

4. Live control and performance

PixelConduit with the Stage Tools add-on is a comprehensive toolset for creating video shows and many kinds of installations that deal with live video. Everything you need to design and run video performances is included.

- Combine visuals from live cameras, pre-recorded media, realtime effects and editable subtitles.
- Control the system with a handy cue list, or using external devices through industry-standard hardware protocols.
- Use accelerated graphics algorithms programmed in JavaScript for unlimited flexibility.
- Output images on up to nine projectors from a single Mac using Matrox GXM units.

Of course all the baseline functionality of PixelConduit is included, so you're also getting a video capture and compositing application in the same package.

Equipped with Stage Tools, PixelConduit can be used like a lighting console for realtime video effects and playback. Practically everything in PixelConduit can be programmed using “cues”: slider and color picker animations, effect changes, image load/play/pause controls, etc. Sequenced together, cues make up a complete show that's very easy to run. With Stage Tools, a single video operator can easily and reliably run a complex show with multiple video outputs and any combination of live and pre-recorded video material.

Stage Tools Overview

Stage Tools consists of a total of 10 components. Three of these are new windows with special user interfaces. There are also 7 node widgets that can be used within a PixelConduit project.

The windows are accessible by the Tools menu. They are:

- **Stage Tools Cue List** - cue list editor
- **Stage Tools Info** - floater window that displays show status
- **Live Titles** - titling editor

The node widgets can be found in the Node Widgets section of the Project window. They are:

- Audio Input
- DMX Source
- Live Titles
- Perspective Warp
- Playback Control
- Stage Tools Trigger

Getting Started with Stage Tools

This section covers the essential principles of PixelConduit and Stage Tools. If you're new to PixelConduit and would like to learn the basics of how to build a video show, this text is for you!

At the beginning of this book, it was mentioned that PixelConduit uses a *control room metaphor*. There is a room full of devices, and you decide how they are connected to each other. Some of the devices produce images – similar to a real-world camera or DVD player – and some produce control signals, similar to a lighting control desk. Some devices process video images, like you might use a video mixer in the real world. Finally, some devices output video onto a display or projector, or record them to disk.

An important part of Stage Tools is that includes a *'robot'* that knows its way around the control room. It can do practically anything that a human operator could do in PixelConduit: move sliders on a controller, load video clips into a player, change video mixer settings after a given delay, and so on. But the robot, like others of its kin, is limited by its inability to think for itself. It only does what its programming tells it to do.

Building a show in PixelConduit is a two-stage process. First you design the "control room" that you need. You'll need to ask questions such as: How many images do we need to bring in? How many screens or displays do we need to output onto? What kind of effects will we need?

Next, you program the "robot" to operate the control room. The robot's programming is a list of events or cues within the show. Unless you're working alone, these cues are often determined by the show's script and direction. At this stage, you'll be answering questions like: When do we need

