ASWF /* ACADEMY SOFTWARE FOUNDATION

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THE LINUX FOUNDATION | Research

March 2022

By Barbara Robertson

With a foreword by David Morin, Executive Director, *Academy Software Foundation*

DUNE

Open Source in Entertainment

How the Academy Software Foundation Creates Shared Value

Contents

Foreword

"If it can be written, or thought, it can be filmed."

— STANLEY KUBRICK

"Clearly, if we'd had the kind of computer graphics capability then that we have now, the Star Gate sequence would be much more complex than flat planes of light and color."

— DOUGLAS TRUMBULL, ABOUT *2001: A SPACE ODYSSEY*

Filmmakers have always strived to tell great stories, create works of imagination, and share them on the big screen. In the process of doing so, they've invented countless new technical tools and processes including, in the last few decades, a lot of software.

The Academy Software Foundation was created four years ago by a group of like-minded technology executives and software developers who saw a need for a neutral place, a common ground, where studios and vendors could come together to write open source software that would benefit everyone.

A lot has happened in this short period of time. This document, the first Open Source in Entertainment report, tells the story of the Foundation: where it came from, what it has achieved so far, and where it aims to go next.

This is a story about a community of people that generates a tremendous amount of value around open source projects, by developing some of the software components that power all productions, and the open standards that we need for our industry to grow.

It is also about the software engineers who empower filmmakers to realize their most ambitious visions, the developers who are filmmakers too, and the technical people who help make the impossible look true. People working together, helping, mentoring, caring, and growing along the way.

We asked Barbara Robertson to research our story. Barbara has chronicled the rise of computer graphics in the motion picture industry, and we are honored that she agreed to explore the topic, interview many of our thought leaders, and write this report.

We present this report to you, at a time of great technological change and innovation in our creative industries. For those of you already participating in our activities, it is a record. For those of you looking to join us, it is a primer. In all cases, we hope that it will act as a springboard for us to travel together in our multifaceted journey forward.

The Academy Software Foundation is a force for good in software development, with roots in 100 years of innovation in the motion picture industry. If you are an individual looking to learn and grow, please join our open source community. There is no cost and everything is open at aswf.io. If you represent a company and want to help fund our activities, please see how your company can join at www.aswf.io/join.

Good reading,

DAVID MORIN
Executive Director, Academy Software Foundation

"We're only a couple years in, but **it feels like the Foundation has been there forever** because it's so critical."

— LARRY GRITZ, *SONY PICTURES IMAGEWORKS*

"There are a lot of software engineers writing amazing code. It's nice to to be able to **shine a light on the development teams** responsible for the tools."

— JORDAN SOLES, *RODEO FX*

"This industry demands that multiple vendors share things and **that ability is built in part upon open source software."**

— JORDAN SOLES, *RODEO FX*

"We rely on member organizations to keep the lights on and grow the foundation, but **there is no barrier at all to contributing."**

— KIMBALL THURSTON, *WETA DIGITAL*
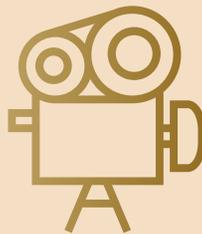
"I feel like **the film industry has evolved a nice healthy ecosystem.** It's not the wild wild west anymore."

— STEVE MAY, *PIXAR*
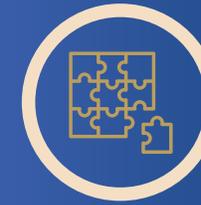
"We're now at a place where **larger and more complex problems can be solved** and we can be more ambitious."

— ROB BREDOW, *ILM*

"If I had to pay a company for every instance of an OpenEXR reader we had, my costs would spiral out of control."

— ANDREW PEARCE, *DREAMWORKS*

"Many of the individual projects are not the groundbreaking part; **they are the foundation** for the groundbreaking part."

— ERIC BOURQUE, *AUTODESK*

"I hope we can build the 'Legos' that people can use to **construct this unique next thing."**

— KIMBALL THURSTON, *WETA DIGITAL*

**"You feel a sense of community and responsibility** to shepherd this work and make it the best it can be."

— CAROL PAYNE, *NETFLIX*

"When we have multiple people with **varied backgrounds and opinions,** we get better software."

— RACHEL ROSE, *ILM*
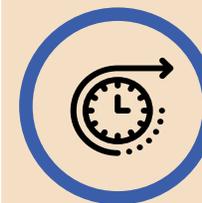
"Let's embrace what is going to be commoditized in five years' time and **move forward."**

— NICK CANNON, *DISNEY ANIMATION*

What Is the Academy Software Foundation? Members of the Community Weigh In.

The Foundation Fosters Collaboration

The Academy Software Foundation is a place for amazing companies to come together, collaborate, communicate common goals, and see connections we wouldn't have seen before. We can coalesce around tools and standards every studio needs. That didn't exist before. The goal is to create amazing content without technical barriers.

— CAROL PAYNE, IMAGING TECHNOLOGIST, NETFLIX

The Foundation is a place where we can have a neutral forum and develop open standards with reference implementations as well as tools useful to the media and entertainment sector. The fact that we're doing this as a group is a shared benefit for all.

— KIMBALL THURSTON, DISTINGUISHED ENGINEER, WETA DIGITAL

[The Foundation] is a place where visual effects and animation companies can come together to solve software problems that help everyone and put competitive issues aside.

— LARRY GRITZ, SOFTWARE ENGINEERING ARCHITECT, SONY PICTURES IMAGEWORKS

The Foundation Is Steadfast

The Academy Software Foundation is an organization that supports the open source software at the core of our industry. It helps guarantee the longevity of software we all depend on as well as provides infrastructure support for the engineers working in visual effects and animation.

— RACHEL ROSE, R&D SUPERVISOR, INDUSTRIAL LIGHT & MAGIC

The Foundation serves a really important role for the industry. We had concerns about a number of open source projects that were critical and withering on the vine without support. The Foundation provides critical support for those projects which everyone relies on so much.

— STEVE MAY, CHIEF TECHNOLOGY OFFICER, PIXAR ANIMATION STUDIOS

The Foundation Is Valuable

Considering that software vendors are competing and studios are competing to get work, it's endlessly fascinating that we all want to make sure that what we use continues to live and grow irrespective of whether or not you're a member of the Foundation. This is open source code – you can use the tools to create amazing things. That's why the Foundation exists and is invaluable and why it continues to grow and play an important role in our industry. It's a template for other industries as well.

– JORDAN SOLES, VICE PRESIDENT OF TECHNOLOGY AND DEVELOPMENT, RODEO FX

The Foundation Is Relevant

We have technology driven by practitioners whose primary job is to make content and to make movies. So, we really understand the problems. The Foundation provides a framework and a community for collaboration not just with software vendors, but it also reaches larger vendors such as NVIDIA, Microsoft and the IT community. It provides a legal framework that gives the technical communities the ability to collaborate on common building blocks.

– NICK CANNON, CHIEF TECHNOLOGY OFFICER, WALT DISNEY ANIMATION STUDIOS

The Foundation Is Open to All

Anyone can attend the Technical Advisory Council meetings and help drive where the software is going. You don't have to be a voting member.

– RACHEL ROSE, R&D SUPERVISOR, INDUSTRIAL LIGHT & MAGIC

The Foundation Is an Engine of Innovation

Now more than ever we're reaping the benefits of open source projects that have made it into commercial packages. If we had done that individually, we'd be nowhere near where we are now. Larry (Gritz) and I talk about open source software as an engine of innovation and what we are really starting to see is that people believe in open source and the Foundation. Whether it's individual engineers, someone on the governing board, or a key decision maker at a software company, when they believe in it, they're willing to get things done as a community.

– MIKE FORD, CHIEF TECHNOLOGY OFFICER, SONY PICTURES IMAGEWORKS

For a long time the industry has been in a long slow transition toward more and more reusable, acceptable, shared components among organizations they saw as competitors. It's quite hard to make a thing like that happen in small pieces. That's why the Foundation makes sense.

– SIMON ROBINSON, CO-FOUNDER AND CHIEF SCIENTIST, FOUNDRY

The Beginning

In fewer than four years, the Academy Software Foundation has adopted 10 open source projects (four fully graduated, six in incubation) and has hosted several working groups, meetings, and events. Established as a safe harbor for open source projects, the Foundation has become much more: In a remarkably short time, it's become a hub for innovation, and a

Pixar, *Toy Story* (1995), used with permission.

supportive, dynamic community for engineers and developers working to create shared tools for the entertainment industry.

"Because of the successful projects the Foundation has incubated and graduated, there's an expectation that this is the place to go to solve challenging problems and to work on the common problems we all face that are really hard," says Michael Ford, chief technology officer at Sony Pictures Imageworks. "It continues to be the place to incubate and develop projects that benefit the industry. It's also become a place for software engineers and individuals who want to learn more about the media industry to come, and learn, and grow. And for me, it's a place to develop and grow as an industry. A nucleus to help develop the industry overall."

"It's a ground-up organization," says Rob Bredow, senior vice president and chief creative officer at Industrial Light & Magic (ILM), and chair of the Academy Software Foundation Governing Board. "Anyone can participate. It's not a traditional structure where a board of directors directs a CEO."

"The Foundation quickly got to the point where now we wonder, 'How did we ever survive before? How did we get this stuff done that speaks to the central role the organization plays in our day-to-day operation?'," says Larry Gritz, software engineering architect at Imageworks. "We're only a couple years in, but it feels like the Foundation has been there forever because it's so critical."

"Before," was July 16, 2018, a scant four years ago when the Foundation was officially launched. But the road to open source in entertainment began some 20 years earlier.

ASWF created

August 10, 2018
Founding members:

Animal Logic
Autodesk
Blue Sky Studios
Cisco
DNEG
DreamWorks
Animation
Epic Games
Foundry
Google Cloud
Intel
SideFX
The Walt Disney
Studios
Weta Digital

Scitech Council
Open source
Investigation
concludes

01

First project

October 23,2018
OpenVDB
New members:

Sony Pictures
Entertainment
Warner Bros.
Blender Foundation
Visual Effects Society

02

February 8, 2019
OpenColorIO

03

May 1, 2019
**OpenEXR
OpenCue**

NVIDIA
ftrack
Red Hat

04

Open Source Day 1

July 29, 2019
OpenTimelineIO

Netflix
Amazon Web Services
Rodeo FX
MovieLabs

05

September 13, 2019
Apple
Microsoft

06

April 16, 2020
Open Shading Language

AMD
DockYard

07

COVID 19

$1M/year

Open Source Days 2

August 19-20, 2020

Unity Technologies
Conductor Technologies
SMPTE

08

December 15, 2020
Adobe
ETC

09

Open Source Days 3

August 4-5, 2021
MaterialX
Maxon

10

January 28, 2022
WEVR

11

Open Source Forum

March 10,2022
**Rez
DPEL
RawtoACES**

12

May	August	Nov	Feb	May	August	Nov	Feb	May	August	Nov	Feb	August	Jan	March
2018			2019				2020					2021	2022	

Disruption

The 1990's were an exciting, inventive time for people creating digital visual effects and CG animated films. *Toy Story, Terminator 2, Jurassic Park.*

Techniques used to create these films and others offered filmmakers new ways to tell stories. Digital compositing. Soft-bodied characters. Hair and Fur. Crowd behavior. Fluid simulations. The rate of change was accelerated by increasingly powerful workstations from Silicon Graphics (SGI) running the IRIX operating system and by that company's sophisticated software. SGI had purchased Alias Research, Kroyer Films, and Wavefront Technologies and merged them into Alias|Wavefront in 1995. Studios used Alias|Wavefront, other commercial software, and their own proprietary tools to create blockbuster visual effects and animated feature films.

