

Audio Middleware

The Essential Link From Studio to Game Design

When I first played games such as *Pac Man* and *Asteroids* in the early '80s, I was fascinated. While others saw a cute, beeping box, I saw something to be torn open and explored. How could these games create sounds I'd never heard before? Back then, it was transistors, followed by simple, solid-state sound generators programmed with individual memory registers, machine code and dumb terminals. Now, things are more complex. We're no longer at the mercy of 8-bit, or handing a sound to a programmer, and saying, "Put it in." Today, game audio engineers have just as much power to create an exciting soundscape as anyone at Skywalker Ranch. (Well, okay, maybe not Randy Thom, but close, right?)

But just as a single-channel strip on a Neve or SSL once baffled me, sound-bank manipulation can baffle your average recording engineer. I'd like to help demystify this technology, starting by explaining what middleware game audio engines are because they are the key to understanding what makes game audio different.

In games, once sound is captured, there's a whole other level to explore: integration. That's where middleware comes in. Middleware is software that connects game developers with the hardware (Xbox 360, PS3, PC, etc.) they use in development. Just as Pro Tools lets you generate sound from a computer, middleware lets users link sounds to game objects, such as animations (firing a gun, running), scripted events (a column falling across a road, a ship going to lightspeed) or areas (inside a church, at the foot of a cliff). Where a programmer was once required for all this integration, this is no longer the case.

GAMECODA

From Creative Labs' Sensaura division comes GameCODA (www.gamecoda.com) for the Xbox, PS2, PC and Gamecube platforms. It supports audio in WAV, AIFF, VAG, AD-PCM, Xbox ADPCM and Ogg Vorbis formats, from mono through 5.1 surround, and the code is low-level, with run-time and APIs. Sounds are automatically compressed to console format.

Within GameCODA is CAGE producer, a sophisticated bank-management tool that's cross platform-compatible, and its tab-type switching between consoles is an excellent feature. While the engine is fully compatible for hookup with Renderware, Alchemy, Gamebryo, Karma, Fonix and Havok middlewares, it doesn't have direct integration with Unreal 3. CAGE plug-ins provide control of 3-D sounds directly in 3DS Max and Maya. However, most game audio engineers aren't familiar with that environment so it is not that conducive to place sounds using those tools.

If your programmers know how to use Renderware, then you can hear real-time parameter changes using

GameCODA. The same is true of Renderware native audio tools. One caveat: Criterion is now owned by Electronic Arts. The Renderware site was last updated in 2005, and many developers are scrambling to Unreal 3 due to uncertainty of Renderware's future. Pity, it's a pretty good engine.

Streaming is supported, though it is not revealed how it is supported on next-gen consoles. What is nice is you can specify whether you want a sound streamed or not within CAGE Producer. GameCODA also provides the ability to create ducking/mixing groups within CAGE. In code, this can also be taken advantage of using virtual voice channels.

Other than SoundMAX (an older audio engine by Analog Devices and Staccato), GameCODA was the first audio engine I've seen that uses matrix technology to achieve impressive car engine effects. Imagine being able to crossfade samples across a grid to achieve multiloop, seamless transitioning during shifting and RPM change. It's that cool.

Alas, there's no way to link directly to game events without a programmer's help. Unlike DirectMusic, there's no VisualBasic scripting equivalent, and unlike RenderwareAudio, there's no message system. However, it is possible to link messages in Renderware to samples in GameCODA directly if you're using that approach. Still, it won't just "work" out of the box, which is what we all have been waiting for. Interactive music support is coming soon. According to company announcements, GameCODA will link seamlessly with Creative's ISACT (Interactive Spatialized Audio Composition Technology).

On the upside, GameCODA is one of the first really hard-hitting audio middleware products of its kind, and where most thought it was dead, it is still possible to license it. It features extensive integration functionality using 3DS Max and Maya, matrices, timeline editing and multiplatform seamless production. Support is provided within a 24-hour response time. GameCODA is also less expensive than some other engines. However, how is next-gen supported? That isn't yet revealed, although it is hinted at in FAQs and press releases. In addition, a number of developments on the horizon could make this engine even better, such as direct ISACT support and other plug-ins for speech recognition. Linking closely with Renderware and not Unreal 3 is also a problem; Unreal 3 is the Number One middleware these days.

