The Academy will strongly promote Common LUT Format (CLF) adoption by its partners and the community.

ACES Leadership Reply 8

ACES Leadership strongly supports CLF adoption - so much so that it is a necessary component for products to achieve the ACES Logo. CLF provides the most robust and flexible framework for embodying complex lookup tables required by image states-based HDR workflows. Lookup tables are only estimations of underlying functions such as the core ACES transforms but high-quality lookup tables require a lookup table format such as CLF to minimize errors and maximize image quality. As with all ACES components, we encourage a dialog on CLF so it can be improved as necessary to meet the needs of end users. Unfortunately, the feedback from most of the ACES Product Partners is that CLF is not a high priority feature for them due to lack of customer requests. It is critical that those in the ACES community who feel that adoption of

CLF is important make formal requests to their tool vendors to support CLF. In the meantime, we are currently working with the OCIO community to add support for CLF in OCIO 2.0 via an open-source CLF reader and writer [17] that can serve as a reference implementation for vendors interested in adopting CLF.

RAE Request 9

The Academy website will be the host for best practice guides for usage of ACES and ACES OpenColorIO configurations within DCC applications.

ACES Leadership Reply 9

ACESCentral.com was created as a more appropriate ACES "portal" than the Academy website due to the more technical nature of ACES relative to the Academy's broader filmmaking and film enthusiast communities. While there is a need for generalized best practice documents (and we are working on them), ACES Leadership also agrees that there should be best practice guides for the usage of ACES within various DCC applications. As we are not experts in all of the software tools used by filmmakers, we feel it would be best for the manufacturers of DCC applications to write these guides. We continue to be committed to working with the manufacturers of DCC applications to help ensure consistent usage of ACES terms and accurate framework-related documentation.

RAE Request 10

The RRT will adopt a more neutral look and a faster parameterized mathematical implementation that will allow better control over the tone scale, thus contributing to spread of RRT usage and enabling true archival [*sic*] of creative intent.

ACES Leadership Reply 10

ACES Leadership has heard the community loud and clear on these issues. Discussions regarding RRT design decisions and potential improved designs are on the table for future major versions of ACES. ACES Leadership is interested in exploring this topic as the definition of "neutral" is the subject of some debate. It should also be noted that while there are benefits to a parameterized model, it requires a robust metadata transport system throughout the production pipeline and into the archive - ACESclip was designed for this purpose but has not yet enjoyed sufficient adoption. We encourage the community to join the discussion on ACESCentral.com and help with ACESclip adoption as well as shape the future of the RRT and related components. As a reminder (and to alleviate compatibility concerns), all past and current versions of the ACES system, including the RRT, will always be available for those working on projects that require them.

RAE Request 11

The RRT will be made fully invertible, and that the various sweeteners will be moved to a default LMT.

ACES Leadership Reply 11

ACES Leadership has heard the ACES community's call for fully invertible ACES output transforms. This work will be on the forthcoming ACESnext roadmap.

RAE Request 12

The ODT will be parameterized to adapt to a wider range of displays and viewing conditions while reassessing usage of CAMs to account for induced changes of the perceptual correlates by the luminance increase of the HDR displays and different viewing conditions.

ACES Leadership Reply 12

There is currently an active Virtual Working Group on ACESCentral.com exploring the possibility of parameterized ODTs that will support a wider range of displays and viewing conditions than is currently supported in ACES 1.0. [18], [19], [20] The results of this work will be introduced in an update to the ACES HDR ODTs as recently noted on ACESCentral. The possible applicability of Color Appearance Models (CAMs) to the RRT and ODTs was explored in depth during ACES 1.0 development, but were found not to be practical at the time. However, the field has advanced somewhat since then, and this work could be added to the ACESnext roadmap. [21]

RAE Request 13

An officially publicized and documented workaround for highly saturated emitters artifacts will be available in the CTL codebase until a long-term solution is developed.

ACES Leadership Reply 13

We agree that this frequently recurring issue must be resolved in a future release of ACES. In the meantime, this issue has been discussed in detail [22], [23], [24], [25], we have been working closely with the camera manufacturers to address these sorts of artifacts, and a temporary solution is documented on ACESCentral.com. [26] The problem stems from ACES values produced by cameras needing to be remapped into all positive RGB values during conversions to the AP1 primaries. Some of the ACES values produced by cameras correspond to real colorimetric values, others correspond to imaginary colors far outside the spectrum locus, the latter causing the artifacts. [27]

RAE Request 14

The ACESclip file format will be simplified and advertised, as the archival promise is currently broken without proper metadata. XMP would be useful to consider along storage of the ACESclip file within the ACES container.