Industrial Light & Magic for Lucasfilm LTD, *Jurassic Park* (1993), used with permission.

Surfing alongside all this technical prowess, though, was a disrupting undercurrent. Digital content creators other than those making films were using increasingly powerful personal computers. So, too, were other industries. And people had begun talking about a more flexible open source operating system called Linux.

Moving to Linux

"The motion picture industry has always been on the cutting edge of technology, so to Silicon Graphics we were like Ford having a racing team," says Ray Feeney, founder and president of RFX, Inc. "Whenever there was a serious issue, SGI's engineers would tackle it because they knew if we were seeing it, 18 to 30 months later it would be an issue at General Motors, other large industry companies, or significant government installations."

But it became clear that SGI decided to no longer focus on the rapid motion picture industry evolution. Once that happened, software that studios depended on would not keep pace with state-of-the-art needs.

"We wanted to move to Linux," Feeney says, "which is open source. But the software vendors were resistant to supporting a whole new ecosystem and figured we couldn't do without their animation and digital content creation tools. So not supporting Linux was considered low risk for them. We needed a production-ready alternative."

After a series of meetings hosted by the VES, several studios laid down the gauntlet. In June 2000, 23 companies signed a commitment to move to Linux, no matter what. If the commercial software vendors refused to provide Linux support, key companies agreed to offer executables and keys to their

proprietary software to visual effects and animation studios: Pixar's RenderMan, ILM's Zeno pipeline, Rhythm & Hues' modelers, and RFX/Silicon Grail's compositor. The combination would make the commercial software less necessary. Word spread about the industry cooperation and the commercial software vendors agreed to attend a meeting.

"We said we were moving forward with or without them," Feeney says. "And that's how as a group we got onto Linux. They had come prepared. They all agreed to provide Linux test versions in 90 to 180 days, and to release commercial versions at their next annual version release."

So, the studios continued using a pipeline made of commercial software and their own tools built from scratch. Among the engineers, though, there was a growing realization that sharing fundamental technology would be an advantage, and some studios released tools as open source — tools they continued to own and support.

Moving in Lock Step

Visual effects studios and animation companies began using Linux in the 90s. But there was more than one version of Linux.

"It got to the point where you needed different workstations to do color grading and animation because there were so many versions of Linux," says Ray Feeney, founder and president of RFX, Inc.

In 2013, the Visual Effects Society invited a group of major software vendors to create a working group to better align Linux support between them. This initiative resulted in the VFX Reference Platform, a list of major library and tool versions that are updated annually with the objective of being a common platform for all VFX and animation studios and software providers to target. The first release in 2014 included OpenEXR, OpenSubdiv, and OpenColorIO among others.

"The VFX Reference Platform helped the industry immensely to settle on migrating in lock step toward new versions of Python and other stuff, and that highlighted the important things happening in other areas of open source like OpenEXR," Feeney says.
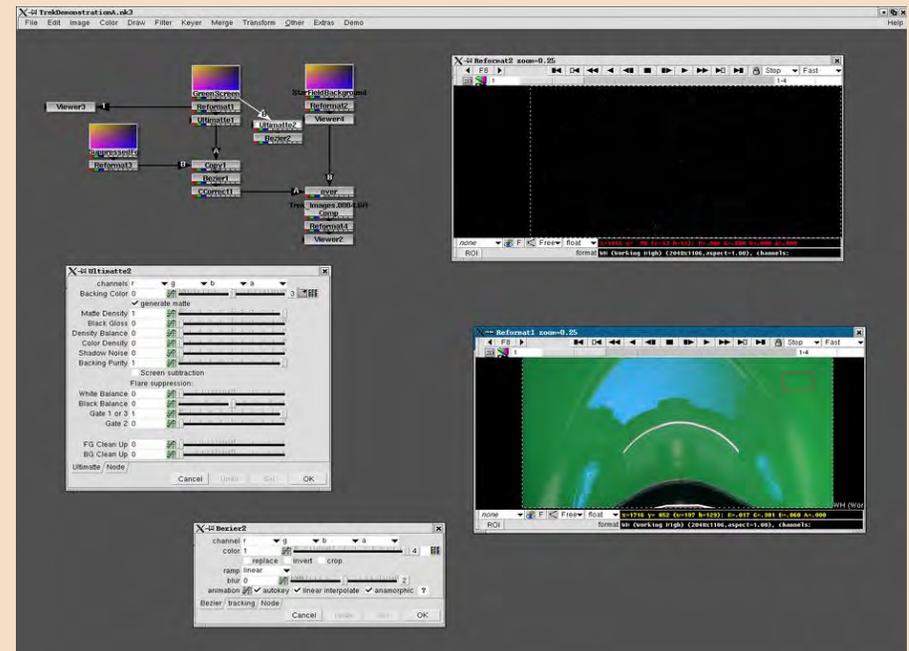
Early version of D2's Nuke on Linux, circa 2002-2003.
Source: Academy Software Foundation

Harry Potter and the Sorcerer's Stone. Used with permission.

Early Open Source Tools

One of those tools was EXR, developed initially at ILM in 1999 by Florian Kainz and Rod Bogart and first used for *Harry Potter and the Sorcerer's Stone* in 2001. EXR offered, for the first time, a high dynamic range format for images in one file that could contain multiple channels for motion depth, motion vectors, and other possibilities.

In 2003, ILM offered source code for what they called OpenEXR to the community. It was one of the earliest open source software projects specific to visual effects. And by 2007, when Kainz received an Academy Technical Achievement Award for developing OpenEXR, it was an industry standard, supported by many commonly used digital content creation and rendering tools. It enabled easier data interchange across studios.

"We realized EXR would benefit a lot of people and if more people could read and write it, it would be less work for us," says Rod Bogart, who was at ILM at the time and is now a senior software engineer at Epic Games. "As soon as we released it, it showed up quickly in products, which was great."

The release of EXR as OpenEXR encouraged other studios to share their internal projects as open source.

Volumetric Fire Simulation with OpenVDB in *How to Train Your Dragon*. Used with permission.

In 2003, Sony Pictures Imageworks developed and released OpenColorIO, a format agnostic color management solution suitable for high-end production. Like OpenEXR, it represented years of production experience for feature films.

And, in 2012, DreamWorks open sourced VDB created by Dr. Ken Museth who invented it in 2009. VDB made it possible to flow volumes in simulations into an infinite domain, yet still be represented compactly in memory and on disk, and be quick to query.

"VDB solved an ongoing problem," said Andrew Pearce, vice president of global technology at DreamWorks. "We needed it to do things such as fireball explosions for the dragons in *How to Train Your Dragon.* There was nothing else like it available. And, there was lots of industry demand."

As these projects became ubiquitous, other studios began requesting and adding features. And, the pros and cons of managing an open source project became evident.

PROPERTY OF DREAMWORKS ANIMATION

Rod Bogart left ILM in 2005, but Kainz continued to support OpenEXR at ILM.

"For the next seven years or so after we released it, I was working on OpenEXR at least half of the time with some periods where I was working on it full time," Kainz says. "OpenEXR continued to grow. There are always things, no matter how careful you were when you designed it, that aren't quite right or new features that people want, and you have to think really carefully about how you're going to add those without breaking compatibility and without cutting off avenues to implement even more features later. Sometimes outside people would contribute some amount of code that had to be integrated, but for quite a while, it was mostly that people would request features and we'd figure out how to add them."[1]

Pixar, *Monsters Inc.* (2001), used with permission.

In 2013, Weta's addition of deep image support to OpenEXR resulted in version 2.0, and the next year, DreamWorks contributed a lossy compression technique.

And then, in 2014, Kainz left ILM.

"OpenEXR was ubiquitous," Pearce says. "But after the maintainer left the company, eventually it was sitting there without anyone taking as much care of it. Everyone was depending on it, but people were making changes that weren't compatible. We realized it would cease being a standard. Then a couple years later, Ken Museth said he was leaving DreamWorks and I thought, 'Oh boy. This is like ILM with OpenEXR. The expert is going to be outside the company."

The same thing happened with OpenColorIO.

"The original author of OpenColorIO left the industry," Gritz says. "The project was stalled. It wasn't in as bad a shape as OpenEXR, which was beginning to get nastygrams from Linux distributions. People were starting to file security issues. If a company like Autodesk, which sells to the government, too, decided to drop support because of security risks, it would have defeated the original goal of OpenEXR being a common format. It was a scary cliff."

Once again, the studios faced an unsettling problem that affected all of them. They were committed to the open source operating system Linux, and were using and releasing open source tools. But, as with IRIX back in the day, there was no assurance the tools would be maintained, updated, and continue to be production ready. "Versionitis" had crept in. Studios might have had to revert back to building their own plugins for each piece of software.

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1 ASWF Deep Dive: OpenEXR Origin Story: Part 2. Accessed 17 February, 2022. https://www.aswf.io/news/aswf-deep-dive-openexr-origin-story-part-2

Joining Together

In June 2016, the Academy's Science and Technology Council began an investigation into the use of open source software in the motion picture industry.

A survey by the Academy's SciTech Council found that almost 84% of the industry used open source software at that time, particularly for animation and visual effects, but barriers to adoption included siloed development, managing multiple versions of OSS libraries (versionitis), lack of governance and confusing licensing models. These needed to be addressed in order to ensure a healthy open source community.

The council also hosted a series of summits led by committee chair Rob Bredow, then CTO of Lucasfilm, now senior vice president and chief creative officer of ILM; Andy Maltz, then managing director, now senior vice president of the Academy Science and Technology Council; and David Morin, then industry consultant and open source investigation project lead, now director of industry relations at Epic Games and the Foundation's executive director.

Other members of the original committee were Paul Debevec, then senior software engineer at Google VR and Science and Technology Council co-chair, now director of research for creative algorithms and technology at Netflix; Ray Feeney, RFX; Cary Phillips, R&D supervisor, ILM; Steve Sullivan, general manager, Mixed Reality Capture Studios at Microsoft; and many others.

At the first summit, attendees asked the Linux Foundation to develop an independent analysis of the industry's open source ecosystem. The analysis presented at the second summit on August 3, 2017, recommended the creation of a software foundation for open source projects developed in the motion

> ## "[Technical leaders] wanted to build open source libraries, but had no idea how to sell the idea and get others to agree."
>
> — **MIKE DOLAN, SENIOR VICE PRESIDENT OF PROJECTS, THE LINUX FOUNDATION**

picture industry. The attendees voted for the Linux Foundation to lead the development of a proposal to set up a motion picture software foundation.