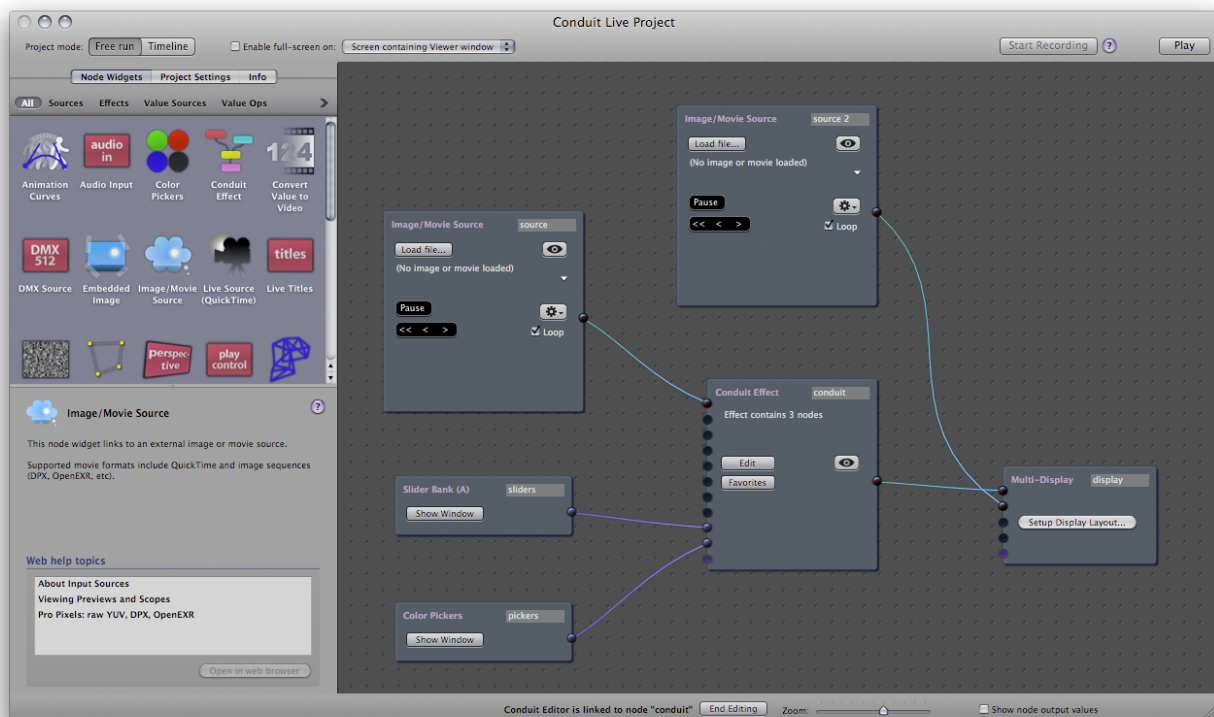
to show a camera image? When should another image fade in? When should an effect change to another? Etc.

When the show is built this way, it's very easy to run it: just go through the events at the right cues. To minimize guesswork within a hectic show, description texts can be attached to events. A simple information display makes it obvious what should happen next.

To provide live controls for effects, just attach a MIDI controller, and you'll have direct physical sliders with motorized feedback from PixelConduit. With these tools, anyone will be able to operate the show on your behalf. Instead of a MIDI controller, you can also use an iPad or other web-connected device thanks to PixelConduit's Web Control feature.

The project's control room

PixelConduit was described above as having a "control room" metaphor. This control room is the **Project Window**. Although this interface was already covered in previous chapters, let's take a quick recap to see what happens in the Project window.



On the right-hand side of the Project window, we see boxes interconnected by cyan and purple lines. These represent the different "devices" within the control room. The connections between the devices are like electric wires that transmit signals from one device to another. As in the real world, some of these wires carry video and others carry control signals. The color of the wire indicates the type of content.

The "devices" are called node widgets. Connections between them are read from left to right. (For more details, see *Node Widgets* in this book.)

In the above screenshot, the right-most device is "Multi-Display". This is the standard video output device. It can display multiple images, which is why it has four video inputs. You can easily direct the images onto different projection screens using a Matrox graphics expansion module (GXM).

Using a Matrox GXM, a single Mac laptop can output onto three separate projectors, and a Mac Pro can be configured to output images on up to 9 projectors.

Moving on in the screenshot, on the left we have two devices labelled *Image/Movie Source*. These are video players. You can load either movie clips or still images into them. Each player has its own playback controls. The button with the "eye" icon opens a preview window, which also offers scopes for analyzing the video content.

Between the video sources and the Multi-Display, there is a big node widget labelled *Conduit Effect*. This is like a video mixer. It can take up to eight individual video connections, and also a set of control signals. The control signals can be sliders, color pickers, or some other kind of values within your project. What differentiates the Conduit Effect from a typical video mixer is that it's fully programmable. You can completely "re-wire" the mixer's internals to create layer effects, color corrections, image warps, blurs... This is accomplished using the Conduit Editor, a powerful visual effects creation view. (For more information, see *Designing Effects: The Conduit Editor*.)

Finally, the above screenshot has two node widgets labelled *Slider Bank* and *Color Pickers*. These devices output control signals. To modify the values with on-screen controls, click "Show Window". Sliders are important because they are the easiest way to create animation within live situations. The idea is to instruct the Stage Tools "robot" to manipulate the slider, for example: "Move Slider 3 smoothly to a value of 0.5 during the next two seconds."