ACES Leadership Reply 14

As noted earlier, ACES Leadership believes that ACESclip is a critical part of the ecosystem, particularly for the archival use case. ACESclip was created late in the ACES beta period without a reference implementation, so few manufacturers have implemented the specification. The ACES Product Partner manufacturers that have examined the specification in depth have provided important feedback, which is likely to result in

a refinement of the ACESclip specification. ACESclip is likely to remain a sidecar file format because embedding "clip-level" metadata into individual frames has performance implications as each file's metadata must be read and parsed to ensure metadata consistency. Embedded metadata also potentially leads to ambiguity if one or more files in a clip have different clip-level metadata in their headers. A straw man alternative to the current ACESclip specification was posted for comment on ACESCentral.com. [28] We look forward to feedback from the community of the pros and cons of the current specification and the straw man and agreement on a path forward to ACESclip refinement and adoption.

RAE Request 15

Remaining issues in the ACES OpenColorIO configuration such as a visual mismatch and ICC profiles clipping will be addressed.

ACES Leadership Reply 15

OCIO and ICC profiles are important implementations of ACES and ACES Leadership has recruited a dedicated volunteer team lead by Thomas Mansencal and Michael Parsons to build and test the ACES OCIO profiles. The OCIO team has recently announced a major effort to build OCIO 2.0. [17] The roadmap for OCIO 2.0 may make it much easier to build and support a high-quality ACES OCIO configuration. We intend to work with the OCIO development team to deliver the best possible ACES OCIO configuration using the new features available in OCIO 2.0. Feedback from end users and developers with expertise in ICC profile creation are invited to help assess and improve ACES ICC profiles.

RAE Request 16

The ACES OpenColorIO configuration repository will be taken under the Academy wing and its development will be more directly supported by the Academy team.

ACES Leadership Reply 16

As noted above, ACES Leadership is committed to a quality implementation of ACES in OCIO, and we will continue to work closely with the OCIO team and volunteer OCIO configuration leads to ensure a quality ACES experience in OCIO 1.0. We also understand that OCIO 2.0 will include native support for a high quality implementation of the ACES transforms. [17]

RAE Request 17

The ACES OpenColorIO configuration builds, i.e. the config file, LUTs and ICC profiles, along the CTL transforms will be hosted as first class products on the oscars.org website.

ACES Leadership Reply 17

OCIO 1.0 configs will be hosted on the Academy GitHub site in the OpenColorIO-Configs repo fork [29] and merged into the main Imageworks OpenColorIO-Configs repo [30]. We understand that future version of OCIO will include more direct support for ACES making the accessibility of up-to-date OCIO configs more seamless.

RAE Request 18

A robust solution will be found for integer based applications such as Adobe Photoshop.

ACES Leadership Reply 18

Adobe Photoshop is a widely used tool at various stages in the motion picture pipeline. ACES Leadership is committed to working with end-users, developers and Adobe to develop necessary workarounds. We invite all interested ACES community members to post their suggestions to ACESCentral.com.

RAE Request 19

The broadened scope of ACES beyond its original context will be accounted for with Video Games being a strong adoption driver to be reckoned with.

ACES Leadership Reply 19

The Academy's primary focus is theatrical exhibition, but we are gratified that ACES has been embraced by other industries. ACES Leadership believes this speaks to the solid fundamentals on which ACES was built. We support the idea of making ACES as applicable to as many use cases as possible as long as it doesn't preclude the needs of theatrical filmmakers, and invite developers from those other industries to join the development effort.

RAE Request 20

Discussions regarding potential changes to the reference environment will be held.

ACES Leadership Reply 20

The reference viewing environment associated with OCES shouldn't preclude any alternate viewing environments. In particular, the maximum luminance associated with the OCES reference display is 10,000 nits and should be sufficient for future applications. [31] The minimum OCES reference display luminance of 0.0001 nits may need to be reconsidered in future version of ACES since there are current generation displays that already achieve that black level.

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