ISACT

Also from Creative Labs, ISACT (<http://developer.creative.com>) supports the PC, Xbox and Xbox 360 platforms, and is free if a PC hardware output layer is used. The program supports WAV, AIFF, CDDA (import), PCM, ADPCM, WMA,

XMA and Ogg Vorbis (export) sound formats, as well as any configuration of surround audio. Sounds are automatically compressed to console format using the Target Platform Settings tool.

ISACT Production Studio (IPS) is essentially a multitrack editing environment. However, the "tracks" are far more varied than audio or MIDI. IPS gives you control of a completely new suite of objects specifically oriented to gameplay situations such as Sound Randomizers, Sound Events and Sound Entities. Don't get scared; it's a whole new ballgame, a whole new playground.

Using the IPS function Realtime Parameter Controls and the run-time component with a network connection to your target platform, you will have real-time control during game play of all ISACT functions.

Although it's somewhat convoluted, it is possible to use Sound Entities and Groups to create a ducking behavior. I've found the best way to do this is to assign each sound or sound object in your hierarchy to a group that you define. Then in a matrix (think Excel document), set priorities (one group ducks a set of another's or an individual), volume and duck time. ISACT makes it nec-

essary to create variables within objects and, well, without going into too much detail, it isn't as simple as my method.

Although there aren't any sound matrices lying around for you to use, once again, the Sound Entity is your friend! Create parameters such as RPM, shift, gear and such, and assign them to pitch and crossfades using RPC (Realtime Parameter Control). Again, not quite as fast or intuitive as other methods (such as GameCODA's), but a Sound Entity is a much more open-ended tool.

As with GameCODA, you can specify whether you want a sound streamed. The plus here is that you can specify preloaded sounds (this means the first chunk of a streamed sound is loaded to avoid the disk-loading latency associated with standard streaming sounds). It's extremely useful for quick, load-required streamed sounds such as voice-over.

ISACT can load a CAGE Producer file for interactive music. ISACT was originally designed to be an interactive music system, and as such, you can create tracks containing music objects with individual volume and spacialization (as with most multitrackers). ISACT also allows you to randomize these, transition them with controllable crossfades linked to events and much more.

Here again, the Sound Entity lets users create parameters that will link to game events. Unfortunately, as with GameCODA, you can't just look up events in a list in your game world editor and then type them into IPS and have them work.

On a happy note, ISACT won a Frontline Award two years ago for a reason: It was the first tool that used a track layout to associate it more closely with traditional DAWs for game audio integration. At this point, it has a huge amount of open-ended, great features that put it in a category all its own. The fact that it is free and allows you to create your own kind of sound behaviors is more than worth the learning curve. And ISACT's near-instant e-mail response to support is excellent. However, it's a bit challenging to get your head around the concepts of Sound Entities, and at this time, there are no plans to go Wii or PS3. At a company like mine, that creates quite a few limitations.

MORE TO COME

So far, I've looked at the first two of the bunch. In future segments, I'll delve into Wwise, FMOD, Unreal 3 and Miles. ■

Alexander Brandon is the audio director for Midway Home Entertainment in San Diego, Calif.

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Audio Middleware, Part 2

More Contenders in This Emerging Field

In the March 2007 column, I began my report on middleware game audio engines: what this software is, how to get it and its value as an essential cog in the game production process. This second installment in a three-part series will look at two other middleware heavyweights: Audiokinetic's Wwise and Microsoft's XACT.

WWISE

Audiokinetic (www.audiokinetic.com) offers Wwise for the PC, Xbox 360, PlayStation 3 and Wii platforms. The software supports Microsoft WAV and Broadcast WAV audio files, and its Conversion Settings dialog box can be set to support any surround configuration. In addition, sounds are automatically compressed to the selected console format within this box.

Although Creative Labs' ISACT (a competing product that was profiled in last month's column) has an open-ended and powerful GUI tool, Wwise is the most comprehensive GUI tool that combines a multitude of editing possibilities. Wwise requires that every sound be assigned an object, and that every object be assigned an "actor," which is an interesting and cool feature. An actor is an object representation within a game. It's an ingenious design, really—the missing link between pro audio and game audio concepts in tool design. You can't simply think of audio objects by themselves anymore. Imagine a "Pro Tools Movie Score" version in which every cue in a project must be linked to a visual or virtual event or object. That's advanced thinking.