It's important to note that the sliders don't have any meaning on their own. The Slider Bank node widget needs to be connected to something that responds to the values in some way. The Multi-Display output can use the values to composite images: just connect Slider Bank to Multi-Display's last input. For more complex layering and effects, you can use the Conduit Effect. (Inside the Conduit Effect, the slider values are represented using Slider nodes.)

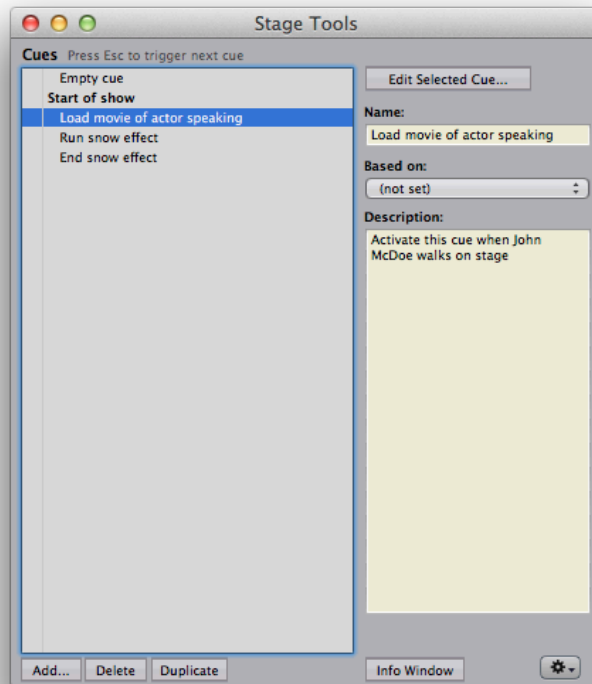
You can get physical control and feedback for sliders using a MIDI controller. For easy setup, we recommend a Behringer BCF2000 controller which is automatically recognized by PixelConduit. You can also use any other MIDI controller by configuring the sliders in PixelConduit's Sliders window. PixelConduit supports MIDI feedback, so motorized faders (available on the Behringer BCF2000 unit and many other pro controllers) will be automatically synchronized to the sliders you see on-screen.

Additionally you can use the *Web Control* feature to control sliders and other functionality over the web on a local network. See Web Control in the Sliders and Controls window.

You can also use the *DMX Source* and *Audio Source* widgets to set up your project to respond to events that occur in a stage lighting control desk or an input audio stream.

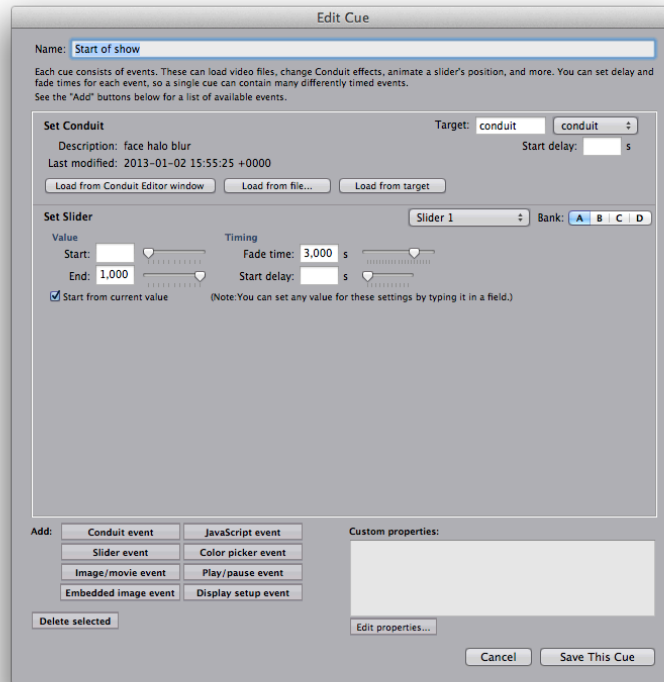
The cue robot

To build a show that runs on its own, we need a way to automate tasks in the PixelConduit control room. This ‘robot’ is the **cue list**. To open it, choose “Show Stage Tools Cue List” from the Tools menu:



This is where we build cues: things that needs to be activated at specific points within the show.