"We realized that having our Foundation operating in partnership with the Linux Foundation was the right combination," Bredow says. "The Linux Foundation is open and inclusive. It provides the infrastructure and the legal and corporate services that we need."

At the third summit on February 12, 2018, the Linux Foundation presented a proposed structure for governance, infrastructure, and legal services developed after a series of collaborative work streams during the investigation.

Helping facilitate the work streams was Mike Dolan, senior vice president of projects at the Linux Foundation.

"The thing most interesting to me was that the request came from developers," he says. "It was not at the CSO (chief strategy officer) level who would have to sell it down the organization. The request came from technical leaders involved in movie creation. They wanted to build open source libraries, but had no idea how to sell the idea and get others to agree. Overprotective lawyers told them they couldn't do that. Business managers cared only about the next movie. When a visual effects person tried to talk to them about tools, they had no idea what they were talking about. They'd say, 'You want us to sell our IP? Why would we do that?' It took time."

Dolan led discussions that brought together lawyers, business management, and technical teams from studios and vendors.

"This was the whole industry having the conversation together," Dolan says. "We opened the doors to rational discussions that weren't there before. The fundamental argument was that this is bigger than any one company. Can we facilitate an environment, share code bases that can be fundamental building blocks and reduce costs? I don't think anyone had made the business case before."

But what convinced the lawyers?

The Formation of the Academy Software Foundation

"The engineers were the ones who convinced the lawyers we should do this," Dolan says. "They had been so segmented from legal counsel, they hadn't known where to go. The only lawyers they knew were patent attorneys. The engineers were frustrated by having to rebuild tools, rebuild the plumbing, because it took resources away from creating the next great innovation. But lawyers are risk managers and the business side didn't understand, so it was up to the engineers."

Members of the Academy Software Foundation. Source: Academy Software Foundation

PREMIER MEMBERS

Academy · Adobe · AMD · AUTODESK · aws · DNEG · DREAMWORKS · UNREAL ENGINE · Google

intel · Microsoft · NETFLIX · NVIDIA · Sony Pictures imageworks · unity · Walt Disney Studios · weta DIGITAL

GENERAL MEMBERS

ANIMALLOGIC · FOUNDRY. · ftrack · MAXON A NEMETSCHEK COMPANY · redhat.

RODEO Visual Effects Company · SideFX · WB · Wevr

ASSOCIATE MEMBERS

blender · etc ENTERTAINMENT TECHNOLOGY CENTER · movie labs · SMPTE · VES Visual Effects Society

"As an engineer, the last thing you want to think about is the legal framework," says Rachel Rose, R&D supervisor at ILM.

At that third summit on February 12, 2018, a non-binding poll resulted in an initial participation of 11 Premier members and 8 General members, which would generate approximately $650,000 in funding per year. Companies and studios had until July to become a founding member. With permission from AMPAS for the use of the name, The Academy Software Foundation (the Foundation) was officially founded the next month, August 2018.

Today, there are 18 premier members, nine general members, and five associate members.

Its mission? To increase the quality and quantity of open source contributions by developing a governance model, legal framework and community infrastructure that lowers the barrier to entry for developing and using open source software.

First Foundation Projects

The first projects considered by the new organization were OpenEXR, OpenColorIO, and OpenVDB. The first project accepted was OpenVDB.

"I wanted it to be the first project adopted to demonstrate DreamWorks' commitment to the Foundation and our belief that it is going to be a key industry player," Pearce says. "I wanted to have Ken (Museth) involved, and since he was outside the company now, it would be easier for him to steer the project." In fact, Museth, who is now a senior director of simulation technology at NVIDIA, is presently the lead architect on the Foundation's OpenVDB project.

Volumetric Clouds in OpenVDB for *Trolls*. Used with permission

PROPERTY OF DREAMWORKS ANIMATION

Today

Today, the Foundation has four adopted projects. OpenEXR followed OpenVDB, as did OpenColorIO, whose design and development at the Foundation is led by Autodesk. OpenCue for render management from Imageworks became the fourth adopted project.

The six Incubating projects include OpenTimelineIO, an open source API and interchange format for editorial timeline information developed by Pixar; Open Shading Language (OSL), an advanced shading language for production GI renderers from Imageworks that had earned Larry Gritz an Academy Technical Achievement Award in 2017; the Raw to Aces utility for converting digital camera RAW files to the Academy Color Coding Specification container files; MaterialX, an open standard for materials and look-development content from ILM; Rez, a cross-platform package manager developed by Allan Johns, now a senior lead pipeline engineer at Method Studios, while he was at Dr. D Studios; and Digital Production Example Library, which recently grew from a working group into incubation.
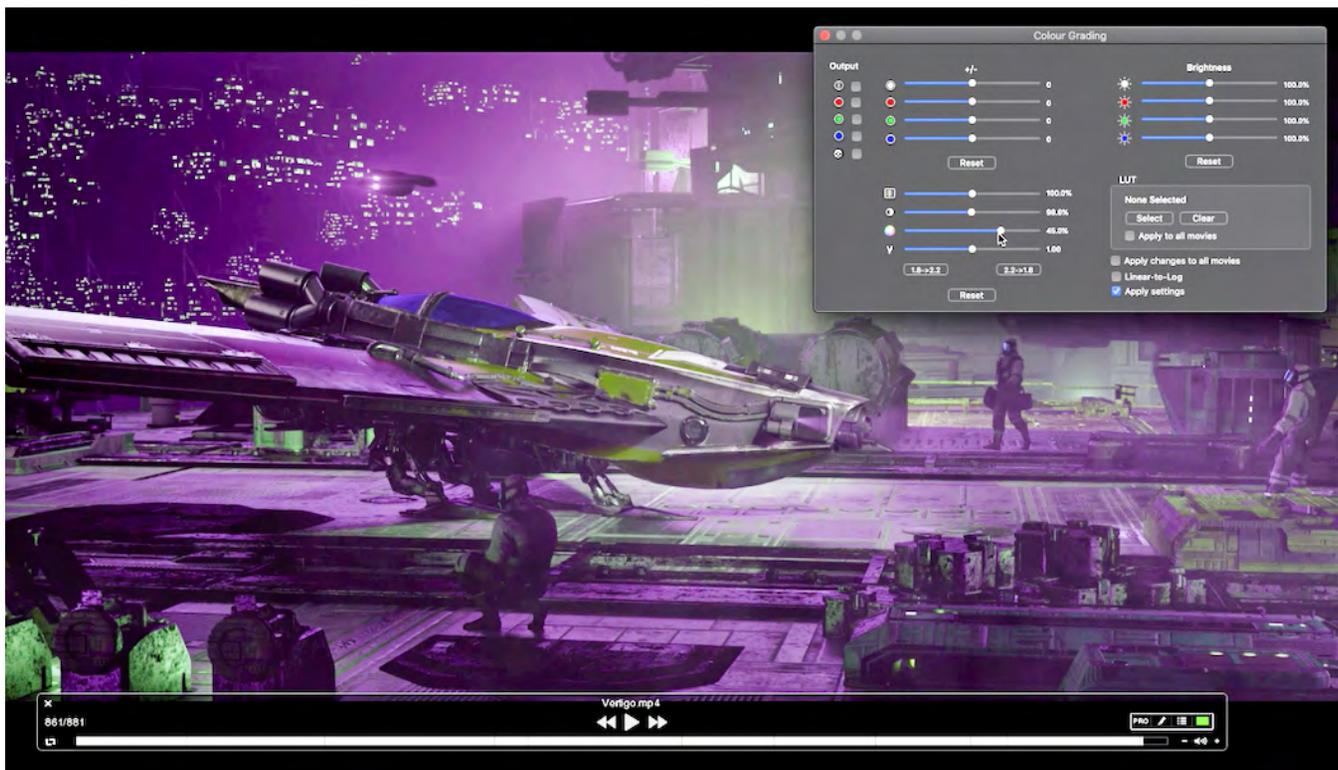
TOP: OSL Example from ASWF YouTube.

BOTTOM: ftrack OCIO support in cineSync. Used with permission.
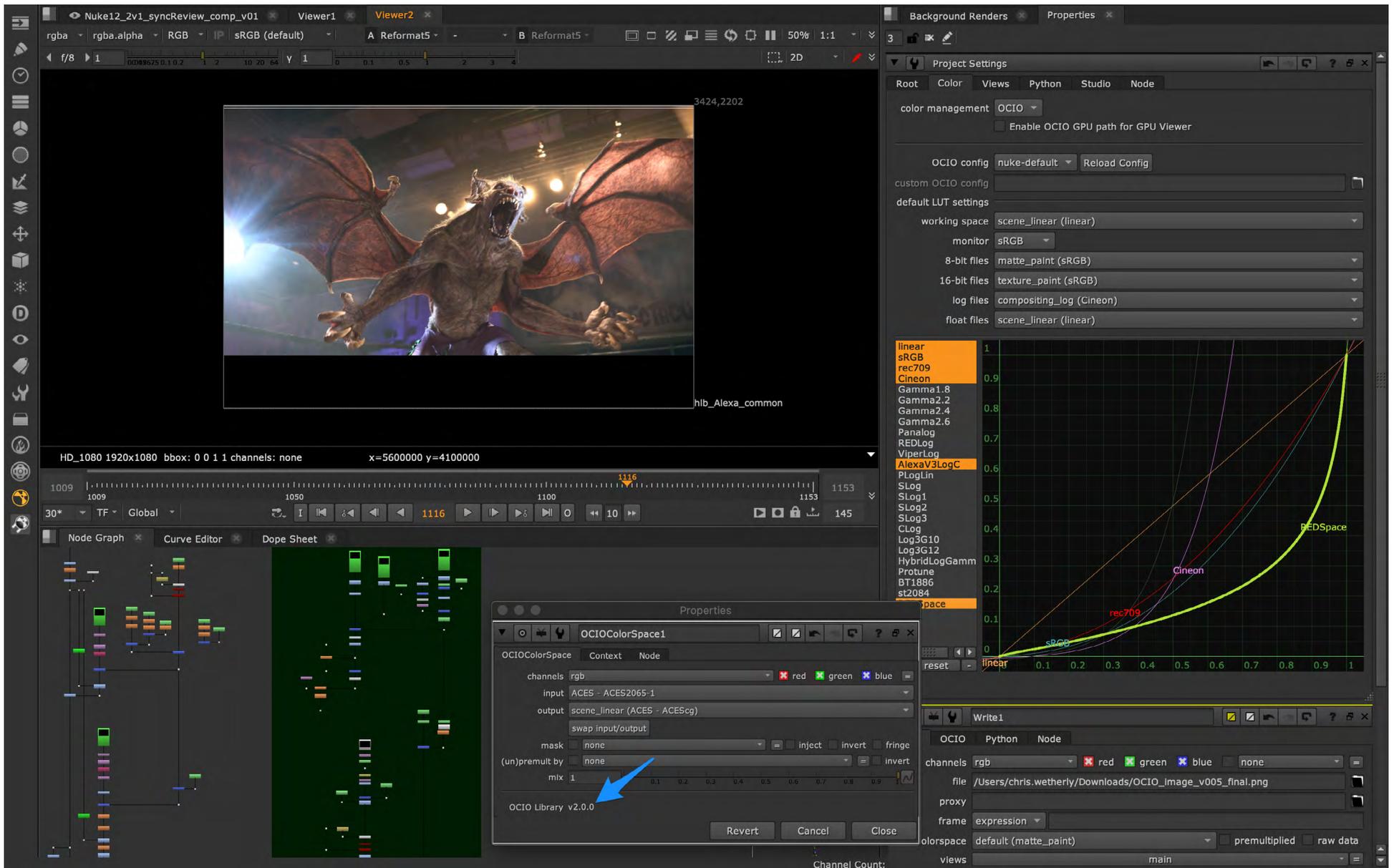
Foundry, OCIO Library v2.0.0 ColorSpace in Nuke. Used with permission.