Apart from that editing requirement, Wwise's GUI design and functionality are elegant and very user-friendly, just like the DAWs we all know and love. Work is divided into layouts: Designer, Profiler, SoundBank, Mixer and Schematic. Learning these layouts is easy with the provided tutorials. Plus, you get just about every bit of functionality you'd want from propagation, effects, specialization and playback behaviors, so you have everything you'd want with current-gen platforms. This is high tech.

Wwise's Soundcaster is a comprehensive method for achieving results in real time and for simulating an environment. It also has a complete setup for integrating directly into Perforce, the industry's leading version/revision control system. (Perforce allows multiple users to work on the same project using a file-checkout system.)

When loading a control bus into Wwise's Property Editor, you can access a marvelous set of auto-ducking parameters, from fade-in/out to curve and priority. This comes really close to my ideal formatting of ducking groups.



Wwise is poised to be the best audio engine for next-gen platforms, but it has a lot of ground to cover in the "proven products" arena before it can compete with such highly optimized engines as FMOD and Miles.

Like ISACT, Wwise has Real-Time Parameter Controls, although Wwise's acronym is RTPC instead of RPC. Going beyond ISACT's capabilities, Wwise lets you use graphic curves to edit these parameters based on user-defined events, states, switches or data objects.

In terms of game-event linking, Wwise uses states, switches and RTPCs to achieve the same goals as the other engines. You create an RTPC in the event that a state change is constant (such as a car engine's RPM during acceleration or deceleration). But for things such as switches, you can simply trigger a sound that is either a one-shot or a loop.

Wwise has a much more open-ended toolset than ISACT. True to form, you can specify preloading (called "prefetching") or streaming on sounds, and Wwise doesn't lend itself as quickly to adaptive soundtracks, but does provide you the tools to link sounds to game objects. However, Wwise does lack ISACT's tempo subdivision control.

Support with any program is always an issue, but Audiokinetic sales and service manager Genevieve Laberge has provided great help. (I always like to acknowledge the people on the front lines.) Also, Wwise offers documentation that is second to none, with comprehensive PDF user guides and APIs with video (!) tutorials. Certainly, this is a first for any game audio engine.

Wwise was created by experienced game audio engineers, programmers and savvy business folk. Wwise is poised to be the industry leader in game audio engines

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with its larger suite of pro GUI tools and multiplatform support. On the downside, the company doesn't actually publish its pricing, and Wwise, like any other new system, does have its kinks.

XACT (XBOX AUDIO CREATION TOOL)

The Xbox Audio Creation Tool (XACT, www.xbox.com) from Microsoft is provided free to registered Microsoft game developers as part of XDK, the Xbox Development Kit. XACT supports platforms including Xbox (Version 1), Xbox 360 (V. 2) and PC, with audio files in Microsoft WAV, AIF, AIFF, XMA and up to 5.1 surround for Xbox 360 games. Sounds must be encoded (compressed) using XMAEncode (a command line tool) or XMAEncoder.lib, which lets the developer automatically add XMA encoding to the build process.

XACT uses a fairly straightforward bank editing tool, which comprises a Project window indicating a number of objects such as Wave Banks (a Wave being equivalent to a cue or a sound that can contain one or more actual sound files), Sound Banks (Sounds being the sound files themselves: WAV, AIFF, etc.), Sound Cues (more complex Waves that can be assigned events and variables), Categories (a means of organizing sound groups into places such as ducking, fading, etc.), Variables (a way for programmers to access user-created runtime parameter controls), Compression Presets and DSP Effects.

You can create Events to add markers, set volume, set pitch and so on. Users can also string Events together in a "Track" (similar to the same way that ISACT handles such things), generating a multitrack environment that is controllable within the game.

Essentially, XACT acts like a patch-control center for your synth on steroids and adds a bit of multitrack editing. The layout is well done and user friendly. You can also instantly audition files on the Xbox 360 using the Audio Console tool, which brings up a set of level meters on your TV.

Unfortunately, XACT's middleware-agnostic design requires programmer interaction to achieve real-time control, but then again, all the engines do the same. Xact.lib is a library provided to the programmers that will enable access from any middleware to XACT's real-time parameters, which can be anything from pitch, volume, events, variables and so on. There is no sound matrix functionality in XACT, but similar functionality can be created with a little more effort using Tracks, Events and/or Variables.

Wave banks can be assigned as in-memory or streamed. And as we have learned before, you can't stream everything.