To create a new event, press "Add". This opens the Edit Cue window:



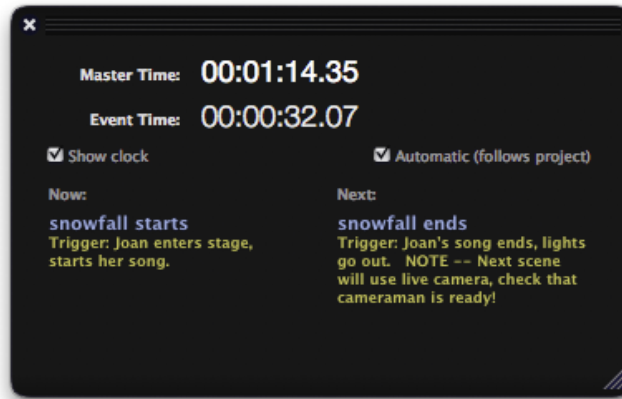
Each cue actually consists of one or more events. In the bottom left-hand corner of the above screenshot, you can see the different types of events. To load a video effect, use "Conduit event". To manipulate slider values, use "Slider event". To load video clips and control playback, there's "Image/movie event" and "Play/pause event"... There's also "JavaScript event", which allows you to enter programming commands that can make the cue do almost anything within the project.

Cues don't have to contain all the necessary commands in themselves: you can create cues that are based on another cue. This "master" cue will be triggered first. To create this type of cue, just select a cue in the Stage Tools window, then select the master from the "Based on" menu in the top right-hand corner of the window.

These master cues are particularly useful when you need to share an effect between multiple cues. For example, you might have one effect setup for basic layering, and another with a color correction setup to make live video stand out. You could place these effect setups in their own cues, and have all the actual cues be based on the master cues. This way, the effects remain editable in one place: when you update the effect, all of the cues that refer to it will follow.

During the show

When the show is running, Stage Tools provides a concise interface that shows only the relevant information about cues and timing. This "Info" window is opened by choosing "Show Stage Tools Info Window" from the Tools menu:



At the top is a running clock that shows the time elapsed since the start of the show and the previous cue. If you don't need this information, just toggle "Show clock".

At the bottom of the window, the "Now" and "Next" columns show the last triggered cue and the following one.

The text in yellow is the description that was entered in the Stage Tools Cue List window. It's a good idea to use this field to contain simple, unambiguous information about when this cue needs to be triggered, and what other things may need to be taken into account. This way, the person running the show only needs to watch the Info window.

There are a few ways to trigger cues. In the Stage Tools Cue List window, you can double-click on the list. (Single-clicking selects the cue for editing.)

When the show is running, you can press the *Esc* key anywhere within the application to trigger the next cue in the list. Alternatively, you can press Return – this is the "smaller Enter key" found on many Mac keyboards. (Newer Mac keyboards typically don't have the Return key anymore.)

What next

PixelConduit + Stage Tools has many other tools that don't fit within the constraints of this Getting Started section. Some node widgets that you might typically use in a live production are:

- **DMX Source** - use a lighting control desk to drive video in PixelConduit
- **Perspective Warp** - used to correct e.g. distortions from a projector that's placed at an angle
- **Live Titles** - a text tool that's particularly useful for live subtitles: it has a separate "cue list" for its titles, and supports complex styling with colors, drop shadows, etc.
- **Playback Control** - very useful for controlling video playback based on slider values or other control signals, for example: "when Slider 2 is lifted more than 5%, rewind the video clip and start playing"

Overview of Stage Tools windows

Designing cues in the Cue List window

The Cue List is where you design the cues that make up a show. The cue list is built up from "cues" that get triggered during the show.

The simplest kind of cue list would be something like a PowerPoint presentation: each cue simply shows a new image or video clip. (In fact, you can create this kind of cue list automatically from a PDF file using the options available in the Cue List window's Tools menu.) More commonly, it's not enough to just show a sequence of images. Using the Cue List, you can add more complex operations like effect changes, slider animations and delayed image loads.

A single cue in the cue list can contain an unlimited amount of operations, and they can be timed at will. This gives a tremendous amount of freedom in constructing cues, and makes it possible to design complex shows in such a way that the person who runs the show doesn't need to understand the inner workings of the system at all.