Foundry, OpenTimeline IO Support in Nuke 13.2. Used with permission.

Project Management

A broad community of software engineers contributes to these projects. Overseeing the collaboration is the Technical Advisory Council (TAC) comprised of engineers, programmers, managers, and supervisors from studios, software companies, media companies, hardware manufacturers, and other non-profit organizations.

Working with the TAC to set the overall scope for the Foundation is an 18-member governing board made of Premier Members and one General Member representative. The board is responsible for budgeting and other business oversight. The governing board does not make technical decisions.

Each project has a different governance model; the person or organization submitting the project writes their own "consti-tution." Sometimes a single person oversees a project, but usually a council votes on features that go beyond simple bug fixes. In any case, contributions from anyone are encouraged and welcome, whether the contributor is a Foundation member or not. Each project's technical steering committee, the TSC, is comprised of interested engineers and others, typically meet once a month, but sometimes more often.

Film Editor Axel Geddes working with OpenTimelineIO. Used with permission.

"Any engineer anywhere in the world can make corrections and have their ideas implemented. We're making it easy to contribute to open source. You might think you have to be the best coder in the world, but most people can contribute in one way or another."

— ROB BREDOW, SENIOR VICE PRESIDENT & CHIEF CREATIVE OFFICER, INDUSTRIAL LIGHT & MAGIC (ILM), CHAIR OF THE ACADEMY SOFTWARE FOUNDATION GOVERNING BOARD

TOP: Academy Software Foundation Structure. Source: Academy Software Foundation

BOTTOM: Academy Software Foundation Contributor Growth. Source: LFX
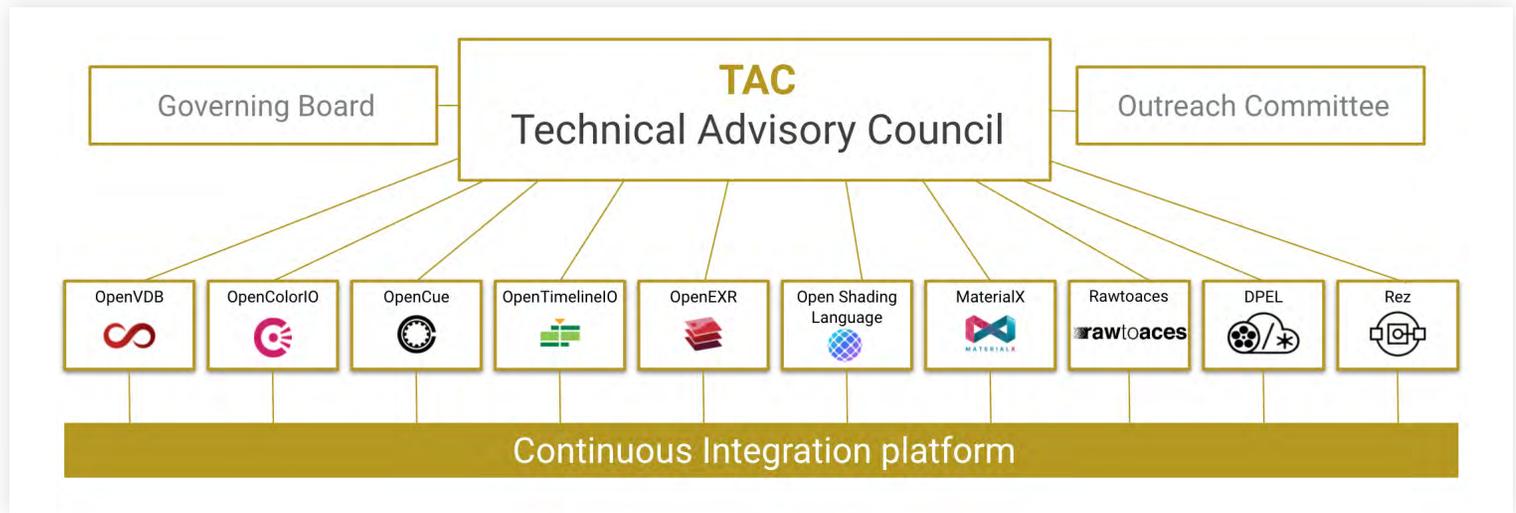
Contributor Strength

The growth in the aggregated count of unique contributors analyzed during the selected time period. A contributor is anyone who is associated to the project by means of a commit or any activity on Pull Requests / Changesets.
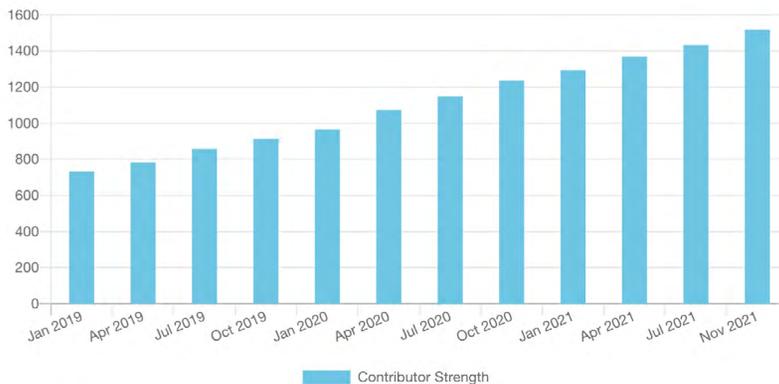

Key Insights

- The contributor strength **increased** by **106%** during the last 3 Years.
- The contributor strength grew the most between the time period **Jan 2020 and Apr 2020** during the last 3 Years.
- The average contributor strength was **1111** during the last 3 Years.

"Any engineer anywhere in the world can make corrections and have their ideas implemented," Bredow says. "We're making it easy to contribute to open source. You might think you have to be the best coder in the world, but most people can contribute in one way or another whether that's fixing a bug, writing documentation, or doing something more substantial that requires specific skills. Making the tools and process as accessible as possible to a wide group. It's been a game changer."

Since August 2018, there have been 54,200 contributions to the open code in 14 Foundation repositories; 3,110,000 lines of code. The number of unique contributors doubled from 734 in January 2019 to 1519 in November 2021.

"Every project we have has grown in terms of contribution over time since they joined the Foundation," says Executive Director David Morin. "And the community around them has grown by the simple fact that people know where to go to participate. The experts are there, the interns are there, and everyone in between. The community works together to organize, keep projects on schedule, and follow up."
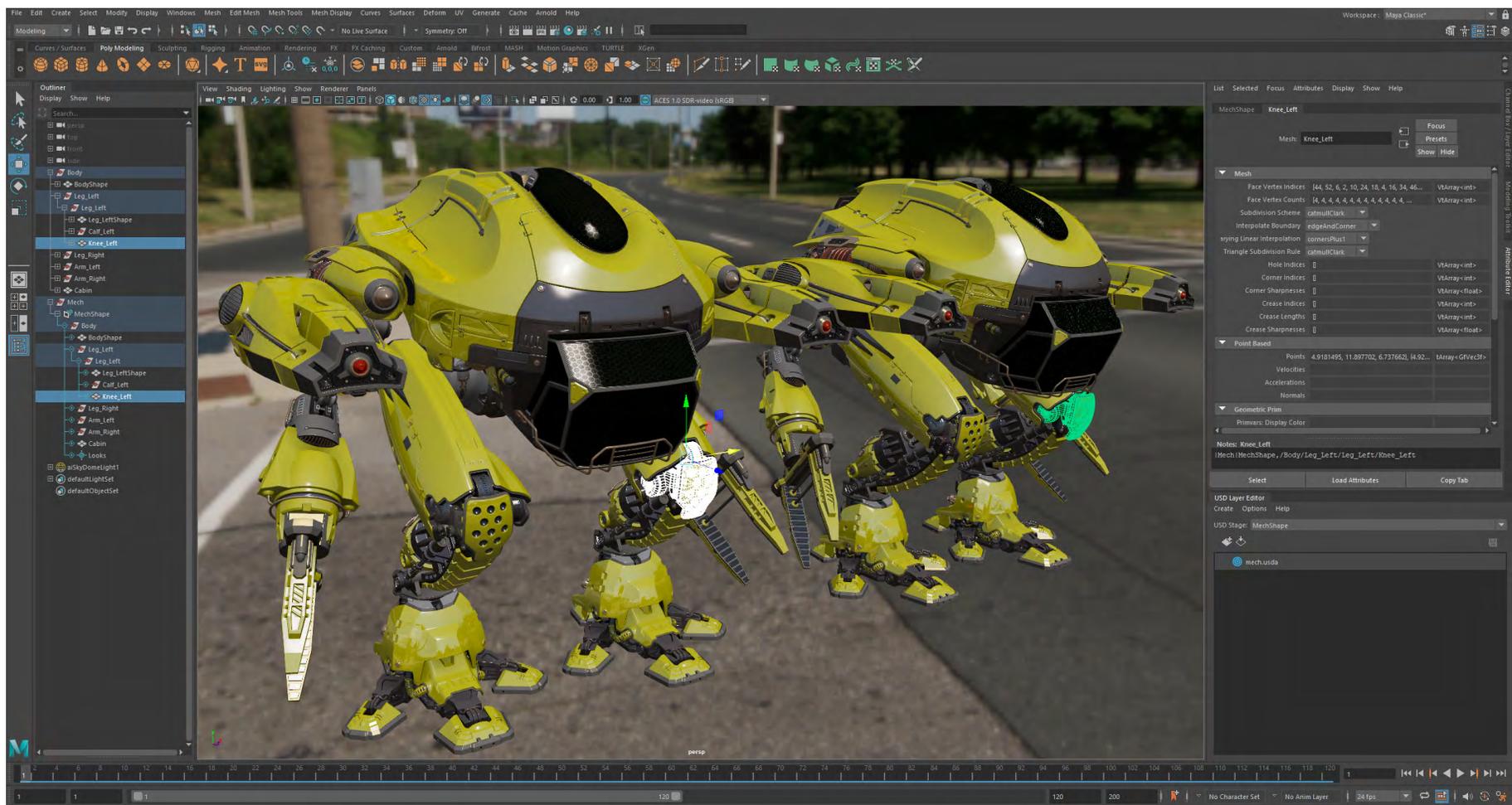
Maya's USD integration makes it possible to work directly with USD data in common Maya editors like the Viewport, Outliner, and Attribute Editor. Used with permission.