A DVD has only so much bandwidth, as does Blu-ray (but we'll get to the PS3 in the next column). In this case, you can specify zero-latency streaming, which, at a given point (specified by the programmer or an audio designer with some good tools within the game world editor), will load the first chunk or a few chunks of a large file. They will stay in memory without having to load the entire file, and when the file is needed, it can instantly begin. This avoids latency when timing is critical, such as in voice-over applications.

The game event sets up everything in XACT via Sound Cues, Transitions and Events, and the code's RTPC libraries do the rest.

The Xbox audio support team, headed by Scott Selfon, has a great history. They offered tutorials at the Game Developers Conference before anyone else, and they created the Audio Boot Camp, a place where developers receive hands-on training for using their tools. This Boot Camp has expanded to cover a number of other tools. Plus, their e-mail response time is 24 hours or less for Xbox developers.

Like Creative Labs' GameCODA and ISACT, XACT is for a single platform. If you then port to the PS3, you'll have to roll another solution. But XACT is the best audio tool for the Xbox 360 because it was written for it from the ground up, as was its predecessor for V. 1. Add to that a great support team and you have a tool that performs brilliantly, combined with some state-of-the-art control of audio through RTPC, actual manipulation of sounds in real time and Events. Want to change a music track while testing a build? You can do that in XACT, too.

XACT's Interactive Audio feature uses a bit of code combined with some of the XACT tool's functionality. When you've created one or more Sound Cues, you can set them to Interactive. At this point, it will read variables set in the sound cue and you can edit transitions based on those variables. The process may seem somewhat confusing, but that's what it takes to create a transparent layer of game behavior.

Everything needs to be pretty abstract to work in a puzzle game, an role-playing game or a sports title. After about three years, you get used to it and it becomes the most fun activity you've ever done with audio.

Next month, I'll round out this series with FMOD, the Miles Sound System and Unreal 3! Stay tuned. ■

Alexander Brandon is the audio director for Midway Home Entertainment in San Diego, Calif.

Audio Middleware, Part 3

The Final Chapter on Game Development Engines

In my March and April columns, I began a report on videogame audio middleware, examining the value of this software in game production. In this final installment, I'll look at three other players in the market: FMOD, the Miles Sound System and the Unreal 3 Sound System. So many choices, so little time.

FMOD

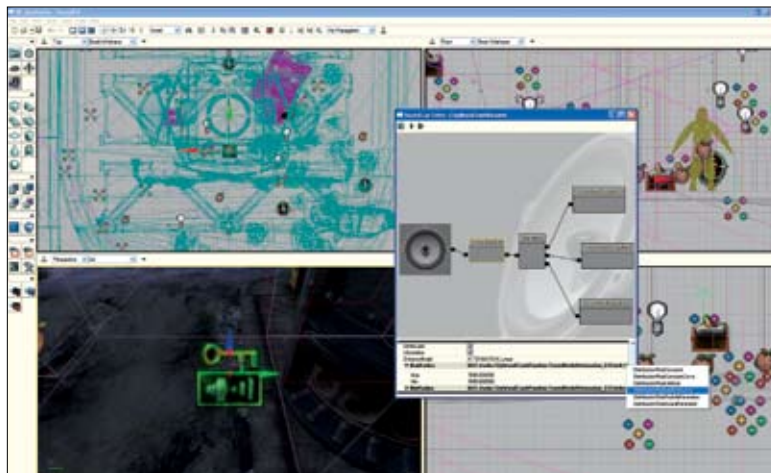
Firelight Technologies' FMOD (www.fmod.org) began as a simple assembly-written (assembly code = *fast*) audio engine that now stands as a serious contender to Wwise and Miles as a great "multipurpose" engine that can pretty much do it all. Its 13 supported platforms include Windows (all), Linux, Mac, Xbox, Gamecube, PlayStation Portable (PSP), Xbox 360, PlayStation 2 and 3, and Wii. Single-platform FMOD pricing begins at \$3,000, plus \$1,500 per additional platform.

Among FMOD's supported file formats are WAV, AIFF, MP3, Ogg Vorbis, ASX, FLAC, DLS, ASF, IT, MP2, MOD, RAW, WAX, WMA, XM, XMA, S3M, VAG and GCADPCM. FMOD has a feature that lets you optimize the sample rate during each sample's build process. However, you will be unable to access certain target platforms unless you have a signed nondisclosure agreement from the respective console manufacturer (i.e., Sony, Nintendo, Microsoft).