Typically cues are triggered by user interaction, for example a video operator pressing the "Advance to next cue" shortcut key. However it is also possible to trigger cues automatically or from hardware input. This can be done using the "Stage Tools Trigger" node widget, or even from custom JavaScript programs.

The main interface for Stage Tools is the Cue List window. To open it, choose "Show Stage Tools Cue List" from the Tools menu.

The Cue List displays a list of cues. This is the "run list" that makes up the show. Everything that needs to be automated for a particular show should be programmed as cues, and later, while performing, the cues will be triggered by going through the run list.

To activate a cue, double-click on it. When the show is running, you can also activate cues using a shortcut key (see below).

To create a new cue, click "Add". To edit an existing cue, select it in the list and click "Edit Selected Cue".

Running the project

Cues can only be activated when the project is playing. So if nothing seems to happen, press Cmd+P (or choose "Play" from the Output menu).

Also, the project must be in Free Run mode. See *Free Run vs. Timeline mode* in this book for a more detailed explanation of project timing modes.

When the project is running, you can activate the next cue by pressing the *Esc* key.

Stage Tools offers an Info window, which shows the current and next cues and their descriptions. To open the info window, choose "Show Stage Tools Info" from the Tools menu.

The Info window is very helpful for running live shows where timing is typically crucially important. Once the cues have been created, the person

actually running the show needs to only pay attention to the Stage Tools Info window to see what cue is coming up next, and press Esc accordingly.

Using the Info window

The Info window is designed to be the "dashboard" to watch when a show is actually running.

It shows the current cue, the next cue, and their descriptions. Typically the description would be something that tells the operator when the cue is meant to occur, for example: ""lights go out, Jane enters stage and says 'Hello'.""

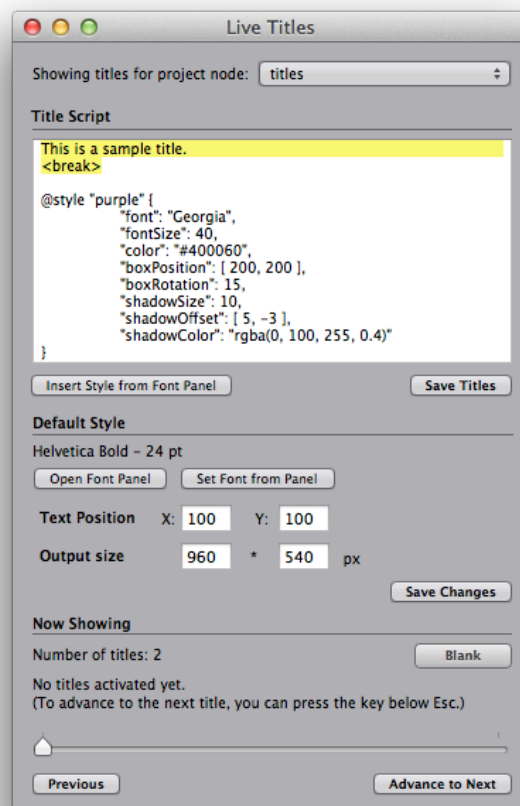
The description is entered in the yellow box in the Cue List. First select a cue from the list, then type the description in the yellow box.

There are also two clocks which can be used to keep track of how long the show has been running. The clocks can be hidden by clicking the "Show Clock" checkbox.

Live Titles window

This window is the interface for *Live Titles*, a graphics generation node that can be used to render complex titles and styled text.

Live Titles has its own cue list, so you can trigger titles separately from the main cue list of Stage Tools.



At the top of the window is the **Title Script** area. This is the list of all the titles that can be shown. The titles are separated by a special marker within the text: **<break>**

For each **<break>** found in the text, a title cue is created. You can advance through the titles by clicking on the “Advance to Next” button in the Live Titles window, or by the shortcut key which is the key below *Esc* on your keyboard. (This key has been chosen so that it doesn’t vary based on keyboard layouts; on an American keyboard this key has the backtick character.)

Titles have a default style – font, color and position – that you can edit in the **Default Style** area.