Contributing to Projects

As Bredow noted, Foundation projects and working groups are open to anyone who wants to show up. Anyone can submit a project. Anyone can attend Foundation meetings and events. Anyone can contribute to the projects and working groups. And, they do.

"We rely on member organizations to keep the lights on and grow the foundation," says Kimball Thurston, head of engineering at Weta Digital. "But there is no barrier at all to contributing."

Thurston offers an example.

"J. T. Nelson is a collaborator who wants to push open source forward in storytelling," Thurston says. "He isn't currently part of a paying member organization, but he comes to the meetings and contributes and we listen to what he has to say. He helped get a Jupyter notebook preview going for Universal Scene Description (USD) so you could see how a web-based pipeline plays with USD in the browser. It was super cool. He just showed up and did that."

Scene using OpenVDB in *Croods*. Used with permission.

Leaning In

Why do people and companies contribute to the Foundation? The open source projects are ubiquitous, and that carries a huge responsibility. The good idea posited four years ago has become a necessity and a path to future innovations.

"We all use these projects," Bogart says. "We want to make sure we all have access to them and they continue to work and are kept up as the world changes."

"If I had to pay a company for every instance of an OpenEXR reader we had, my costs would spiral out of control," Pearce says.

Foundation collaborators cite other reasons, as well. Open source projects help studios working on multi-vendor films up their game.

"We want to create the very best images in the most efficient manner possible with tools we can all use and enable us to share things back and forth," says Jordan Soles, vice president of technology and development at Rodeo FX. "The ability to share between studios is in part built upon a lot of the open source software and principles that exist. If you're able to share things and pull them into your system quickly, you'll definitely see that extra time on the screen."

Software vendors and software developers within studios appreciate that engineers can concentrate on building creative tools rather than foundational tools.

"We are successful as a software company in the M&E space because the ecosystem itself is healthy," says Eric Bourque, senior director, engineering, entertainment & media at Autodesk. "Making the case for why we should have our full-time engineers write code everyone can use freely required a shift in thinking. Having a common foundation of components makes everyone's software more relevant, robust, and maintainable. Having more eyes looking at the foundational pieces makes them stronger. We provide value by building workflows on top of that foundation, by building tools for artists."

For studios, knowing that open source projects will continue to be useful, viable, and best in class is vitally important.

"The Foundation gives us trust in the viability of these open source projects," says Rachel Rose, R&D supervisor at ILM. "We want to make sure these projects that sit at the center of a software stack don't go away. The Foundation provides a feeling of relief that the tablecloth won't be pulled out from under everything. But, the thing that's so important to me about open source is the collaboration. The Foundation brings people together to come up with better ideas, to find the best answer versus one person's answer. That's something we all want to strive for."

Linux Foundation's Dolan gives an example of one way in which the Foundation helps ensure the longevity of the projects.

"There aren't a huge number of color scientists," he says. "Everyone is fighting over a limited number of experts. But

because of the Foundation, someone can switch companies and continue to work on OpenColorIO."

And that's exactly what happened for color scientist Carol Payne.

"The Foundation gives us trust in the viability of these open source projects. We want to make sure these projects that sit at the center of a software stack don't go away. The Foundation provides a feeling of relief that the tablecloth won't be pulled out from under everything."

— RACHEL ROSE, R&D SUPERVISOR, INDUSTRIAL LIGHT & MAGIC

Payne says, "Open source depends on the people who do it. I was at ILM when I first started contributing to the Foundation – helping find bugs and being a power user of OpenColorIO. Now I'm at Netflix, and I helped develop the latest version, overhaul the documentation, and re-do the website. OpenColorIO provides a framework for color management systems that enables users to write a config file once and use it in many software programs rather than doing the same task over and over and over again. Software applications use it on the back end as a basis for color science recipes. You feel a sense of community and responsibility to shepherd this work and make it the best it can be. Being part of that process makes me better at what I do. It's been rewarding for me."

Recognizing Engineers

Engineers working on projects and contributing to the working groups come from the community and member companies. For these software engineers and developers, the opportunity to be part of a thriving technical community at the Foundation that exists beyond the workplace has become important. Interviewees noted that in this community, they can speak the same language, exchange ideas, and demonstrate their skills.

"We're seeing a side benefit to the Foundation that in retrospect is obvious," Bourque says. "Our internal developers love that people can see the work they're doing. Visual effects artists can see their work on the screen in the theater, unlike someone working on code. Now, their code is exposed and people can learn from it – they can be proud of their work because it's out there. Others are able to benefit from their contributions, which is very motivating to the individuals working hard on these open source projects."

The same benefit is true for engineers and developers in visual effects and animation studios.

"One purpose for the Foundation, and I hope it grows, is that it's a real boon for people in facilities who are toiling away on internal R&D projects," Gritz says. "They might get a once a year hit if they make it to SIGGRAPH. But the open source projects can provide a huge amount of networking. The stuff you're working on may not be visible beyond the three people working on it, and there are like two people in your company who get what you're working on. At the Foundation, there's a community of people from different studios who can exchange ideas. There's a lot of common ground on technical matters. I've seen people become recognized by their peers and grow professionally. Junior people can grow and shine and get

TOP ROW: Aliza Carpio, David Aguilar, Dhruv Govil

SECOND ROW: Rachel Rose, Rebecca Bever, Robin Rowe

THIRD ROW: Sean Cooper, Shabnam Abbarin, Simon Yuen

BOTTOM ROW: Susan Salituro, Tram Le-Jones

recognition for things they do. There's a more visceral feeling that goes beyond making contributions."

"Behind the Screens" on the Foundation website provides engineers with visibility and recognition beyond the projects they're working on through profiles and interviews.

"Most engineers don't do their work for the accolades, but there is certainly an interest in being seen for the awesome work being done to drive forward artistry," Rose says. "That the Foundation is making it a goal to highlight engineers is something we all appreciate."

"The visual effects industry is a service industry," Soles says. "It doesn't get the glamor that other areas of this industry get but it's vitally important. And the people in it are all artists. I see the same level of creativity, the exact same level of creativity from our software engineers and developers. There are a lot of software engineers writing amazing code. It's nice to be able to shine a light on the development teams responsible for the tools."

Submitting a Project

On the Foundation's main website (https://www.aswf.io) are meeting notes, information on working groups; a calendar of upcoming meetings; blogs, profiles of software developers, engineers, TAC, GB, and staff members; and links to github for interactive project management and development. It's an interactive, thriving community resource.

The website also provides information for those interested in submitting projects.

"We can adopt projects or create projects that respond to a need," Morin says. "That's our role. When a developer thinks about open sourcing software that others might need, we're

available to help, even if it is not one of our projects. We don't take over projects. If a company wants to submit an existing project, we have a clear process for submitting. The engineers on the TAC look at all submissions, do the due diligence, and vote for adoption."

"There was a concern with OpenVDB that we'd lose control," Pearce says. "But you get to write the 'constitution.' You can specify who the benevolent dictator for the standard will be, how people can vote, and how you replace people. You set up the parameters."

"The visual effects industry is a service industry. It doesn't get the glamor that other areas of this industry get but it's vitally important. And the people in it are all artists."

— JORDAN SOLES, VICE PRESIDENT OF TECHNOLOGY AND DEVELOPMENT, RODEO FX

That process starts with the Project Contribution Proposal Template on the Foundation website: https://tac.aswf.io/process/proposal_template. In addition to the project name and description, the form asks about the current state of the project, how it is aligned with the mission of the Foundation, and other information.

Once accepted, a project moves into incubation where it must gather a healthy number of committers from a diverse contributor base an ongoing flow of commits and merged contributions, achieve a Core Infrastructure Initiative Best Practices Badge, and complete an initial license scan of the

project codebase, among other requirements in order to achieve Adopted status.

Adopted projects benefit from code hosting, dynamic scaling, automated test and build, source code analysis, release distribution, collaboration tools, issue tracking, consultative support, 24/7 monitoring for proactive maintenance and incident response, SSL certificate and domain management, and much more.

Anyone can propose a project.

"Just the other day someone who maintains an important set of tools submitted their application for a project," Bredow says. "That was fantastic. It was based on this person attending project meetings, seeing how the Foundation works, and realizing this would be a healthy home for their project."

But maybe not the kitchen sink.

"We like to foster projects in the media and entertainment space, especially when you're talking about storytelling," Thurston says. "Some projects have a life of their own and feel they don't need what the Foundation provides, and then decide they do. MaterialX moved into the Foundation during the North American summer. It had been a project on its own like many others, but they felt they would be better served by a larger organization. Pretty much any project can show up, although we are unlikely to take on projects outside our industry."

The *Moana* Island Scene. Publicly available dataset courtesy of Walt Disney Animation Studios.

Working Groups Spark Innovation

One way in which the Foundation has expanded its scope and influence is through projects and working groups that "color outside the lines." Among them, three innovative undertakings are generating a lot of buzz: the Digital Production Example Library project, and two working groups, one for Diversity and Inclusion(D&I), and another for Review and Approval. Each in its own way points toward possible future directions for the Foundation.

Digital Production Example Library

The Foundation's groundbreaking Digital Production Example Library project was initially inspired by a SIGGRAPH research community discussion. That discussion led Disney Animation CTO Nick Cannon to look for some way to help researchers struggling to find real world production data for render research.