Surround support includes Dolby Digital 5.1, DTS and Pro Logic, with a panning matrix that lets you route mono/stereo/multichannel sources to any speaker in a 5.1 matrix.

FMOD has its own set of effects such as chorus, reverb, etc., yet it supports VST plug-ins, which is a huge plus. It would be too processor-intensive to run, but imagine using Waves Renaissance reverb in your game in real time! This is something to investigate. Certainly, the power to run a good, old-fashioned Eventide reverb or something from a Lexicon PCM90 is probably very achievable on an Xbox 360, isn't it?

The FMOD Designer is meant to compete with tools such as Creative Labs' ISACT and Audiokinetic's Wwise. It is an excellent bank-manipulation tool that allows most of the functionality of Wwise and nearly all the functionality of Creative Labs' GameCODA. It introduces a set of terms such as Sound Definitions and Layers, and completely leaves out the term "cue," which is something of an oddity, yet it takes only a few hours



Unreal's sound cue editor provides one of the best visual representations of audio objects as an extension of its highly object-oriented Kismet tool.

to get used to it.

The Designer GUI has a clean interface with tabs and a fairly intuitive hierarchy of objects and effects. Within the Event editor, you can create a rough idea of what a combination of sounds will do in the game.

FMOD's network-based auditioning lets you use Designer to try out sounds on the target platform while a game is running. It also includes a simple set of commands in the API that are also usable by the Designer tool, which is a simple way to expose commands to the integrator. Here, the documentation is somewhat sketchy and I'll look at a successful "real-world" implementation of this in a future column.

The channel groups and submixing function are straightforward, allowing the routing of sounds into different groups with independent control of volume, effects, etc., in those groups. The software doesn't include a sound matrix, although it does offer events that can be manipulated in different tracks to simulate a matrix. For some reason, streaming must be specified as a bank type (just as you specify memory-based sounds as a bank type) rather than on individual sounds.

In terms of interactive music, FMOD makes use of its basic event and sound definition functionality, and the Designer manual provides a tutorial on using these functions for music. It lets you randomize a number of clips and set up a sound definition to set "seek points" that will jump to a particular clip or ignore a particular clip based on parameters that you set. If your programmer can't do it for you, then the commands that let you sync to game events are Init, Close, Load, GetEvent/Start and UpdateParameter.



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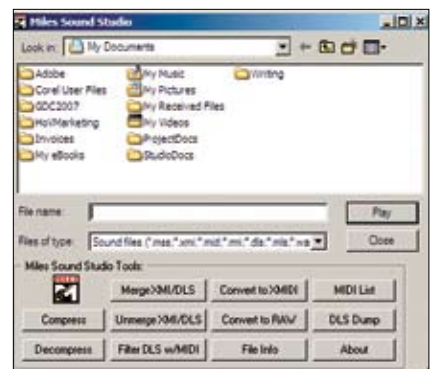
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FMOD Designer isn't quite as full-featured as Wwise and doesn't have the attraction of video tutorials. However, Brett Paterson, who wrote FMOD, answers support e-mails personally and is grappling with the massive task of providing support on a developer-wide basis. FMOD is less expensive than the competition and is one of the most stable, reliable engines currently on the market.

THE MILES SOUND SYSTEM

From RAD Game Tools (www.radgametools.com), the Miles Sound System supports Windows (all except Vista), Xbox, Xbox 360, PS2, PS3, PSP (coming soon), DOS, Linux and Mac OS 8/9/X, and is priced at \$3,000 per title for any platform. File formats include Microsoft WAV, ADPCM, Ogg Vorbis, MP3 and MIDI, and mono, stereo or surround in SRS Circle Surround (6.1), Pro Logic, quad, 5.1, 4.0 DTS, 5.1 DTS, 6.1, 7.1 and 8.1. Compression is offered for MP3, ADPCM and Ogg Vorbis.

Miles has the leanest feature set, the smallest set of tools and perhaps the most support for its code base of any of the engines. It comes with MIDI Echo, Miles Sound Studio and Miles Sound Player. Sound Studio lets you convert and merge multiple kinds of files, and that's really about it. The rest of the functionality is through the SDK (Software Development Kit) via programmers.



Miles Sound Studio is a bit short on designer tools, but long on reliability.

Miles claims you can have sound playing using three function calls (essentially, sentences in your game engine's code). This is pretty quick for engineering integration, but it certainly doesn't compare with real time. No sound-matrix function is provided, but like everything else, it can be programmed more quickly than in other engines.