You can also create custom styles for individual titles. These can include advanced style effects like rotation and text shadow. Custom styles are created using a **@style** marker. The default script for a Live Titles node includes an example of such a custom style.

Sometimes you may want to trigger Live Titles cues as part of a cue in the Stage Tools cue list. This can be accomplished by using a JavaScript event that targets the *Live Titles* node.

Combining Stage Tools node widgets

There's a vast amount of creative control setups that can be built by combining the node widgets in Stage Tools. Some examples:

- With a *DMX Source* connected as the input to a *Conduit Effect* node widget, a stage light controller device can be used to drive visual effects parameters.
- A *Perspective Warp* can be used to correct the distortion from a projector installation.
- *Audio Input* connected to *Stage Tools Trigger* could be used to perform specific Stage Tools cues when a signal is received over a regular audio line connection. *Audio Input* also performs spectral analysis, so the cue could be triggered only when something occurs on a specific frequency band (e.g. a high-pitched sound).
- Similar to the previous idea, cues can be activated from a stage light controller device by connecting *DMX Source* to *Stage Tools Trigger*.

Hardware control protocols

MIDI: connecting to musical control hardware

MIDI control is included in PixelConduit as a standard feature. To enable MIDI, open the "Sliders and Color Pickers" window and click on "Setup MIDI control".

When MIDI control is enabled, PixelConduit's slider values will change in response to signals from the MIDI hardware.

PixelConduit also supports MIDI feedback. If your MIDI hardware has motorized sliders, they will reflect the slider values in the Conduit user interface.

DMX512: connecting to light controllers

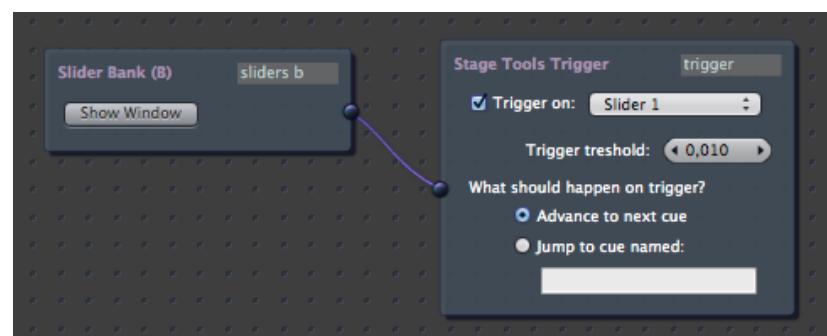
DMX512 is a standard protocol used to control lighting equipment. Stage Tools includes a node widget called *DMX Source* that outputs values received through the DMX512 connection. This allows PixelConduit to be controlled alongside stage lights.

A hardware adapter is required to connect your computer to the DMX interface. Currently PixelConduit supports the *Enttec DMX USB Pro* adapter. This device can be purchased from many online resellers.

Note that you need to install Enttec's Mac driver for the DMX USB Pro device to be seen by Mac OS X. Visit www.enttec.com for more information on drivers.

Triggering events and clips

The **Stage Tools Trigger** node widget can be used to trigger video clips or any other Stage Tools cues based on input. The input can be a MIDI slider, DMX controller, or any other value in the Project view.



In the above screenshot, the Trigger node has been set to trigger cues based on the connected *Slider 1*. When the user moves *Slider 1* above the "trigger threshold" of 0.01, the next cue in the Stage Tools cue list will be triggered.

The trigger threshold is useful to avoid accidental triggers from small motions e.g. on a physical MIDI hardware controller. By setting the trigger threshold slightly above zero, the trigger happens when the slider is moving up from its zero position.

This same technique can be used to trigger cues based on any other kind of input. For example, to trigger clips based on a DMX signal from a light controller, connect a *DMX Source* node widget to the Trigger node.

The Trigger node offers an additional setting for choosing which cue to trigger. By selecting "Jump to cue named" and entering the name of a specific cue in the Cue List window, you can create triggers that always activates that specific cue.

Note that you can have multiple Stage Tools Trigger nodes within the project. This allows different cues to be activated even in response to the same input.