"I asked filmmakers if they would agree to open source an environment from a film," he says. "I wanted to make real production data available to the research community.
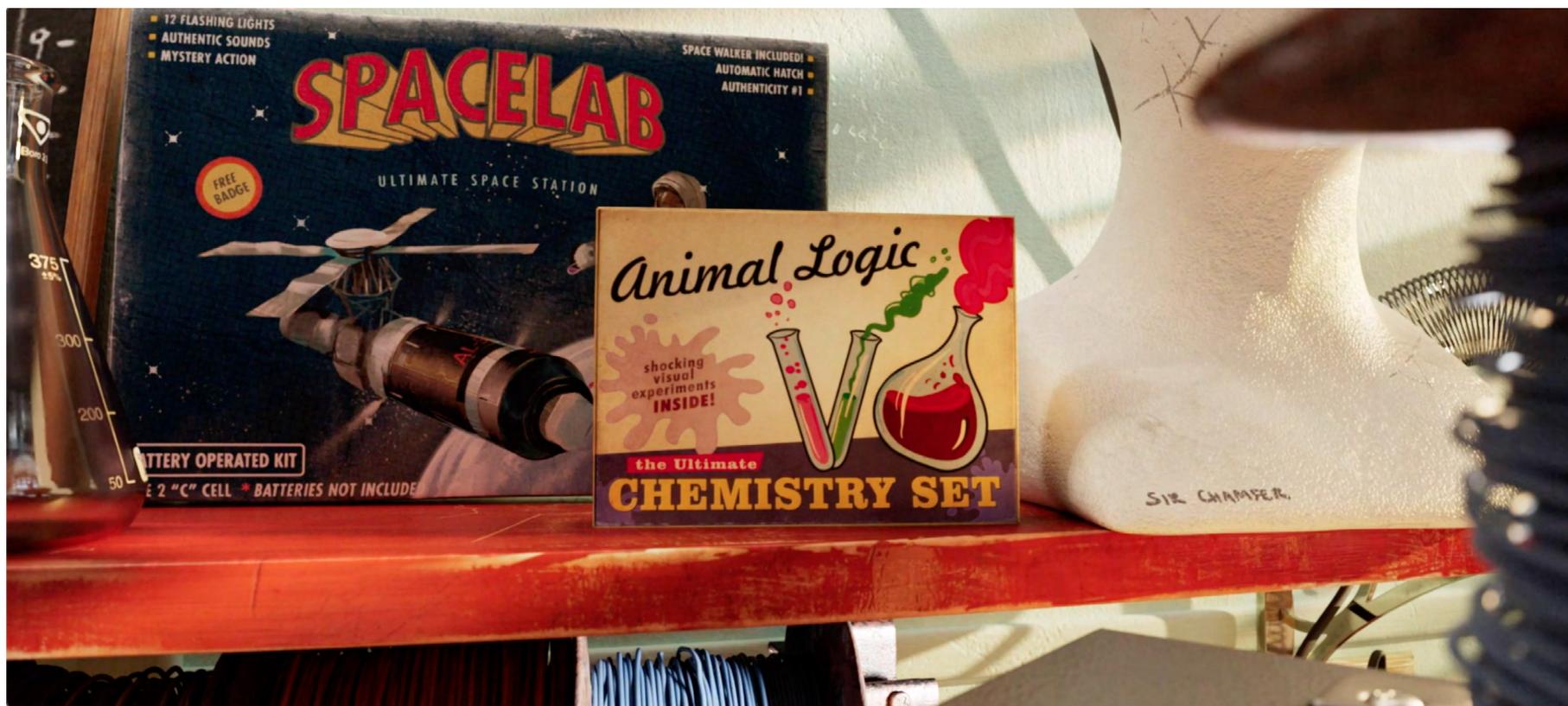
"We took the Moana island scene, an environment from Moana's home island in the movie, extracted the proprietary code and made it more standard," Cannon adds, referring to Disney's popular animated feature. "Now anyone can download that scene and use it. I hope we've inspired others to do the same."

Disney released the Moana island scene in 2018. The positive reception to the dataset and the clear need for more inspired the Foundation to open a working group, which evolved into an incubating project. The working group quickly identified licensing as the key roadblock to making production data available for use. The result is the Academy Software Foundation

Digital Asset License for content used strictly for testing and documentation.

"This is so reflective of open source and the Foundation in general where many of the individual projects are not the groundbreaking part; they are the foundation for the groundbreaking part," Autodesk's Bourque says.

"One of the advantages all studios have is that they can test internal software on actual production data," he adds. "They have the real assets. But those assets have IP, so they can't be shared. Someone at a studio might report a bug in Maya, but they can't share what produced the bug. We want to have

a way to benchmark, validate software, and learn how studios work. It's easier with real production data."

Now, software vendors like Autodesk and others can adopt the Open Asset Digital Assets License to test their research with real production data. The Foundation's Digital Production Example Library can house Hollywood-scale testing data.

Joining Disney in providing data is Animal Logic, the first to adopt the Foundation's Digital Asset License and release production assets.

"Animal Logic provided an asset from their USD ALab," Bourque says. "It's sparking a lot of good conversations because it is showing an interpretation of how USD can be used in production."

VFX Careers:
Art + Technology led by
Rachel Rose.

The hope is that data released under the Digital Access License will turbocharge innovation.

"The Digital Production Example Library project is filling a need to have a set of data that represents the type of work we do and can be used openly by companies, universities, and students that can push forward the state of the art," Rose says. "I was in school for a long time getting my PhD, and it was really hard to get the data I needed. This provides that opportunity and levels the playing field."

That playing field might extend beyond the entertainment industry, as well.

"The more you can democratize and provide examples of the types of complex scenes as they are really built, the more that software vendors can see the complexity and develop around it," Ford says. "And those outside the industry can see, too. They can see the detail in the textures and what goes into a feature film model. It's not just the polygon count. They see it's well beyond what they thought."

Diversity and Inclusion

Already opening people's eyes are efforts by the Foundation's D&I working group. Opened in June 2020, the group has grown to 127 members.

The Academy Software Foundation is not the first organization in the entertainment industry to recognize the lack of diversity among its members. But there is an especially serious lack of diversity in the ranks of engineers and computer scientists working in the entertainment industry.

"When I graduated, I was one of only a couple women in that class," Rose says. "The number of women we have in computer science is still pretty sad. Software development is quite an art; there's a lot of art in the science. It requires

Presenting VFX Careers: Art + Technology

Kathryn Skorpil
DreamWorks

Shabnam Abbarin
Sony ImageWorks

Aileen Bustos
DreamWorks

collaboration and cooperation. And when we have multiple people with varied backgrounds and opinions, we get better software."

In 2020, the Foundation governing board and leadership asked Rose and Carol Payne if they would co-chair a working group on diversity and inclusion.

"Open source has the power to break down racial, gender, and corporate barriers to unite people around a shared goal," says David Morin, the Foundation's executive director.

"When you think about open source, ideally it's open in all aspects," Payne says. "Open is open. Anyone from any background should be able to contribute, and technically they can. But we find in practice that the baseline metrics reflect the industry overall. We see this working group as an opportunity to drive change."

"It gives us the opportunity to bring diverse voices into software development," Rose says. "Many of the most influential companies in the industry are putting resources and money into the Foundation, so this is a natural way to affect the industry and software engineering. Obviously, it is not a simple problem to solve. The film industry will not change overnight. But it won't change without grassroots efforts and the Foundation has access to the grass roots."

The D&I working group identified three goals. First, to provide information in a central location for members to learn more about D&I. With this in mind, the group is working toward bringing D&I efforts at various companies together into one description that studios and companies can use as a foundation.

Second, they are trying to affect the makeup of the Foundation itself to better reflect the communities in which people live.

The third goal is to educate communities at large and bring more engineers and scientists into the open source community. When Rose speaks at computer science conferences, she highlights the fact that the entertainment industry is at the intersection between art and science.

And, the D&I group is reaching out to students.

"Kids know about games, and they have exposure to writers, directors, and actors, but they don't make the connection between writing code and making movies," Payne says. "We let them know they can work on cool content; that code writing is instrumental toward making movies and television shows happen."

"Open source has the power to break down racial, gender, and corporate barriers to unite people around a shared goal.

— DAVID MORIN, EXECUTIVE DIRECTOR, ACADEMY SOFTWARE FOUNDATION

The first educational initiative, carried out during the pandemic, was a webinar series of six one-hour lectures, each featuring three individuals within the industry. Five lectures were on specific technical careers, the sixth was on how to use open source software.

"We shine a light on the people behind the scenes," Payne says. "We brought in technical directors, animators, color scientists, and others who talked about what they do and how they use open source in their careers."

Supporting the Ecosystem

The Academy Software Foundation is one part of a large ecosystem of open source tools supporting the entertainment industry. Pixar CTO Steve May describes how three organizations within the ecosystem function in regard to each other.

"The Foundation serves a purpose as a central home and does that with the Linux Foundation," he says. "Rather than owning a technology like the Foundation, the Visual Effects Society's VFX reference platform is focused on owning an unofficial policy about an alignment between vendors and studios. The vendors can rely on the Foundation to make open source software they can continue to rely on. And the VFX platform tries to reduce the friction so they can support us. I have less experience with MovieLabs, but they look at where the future of the industry is heading in broad terms. It's not a big industry, so there's overlap. But the way it's organized makes sense."

The Foundation works with the VES Technology Committee to coordinate releases of software that will go into the VFX reference platform.

"That a group of studios and vendors will get together each year to determine which version and library to move forward, showcases the willingness within this industry to work together to make sure the tools and product we create are great," says Jordan Soles, vice president of technology and development at Rodeo FX. "It's incredible."

On the Foundation website is the ASWF Interactive Landscape, a dynamically generated interactive compilation of open source projects, a map of the ecosystem with which viewers can explore open source projects within the animation and visual effects industry, a list of Academy Software Foundation members, and more. (https://landscape.aswf.io)

The Foundation has organized the open source tools by categories. This means anyone can get a quick look at all the tools in a particular category using various parameters. For example, it's easy to see all of the rendering and lookdev open source tools available, only those that are Foundation projects or projects in incubation, the Foundation members' products/projects, or only the non-Foundation member products/projects in the category. The same is true for other categories including pipelines, timelines, image formats, geometry, and so forth.

Open source in entertainment is huge. The ASWF Open Landscape site tracks 107 cards, that is, projects from studios and companies.

"I feel like the film industry has evolved a nice healthy ecosystem," May says. "We have competitive studios and companies with good leadership that sees there's more benefit from sharing than from keeping things to ourselves. That points to a maturing of the industry from a technology standpoint. It's not the wild wild west anymore. There's still a lot of innovation, but as an industry, we need to look for broader needs."

A second initiative was a summer learning program.

"This year we focused on women and people of nonbinary backgrounds," Rose says. "We put out a call saying they didn't need any experience to apply. Those chosen had access to an online platform that provided a series of classes in visual effects, a community of others doing this at the same time, a slack channel, and a personal mentor within the industry."

Between 25 and 30 people signed up, and at the end of the summer, some got jobs in the industry. One of the mentors was Rodeo FX's Jordan Soles.

"I was a mentor for a young woman in art school," Soles says. "We're reaching out and making a real commitment to inspire new people from lots of backgrounds and genders to realize there is a foundation behind a lot of the software being used in studios and by software vendors."

Review and Approval

A working group centered on review and approval was created early in the pandemic as virtual workspace management became even more pervasive. Netflix's Erik Strauss co-chairs the group. Bredow explains why the Foundation organized the working group.

"The industry has a handful of commercial tools that each studio supplements with in-house tools, and we're creating workflows on top of that," Bredow says. "But the interest in continuing to invest in commercial tools seems somewhat limited. It's a hard thing to write well and not an expensive tool to sell, so it's unlikely that anyone is making much money in that regard. It might be an area where open source software could be transformative."

"It's a big challenge," he continues. "But it's a critical part of a workflow. We need rock-solid playback and tracking of what's been viewed. It's really fundamental. But what would a tool for how we review our content in a distributed building block look like? It's an area of current exploration."

