MOX File Format

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Summary

MOX is a new movie file format intended for people working in video and film production, particularly visual effects. It is uses the ".mox" file extension and is pronounced as one syllable, rhyming with "box." MOX is an acronym for Movie Open Exchange. The key features of the format are:

Professional
MOX is designed for creative professionals. It focuses on storing audio and video at the highest possible fidelity, allowing users to move media between applications without loss. It holds all relevant metadata such as timecode and color space.

Open
MOX is based on open standards. It uses the industry standard MXF container and only supports audio and video codecs that are open source and patent-free. MOX will include an official open source library to allow applications to easily support the format on any platform. MOX's non-proprietary, non-commercial nature means that users can be confident that MOX files they create today will be readable by application software into the distant future. The MOX design philosophy mirrors the widely-used OpenEXR still image file format.

Movie
MOX files are movies, which is to say a sequence of frames with synched audio, all stored in one file. While there have long been production-friendly still-image and audio-only file formats that were open, MOX is the first movie format.

Container

MOX uses MXF (SMPTE 377M) as the container to hold audio, video, and metadata streams. All MOX files are legal MXF files that use a subset of what is allowed in the overall MXF spec.

MOX files exclusively use "internal essence," meaning that all media streams are contained within a single .mox file without any external dependencies. MOX files are limited to a specific set of codecs that are open source and patent-free so that any application may support the format without legal complications or royalty payments.

Multiple Streams
The MXF container allows the embedding of multiple video and audio streams. In the case of video, this will make it possible for MOX to hold extra channels like Z-depth, extra views for stereoscopic productions, or separate layers of video to be used in motion graphics.

Video

MOX supports a variety of video compression formats, each with different capabilities. The sum total of the different codecs means that users have the ability to compress video with the following options:

- lossless or lossy image encoding
- choice of bit depth (8-, 10-, 12-, 16-bit integer; 16-, 32-bit floating point)
- optional alpha channel

The features available will depend on the codec used. The video codecs used by MOX are:

Dirac
Developed by the BBC, this wavelet compression format supports both lossy and lossless encoding of 8-, 10-, and 16-bit images. It also has the the ability to "auto-proxy," accelerating the decoding process when lower resolution or quality is acceptable.

VP8/VP9 (proposed)
Lossy codecs owned by Google, they are similar in quality to the patent-encumbered H.264/H.265 compression formats. The VPX codecs may be useful for times when some quality loss is acceptable in the name of reduced file size and realtime playback. After seeing the performance of the Dirac codec, we will decide if it makes sense to support these codecs as well.

Image Sequence Codecs
In order to support features that until now have only been available in still image formats, MOX takes existing single-frame formats and embeds an entire sequence of them to form additional video codecs. The image formats used are:

- OpenEXR
- DPX

- PNG

- JPEG

- JPEG 2000

For these codecs, a complete still image file will be stored for each frame. A utility could (should) be written to convert image sequences to MOX and vice-versa without re-compression.

Audio

MOX supports the Vorbis, Opus, and FLAC audio codecs, as well as uncompressed PCM audio. This gives the user the following audio encoding options:

- lossless or lossy audio encoding

- choice of bit depth (8-, 16-, 24-, 32-bit integer; 32-bit floating point)

- mono, stereo, or surround audio channels

Metadata

MOX stores all the usual movie attributes, such as frame rate and pixel aspect ratio. It also stores information more common in still image formats, such as alpha interpretation and color space. By virtue of using the MXF container, MOX can store timecode and other metadata that may be found in footage created by modern digital cinema cameras.

Color Space

The color space of a MOX can be described by embedding an ICC color profile, specifying gamma and chromaticity values, or by naming a standard color space such as Rec. 709. In addition, a LUT can be embedded to tell viewers how a file is intended to be displayed.

MOX Background

In visual effects we tend to work with image sequences, but occasionally it may be necessary to make a movie. Maybe we need to import a shot into an editing system, or send a clip to a client for review.

But have you ever made a QuickTime movie and then found that the video played back from that file doesn't match the original frame sequence? Or have you ever tried to open an old movie, only to find that its proprietary codec no longer works with your operating system? Ever wanted to save anything beyond a standard 8-bit RGB image and found that playback-oriented movie formats don't not allow it?

These are not problems you would ever have with still image formats like PNG, DPX, or OpenEXR. If you were to ever question the appearance of a DPX file, you could try reading it in different programs or even have a programmer dive into the code to examine how data is being read. Because those formats are standardized and have open source libraries, you can be confident that a PNG file you write today can be read in the future, even if the software you created it with has long been rendered obsolete. If one file format doesn't suit your production needs, you simply pick another that does.

On the other hand, it's really nice how movies have audio and video synched up inside a single file. It would be great to use a movie format in production, if only there were one as versatile and open as the still image formats. This is the reason for MOX.

Ten years ago, creating a movie format to compete with the likes of QuickTime would be a daunting task, the sort you might try to build an entire company around. But in that last decade we have seen the release of open source codecs and containers, representing millions of dollars in R&D value, freely available and waiting to be assembled into a cohesive whole.

Funding Goals

While the MOX software library will be free to use, it will not be cheap to create. It will take months of dedicated development time to get an initial stable release done, not to mention the follow-up work of fixing bugs and shepherding the adoption of MOX. The more money is raised, the more work can be put into the project.

Money will be raised using Kickstarter or Indiegogo. Here are the proposed funding goals:

Total Amount Raised	Work
$20,000	Creation of MOX spec and MOX software library. Development of an Adobe Media Core plug-in to read and write MOX in Adobe Premiere and Adobe Media Encoder. Also allows After Effects to read MOX and render through Media Encoder.
$25,000	Develop After Effects native plug-in.
$30,000	Develop plug-in for The Foundry's Nuke.
$40,000	Develop MOX QuickTime component.

Total Amount Raised	Work
>$40,000	Promote MOX using trade shows, advertising, public speaking, studio visits, etc.

Note that the open source library will allow anyone to write their own MOX file support for any program, but these are the plug-ins that are proposed to be part of the main project.

Crowdsourced projects usually offer perks encouraging people to contribute more, and the MOX project is no exception. Bigger perks include all the perks below them. Here are the perks:

Amount Contributed	Perk
$10	MOX Supporter. You will be subscribed to the MOX online forum for access betas and be able to contribute to discussions shaping the development of MOX.
$100	MOX Ambassador. Achieve MOX immortality with a credit in the PDF documentation that will accompany the MOX library and open source plug-ins.
$500	MOX Nobility. Your name will be typed into the actual MOX source code and you will receive a printed copy of that code with a thank you note from the author.
$1,000	MOX Illuminati. A credit on the MOX website for all the world to see.
>$1,000	Let's talk.

About the Author

I've worked in the visual effects industry for over a decade as both an artist and a programmer. My artist credits include Hellboy, Sin City, and Superman Returns.

As a programmer, I wrote and still maintain the OpenEXR plug-ins that ship with Adobe After Effects. They are part of my ProEXR package which provides full access to the format in Photoshop and Premiere as well, used by visual effects studios around the world.

I have also released various plug-ins (some open source) to handle color management and image pipeline issues, and I have contributed code to the OpenEXR and OpenColorIO projects. In 2013, I wrote an open source Premiere plug-in to use Google's WebM movie format, which got me thinking about challenges I've had using movies in production ever since I started toying with digital video in the 1990s.