To trigger individual video clips rather than cues, use the **Playback Control** node widget. This node widget does basically what is known as "fader start" for video clips. You can specify that a movie will start playing when a specific slider (or other value) goes over a given threshold. When the slider goes back down, the movie will stop playing.

For more details on using *Playback Control*, see below in the node widget's description.

List of node widgets in Stage Tools

Audio Input

Captures audio from the system's default input device, which can be the internal microphone, Line In jack, or a 3rd party device. You can select the active sound input device in System Preferences > Sound.

This node widget has three outputs:

- Output 1: **raw audio data** (data is of type 'video'). This is a one-dimensional video stream that contains the latest audio data waveform as floating-point values.
- Output 2: **min/max/average values** (data is of type 'value').

A list of numbers which represent the minimum and maximum values in the incoming audio. These can be interpreted as the dynamic range of the sound. For example, a loud clap will temporarily increase the maximum, and a constant background hum will prevent the minimum from ever going to zero.

The first two values in the list are min/max computed as a running average computed over a short period of time. This value has a falloff, so it looks better for controlling something like image brightness, as it won't "flash" on and off instantly.

The other two values in the list are min/max computed only from the most recent sound data.

- Output 3: **frequency bands** (data is of type 'value').

These values represent frequencies of the audio spectrum. The first values are bass and the last values are the highest frequencies.

DMX Source

Outputs values received over a DMX512 connection commonly used for stage lighting and effect installations. This allows for PixelConduit to be controlled together with stage lights.

An USB adapter is required to provide the DMX->computer connection. Please see section *Hardware control protocols* for details on supported devices.

Live Titles

Live Titles is a tool for displaying live-operated text, e.g. theatrical subtitles. It's possible to apply styles to text blocks. This allows for multiple layers of text with color, placement, rotation and drop shadows.

During the show, a separate shortcut key can be used to advance to the next title. This is convenient in typical titling situations where the titles are related to dialogue, because regular Stage Tools events and titles can be advanced separately. Naturally it's also possible to advance to the next title automatically as part of a Stage Tools event.

Live Titles consists of two parts, the "Live Titles" node widget and a window for editing and controlling the title texts.

For more information on the Live Titles window, see the section above on Stage Tools windows.

The Live Titles node widget can be used in the Project view in the same way as other image sources. In most situations, the titles will be shown on top of any other content (such as video clips). The easiest way to accomplish this is to connect the Live Titles output directly into one of the inputs on the *Multi-Display* node widget. The titles will be composited on top of the other inputs.

If you don't need to manipulate the title texts with effects, it's recommended to use the direct display connection approach outlined above. Typically, you might have a *Conduit Effect* connected to the Multi-Display's first input to provide the background content, and a Live Titles in the display's second input to provide the texts.

Perspective Warp

Warp the input image in perspective. The perspective can be computed from corner points. Typically, this node widget is used in combination with *On-Screen Points*, which allows you to pick and manipulate four corner

points directly in the Viewer. The *Perspective Warp* node widget will then map the video within those corner points with correct perspective applied.

Alternatively, the corner points could be the output from an *Animation Curves* node for an animated warping effect. Using the *Script Widget*, it's also possible to write custom JavaScript programs that can operate on input data, and then pipe the script's output into Perspective Warp.

For special applications, you can also supply a custom perspective matrix (an array of 16 number values that determines how the input image is warped).

Playback Control

This node widget offers a feature known as "fader start" for video clips. You can specify that a movie will start playing when a specific slider (or other value) goes over a given threshold. When the slider goes back down, the movie will stop playing.

This is highly useful for building setups where the same slider controls image opacity and starts the video playback.

To control values with sliders, connect the Slider Bank node widget's output to Playback Control. The names and values of the sliders will be displayed in the Playback Control node widget, allowing you to select which slider affects which movie clip.

The control values don't have to be sliders. You can also connect any other node widget that outputs a value, for example "Audio Input" or "DMX Source".

Stage Tools Trigger

This node widget triggers Stage Tools cues based on input. The trigger occurs when the input value crosses a specific threshold; for example, when a MIDI slider is moved above 10%.

This node widget can be used either to activate a specific cue each time the trigger occurs, or to advance to the next cue in the list. The latter mode may be particularly useful to run a live show based on input from a DMX light controller, or other hardware trigger.