The working group brought together industry experts and asked what they want in a review tool.

"This is different from project work," Payne says. "It's discovery work."

"It's a big challenge. But it's a critical part of a workflow."

— ROB BREDOW, SENIOR VICE PRESIDENT & CHIEF CREATIVE OFFICER, INDUSTRIAL LIGHT & MAGIC (ILM), CHAIR OF THE ACADEMY SOFTWARE FOUNDATION GOVERNING BOARD

"There was a feeling in the air that there is a gap that needs to be filled," Gritz says. "The working group provided that necessary place for people to sit around the table, a neutral area where all the major players could show their hand, the tools they built. Everyone has good ideas and we saw a trend heading toward where no one is yet there. The question is whether we can pool resources and come up with a solution that works for more than one facility. We don't know if the solution is to build something, highlight something that's there, gather requirements, or what. We're still exploring, still figuring out where it will go."

The group has attracted wide interest from software developers in studios and vendors.
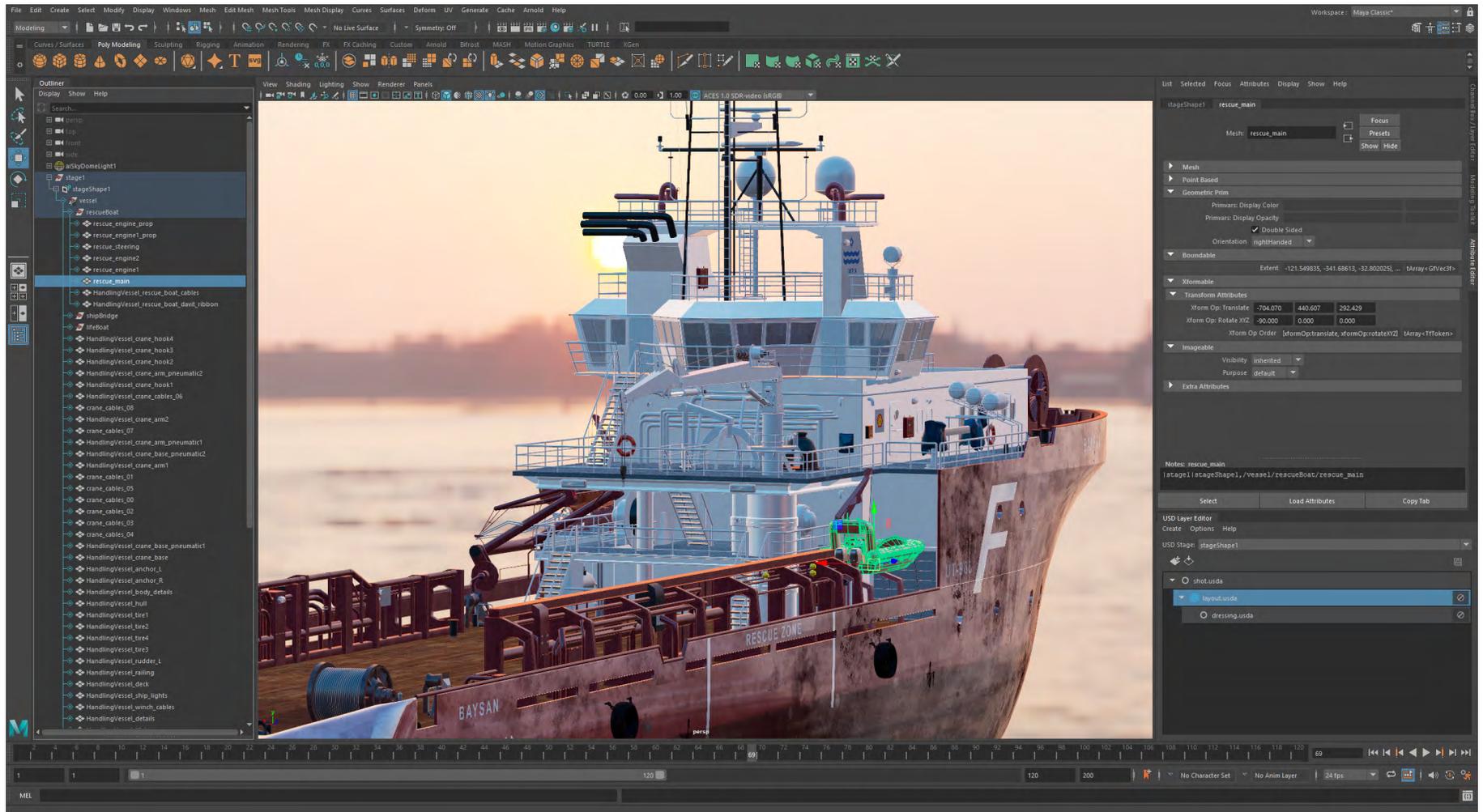
One of the many benefits of USD in Maya is the raw speed at which you can bring in massive data sets. Artists can load multiple gigabytes of data into Maya in a matter of seconds. Used with permission.

"The main group I'm following is the Review and Approval working group," says Tram Le-Jones, vice president of solutions for ftrack. We want to work closely with the Foundation in the review area to make sure all of our new review products contain open source standards. We want to make our solutions flexible and usable for everyone."

Thurston is optimistic about the possible results.

"I think some module will come out of the Review and Approval working group that would really benefit people in terms of standard realtime playback and support annotation that we can use in our own software and integrate with third party vendors, as well," he says. "I hope that projects will appear in this space."

Four other working groups coalesce under the Foundation umbrella: CI (Continuous Integration), Python 3, Rust, and USD. Of those, USD is the most active.

USD

Universal Scene Description (USD) is an open source project developed, owned, and supported by Pixar. It is a high-performance extensible software platform for collaboratively constructing animated 3D scenes.

The core of Pixar's 3D graphics pipeline, USD addresses the need to robustly assemble, visualize, and interchange highly complex 3D scenes created by large teams of artists and technicians working simultaneously.

Since Pixar released USD as open source in 2016, it has become widely adopted. "We're 100% in on USD," Andrew Pearce, DreamWorks' VP of global technology, says. "We've embraced it. It's core software at DreamWorks."

The Foundation's USD working group's purpose is to support Pixar's USD project by assisting adoption efforts through consolidation and sharing of best practices and helping with issues raised in various USD support channels where possible. The working group notes that strong industry-wide interest in USD is beyond the capacity of Pixar alone to support. Cory Omand, a lead software engineer at Pixar was the group's initial TAC sponsor.

"The USD working group collaborates weekly with the USD developers to make sure that USD integrates with Foundation projects," Payne says. "It's important work for the team, even though USD is not in the Foundation."

It's no surprise that many foundation members hope that Pixar will bring USD into the Foundation.

"I would like to see a project like USD come into the fold so we could continue to grow that open standard mantra around data formats and exchange," Weta Digital's Thurston says. 'We're not saying you must join to them. Pixar needs to go through their own thing and figure out if and when they want to put USD into the Foundation. But I'd love for them to join, which would help push our mission forward."

That might take some time.

"USD is an enormous project, bigger than any other project in the Foundation," says Disney Animation CTO Nick Cannon. "Pixar has the option to bring it into the Foundation, and it could end up there, but it's quite new. It's still being adopted, still evolving. It's on the journey of maturing. It may not be ready for the Foundation yet."

"It could end up at the Foundation," says Pixar's CTO Steve May. "We talk about it. There's a beauty and effectiveness to the focus the Foundation currently has. The Foundation has built a great home for an important set of libraries. But, we're innovating very very rapidly and USD is an integral part of Pixar's pipeline. It would be challenging for us right now to have it be completely housed somewhere else."

USD is a good example of one way in which the Foundation supports important open source projects when needed, even those that are not Foundation projects.

Star Wars: The Rise of Skywalker. Used with permission.

Looking Ahead

The working groups point to interesting directions the Foundation might take in the future. The Digital Production Example Library and Open Asset Digital Assets License are focused on content not libraries of code. D&I is leading the Foundation and the film industry toward education as well as providing inspiration and tools for studios and companies invested in attracting and supporting more diversity among their ranks. Review and Approval might point the Foundation toward tool making. And the USD working group shows a willingness to offer community support for open source software wherever it's housed.

So, what's next?

"The Foundation is young," Bogart says. "As with anyone who is young, it's trying to find its place in the world and find its best contribution. What is the best self the Foundation can be? I think that's still to come. And that's a positive statement. The Foundation has already been successful. Contributions are going on and they're great. Now, it has the opportunity to do more, yet be specific about what that more is; to know what it's going to be when it grows up."

The interviewees had many ideas about how the Foundation might grow and innovate. But nearly all targeted one goal: bringing in more small studios and vendors into the open source community.

"Open source is an opportunity – anyone can get involved," Dolan says. "The biggest problem is that there is not enough talent coming into the system. Not enough at an academic level. We're trying to figure out how to get more people into the industry."

"It's a lot of work to keep the community thriving and to keep participation," Payne says. "The same people can't maintain a project forever. We need to get new people involved and invested."

"Right now the bigger players are aware of the value of open source because they can't afford not to be," Bourque says. "Others are becoming more aware and they're making the same observation: They're not giving things away. They're multiplying their value."

"They benefit from helping build the infrastructure. They benefit from the chance to weigh in. Companies that have joined say they were already spending as much for lawyers and maintainers as for the few thousand dollars of sponsorship, and they got a better system in return."

— ROB BREDOW, SENIOR VICE PRESIDENT & CHIEF CREATIVE OFFICER, INDUSTRIAL LIGHT & MAGIC (ILM), CHAIR OF THE ACADEMY SOFTWARE FOUNDATION GOVERNING BOARD

Meeting Small Studios' Needs

In any case, engineers can participate in forums and working groups and contribute to projects whether or not the organization they work for is a member.

"I'd love to have more general members," Bredow says. "We want to hear their voices and what they're looking for. But the truth is, you don't have to contribute money to contribute to projects and many people contributing are not those chipping in money."

Why should a small studio support the Foundation when they can download free software without joining?

"They benefit from helping build the infrastructure," Bredow says. "They benefit from the chance to weigh in. Companies that have joined say they were already spending as much for lawyers and maintainers as for the few thousand dollars of sponsorship, and they got a better system in return."

Pearce suggests that small studios think about contributing time or money to the Foundation as an investment, not a cost.

"Any small studio should understand that investing in open source is investing in their ability to make bids on shots that require interoperability among multiple studios," Pearce says. "It's an investment that will pay off for them in the long run."

Rodeo FX is a good example of a rapidly growing studio that became involved with the Foundation when they were small knowing they couldn't develop all the tools they needed themselves. Now, the studio is a General member.

"The reason we thought it was important to join is because we weren't a big company, so our reliance on open source

Tram Le-Jones, vice president of solutions for ftrack

software was enormous," Soles says. "When we needed a tool, we'd look for something in the open source community. We appreciated that a larger community, the Foundation, was able to support the tool. When you're a small studio, you love and rely on that community."