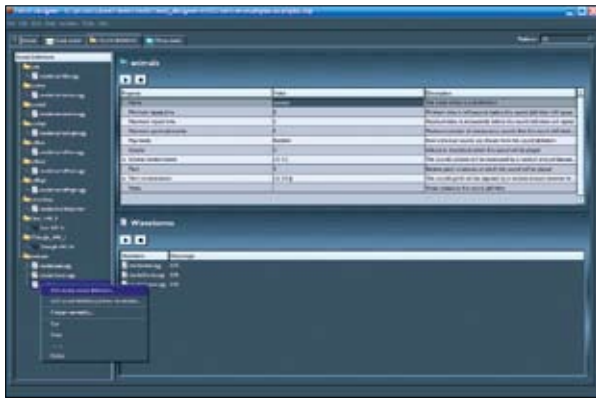
Regarding code, Miles is about as clean or possibly even cleaner than FMOD. This enables streaming Redbook audio without using your CPU. It also allows you to stream in as little as three calls. Yet again, though,

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When used with its rock-solid, low-level code, Firelight Technologies' FMOD Designer provides very reliable performance.

if you're not an engineer, then you're out of luck. In terms of interactive music, roll your own: Miles will be a solid backbone. Also, the documentation has nothing specific about game-event linking.

At this point, you might wonder why I've included such a skeletal audio engine in this roundup. By current standards, Miles is dated. Without real-time parameter control and some sort of GUI interface that lets you organize your files beyond a simple directory structure, it doesn't offer much in the way of additional features, especially the ones required by larger projects. Yet John Miles revolutionized the industry and this engine is still used by a wide range of products. Why? Because it's super-cheap at \$3,000. It's solid and won't break, and it includes solid support with fast response to e-mails and phone calls. Can't say much better than that.

UNREAL 3 SOUND SYSTEM

Designed for Windows and Xbox 360 platforms, the Unreal 3 Sound System from Epic Games (www.epicgames.com) is arguably the most commonly used middleware in the industry today. Unreal offers support for Microsoft WAV, XMA and Ogg Vorbis files, with up to 5.1 surround and XMA or Ogg Vorbis compression that's customizable for each cue.

The Unreal Editor GUI is the best in the business; as a plus, it's all self-contained. You load a level—graphics animations and all—and the audio with it, and everything is integrated. It provides good visual feedback, which can get a bit tricky with larger sound cue structures, but many of the sounds' parameters are editable, such as volume, radius and crossfade functionality within Kismet, the integrator's link.

You can run the game right from the editor, with all sounds included. Sounds do not react in real time to changes, but it's the next best thing. Animations are a bit different.

You can use animation event notifications (Anim-Notifies for short) to add sounds directly to animations on a per-frame basis and preview them in real time. This is something I desperately wanted in the last Unreal game that I worked on, and thankfully it is now available.

There is no sound matrix. Unreal relies on sound cues alone for its object structure; just take a single file or group of files and create a cue. Streaming isn't currently supported. You simply play a file and it loads into memory.

Unreal has a great comprehensive interactive music system that allows you to manipulate multiple sections of songs at cue points that you define. Kismet controls just about anything that happens in an Unreal level, which is like Microsoft Visio—a flowchart of events, if you will. Renderware also had this view, and it can get insanely confusing to look at boxes and circles connected with lines. But, believe me, it's far easier to do this than to figure out code. Kismet is a godsend to audio folk and it provides a great playground for the engineer to dig in and create a lot of custom audio events that sync to game action.

In recent years, Epic Games has stepped up with much better support. Licensed Unreal developers have access to a Website with a comprehensive set of tutorials and information about each version of the engine, as well as a message board detailing prioritized bugs and feature requests that the team is working on. Your suggested feature may not be added right away, but you do get responses in 24 hours or less.

Unreal's audio system is solid and user-friendly, thanks to its unique visual interface, yet not as comprehensive by any means as Wwise. (Good luck doing vehicle engines using Cues, for example.)

Audio engines are rapidly expanding and evolving into slick professional tools, and I hope that after reading this series you have a good understanding of what they can do. However, they still have a long way before achieving the ease of integration provided by post tools such as Nuendo and Pro Tools. That's my next crusade. ■

Alexander Brandon is the audio director for Midway Home Entertainment in San Diego, Calif.

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