"This industry demands that multiple vendors share things and in part that ability is built upon a lot of the open source software," Soles adds. "Even though we're larger now, it's still something we rely on. The community that lives behind an open source project is as valuable as the project itself. To be able to be part of a community of developers who understand what you're trying to do and can lead you in the right direction quickly is fantastic. So, we put our money where our mouth is and joined and it's been great."

As Rodeo FX found, the Foundation can be especially valuable for small studios with small budgets.

"There are a lot of small facilities that do amazing work, but don't have the budget for a technical staff to develop all the software they need," Thurston says. "But the Foundation provides resources and prebuilt libraries. If they need someone to make a plug in for Maya, for example, that person wouldn't have to spend months building the libraries needed to make the plug in. They'd have the prebuilt libraries, a support

structure, and a neutral forum. We're here to help. And if we do some things like the review and playback, it would be a direct benefit. We'll have components they can just use. They don't have to write them."

Thurston offers a recent example: "We aren't security experts, but the open source libraries can get security reports against them," he says. "So as a group, we found people who had studied security. Then we tried things to find the best pattern. The fact that we're doing this as a group is a shared benefit for all."

Bredow provides another example. "Let's say you want to use OpenTimelineIO, which was contributed by Pixar," he says. "You might not have the resources in house to manage timelines and provide an integrated playback to Avid, and other editorial systems. But, if you can make maybe just five tweaks to a version you download, and have the committee check to make sure it's still secure, you have just amplified what one person can do."

Amplifying the Voices

One reason some might hesitate to join is that the might of the Foundation members can overwhelm a smaller studio, vendor, or individual person and make it difficult to have their voice heard.

"I really like that the community can contribute to open source software; if you need a feature or a bug fix, you aren't bound to someone's schedule," Le-Jones says. "However, this can also be to the detriment of smaller teams. If you're a small studio with no or limited technical resources, you're at the whim of others who are better resourced to maintain the software."

Le-Jones offers some ways in which the Foundation might help give smaller studios a larger voice.

"Often the working groups and forums are dominated by larger studios and software companies," Le-Jones says. "This is the A-list. The big guns. The really smart people. So, I can see that a small studio might feel a little intimidated. But when I went to my first working group, I realized, "Oh yeah. I've worked with you guys. When I come and join in, everyone is extremely welcoming, open minded, and absolutely terrific.""

"Perhaps there's a way to organize or help organize a small studio working group that could act as the voice of the smaller studios," Le-Jones adds. "That way, the Foundation can encourage small studios to have a seat at the table. A working group space for smaller studios might break the ice. And, perhaps a cohort of developers might be willing to work as an extended part of the Foundation to help support the smaller studios."

As the Foundation considers future directions, the time couldn't be better for smaller studios to become involved and have their voice help determine what comes next.

"If the first couple of years were an experiment, we know the answer to that question now," Bredow says. "We're able to collaborate across companies and industries so we don't have to solve problems more than once. We've reached a level of maturity that we can support more projects and more substantial projects, and we have an opportunity to build from scratch if needed. We're now at a place where larger and more complex problems can be solved. We can be more ambitious."

What might those new projects be?

Machine Learning

One area in which the interviewees suggested the Foundation play a part with foundational tools is machine learning.

"I would love to see the Foundation looking at and pursuing open source projects that would help create a pathway for innovation in the AI space," Rose says. "A lot of it lies in data representation – what is the best data format. Our industry as a whole is looking for guidance in the machine learning and AI space where there are already libraries and common ways to process machine learning data.

"There are underlying projects for data representation that I would love to see the Foundation look at and pursue with open source projects," she adds.

Pipelines

Tools aimed more directly at artists were also mentioned.

"If you look at our projects now and at a lot of the open source tools, they're concentrated on low-level file formats and libraries," Cannon says. "I'd like to see that continue, but also like to see us getting into more pipeline-oriented software. How do we collaborate, share work across studios, and share across industries? How do we share character rigging? A lot of that is built on proprietary technology or software. Ultimately, I'd like to see us getting into artist tools. Media playback. Basic compositing. Basics of paint packages. Maybe there are core capabilities every studio needs to have that software vendors could build on an open source foundation. The nature of technology evolution is that it becomes commoditized. Let's embrace what is going to be commoditized in five years' time and move forward."

Platform Opportunities

A January 2022 report of a 2021 Studio Platform Survey by the Visual Effects Society Technology Committee and the VFX Reference Platform Working Group found that currently

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studios with less than 200 employees primarily use Windows, those larger use Linux, and Linux's overall 60 percent share of workstations across all studios is likely to grow. A higher proportion of Windows-based studios seem to be looking to migrate to Linux than the reverse.

But many studios have both, and survey respondents noted the difficulty in supporting multiple operating systems.

Those who use Linux also pointed to uncertainty around the news that support for CentOS Linux, which has the majority market share, is coming to an end. Most studios impacted by the CentOS news will decide which Linux distribution to move to in 2022. "The risk of further distribution fragmentation is

very real and clearly demonstrated in these survey results," the report states. It adds that at the same time Linux is becoming more important to studios, it's becoming less important to many software vendors who see the customer base grow significantly in other areas and issues a rallying cry: "It's up to us collectively as a community to take action."

"You can equate this with the industry's move from IRIX to Linux," Cannon says. "It's a similar situation, and perhaps arguably more complex as there are more options this time around."

"Someone needs to step up in the same way we needed leadership to get applications onto Linux," Feeney says. "The Foundation can shine a light on the work we need to figure out.

Community members Linda Lam, Karthik Iyer, Kaitlin Pollock.

"I'm hoping for more tools," Thurston says. "For projects that will help provide components that help people make movies in the cloud and deal with security; for when your computer is not yours but someone else's that you're renting. If everyone has to have those tools, there's no reason they should do it on their own. There will be a whole bunch of workflow problems that will need solving. I hope we can build the 'Legos' that people can use to construct this unique next thing."

Not to dictate an answer or even solve it. But to socialize the ideas that need to be addressed. Linux and Windows need to co-exist in a better manner. It needs to be less painful to use both. If the Foundation puts its weight behind something, and say we should have a three-year plan to do "x," that has cred-ibility. I think the Foundation needs to be thought of as doing compelling work, charting a path to the future."

Road Maps

Le-Jones noted that having a road map for when new versions of open source projects are scheduled to be available for testing and release would help smaller studios especially.

"As a studio, it's hard to know how much of your time you should spend on bug fixing if you don't know whether a particular bug or feature is coming soon," she says. "That's especially important if you don't have enough resources to fix the bugs yourself and have to rely on someone else."

Working in the Cloud

Thurston is also looking for pragmatic projects that help facil-itate future workflows.

Education

The D&I working group is reaching out to teach students about the industry and about open source. Bogart would like the Foundation to extend education efforts beyond that in terms of content and geography.

"The one thing I would push on the Foundation to do more of is education," Bogart says. "It's not really part of the role right now, but in the presence of more projects and the number of ways things could be used, education could be important. Education of individual projects themselves, how important and unique a project is, but also how projects could work together. Big time moviemaking software is available for everyone and that has a global aspect. We could be more aware of international filmmaking and reach folks doing this for a living with fewer technical resources. We would also like their opinions."

Realtime

Realtime is unarguably making an impact on filmmaking. But is it an area in which the Foundation might become involved?

"There is an overlap between film, streaming, and interac-tive production," Bredow says. "That middle ground between immersive and interactive is a possible area of expansion.

ILMxLab is very tied into what we're doing at the Academy Software Foundation. Epic and Unity are members."

Cannon agrees, and raises questions.

"I think we're seeing increasing crossover between linear and interactive, real-time applications," Cannon says. "The opportunity is there. But what is our role? How do we share our learning, ideas, things that level our capabilities up, and those of video game companies? How do we collaborate?"

Pearce notes that Foundation projects are already making inroads.

"NanoVDB and some other projects we're building are becoming useful to the realtime world," Pearce says. "NVIDIA has taken the global standard of OpenVDB to enable rendering the dataset for playback in the GPU environment. It's an exciting extension and starts to go toward game engines, which is the next logical step, and that starts to go toward games. Five to ten years after we're doing something in a movie, they're doing it in real time. There's no way you can get to a place where you can represent high-quality visual effects in the Metaverse without open source components. Selfishly I want the Foundation to focus on my industry. But, realtime might be the right area for continuing growth. It's starting to play in how we're making films right now and maybe that crosses into games."

"I think companies providing realtime tools already see the benefit in adding storytelling to their repertoire and see the Foundation as being the place where they can have a neutral forum and develop standards for whatever buzzword you want

to apply – Metaverse?," Thurston says. "I think they see it as a valuable mechanism for getting companies to work together. And that's a good thing."

Bourque notes the difficulty, though, of hitting a moving target.

"Because XR / real-time / virtual production projects are heavily dependent on the underlying hardware today, and the hardware itself is changing at a rapid pace, it's difficult to establish what will have longevity and what won't," Bourque says. "That in itself is a very interesting area of focus for the Foundation as we try to move forward as a community and industry."

And, Linux Foundation's Dolan notes the importance of paying attention.

"I've been involved in conversations about things like the Metaverse and storytelling in an augmented reality context, and I don't think they will end," Dolan says. "People are already having conversations about pipelines. I hope that as we continue, this community will re-evaluate itself around where storytelling is going. I hope the Foundation brings in new open source projects around these areas. The fact that conversations are happening is insightful to me."

Morin summarizes the significance of doing so.

"If there is a Metaverse, we want it to be open and driven by artists and engineers," Morin says. "We want individual engineers to be able to write open source code for it and participate in developing open standards for it. Open source is more than a trend, it's a necessity for the underlying technology that everyone and every company will use."

Conclusion

Clearly, the Foundation has become much more than the sum of its open source projects.

"Where we are today points to the future where open source software will become a strategic technology for everyone who wants to share, innovate, and develop a sense of community around software" Morin says.

"I marvel at the speed at which the Foundation has grown and not only that, the notoriety of it," Ford says. "People are starting to look to the Academy Software Foundation to provide leadership and governance in the open source community. To go from a place where there was a lot of risk to where the projects are now, the growth and depth of the projects, and the collaboration has been fantastic."

"Our initial meetings were because there were a couple projects in trouble," Gritz says. "The projects are all healthy, but that's such a small part of what we're doing now. The interesting thing to me is how far the organization has gone beyond that. It speaks to a hunger maybe we couldn't put a finger on. We now have a means of communication to solve common problems, a forum."

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The Academy Software Foundation was developed in partnership with the Academy of Motion Picture Arts and Sciences and the Linux Foundation to provide a world-class home for open source software developers in the motion picture and broader media industries. In addition, it serves as a place for people to share resources and collaborate on technologies for image creation, visual effects, animation and sound. It is home to MaterialX, OpenVDB, OpenColorIO, OpenEXR, OpenCue, OpenTimelineIO, Open Shading Language, DPEL (Digital Production Example Library), Rawtoaces, and Rez. For more information about the Academy Software Foundation, visit https://www.aswf.io.

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