Robe ESPRITE

By: Mike Wood

Figure 1: Fixture as tested.

Earlier this year, we looked at a Robe spot (the T1 Profile) using additive LED color mixing, but Robe hasn't abandoned fixtures using white light engines. Quite the contrary: It seems that Robe has been working on its own white light LED light engines rather than using the off-the-shelf solutions from Appotronics and others that it, and many of its competitors, have previously chosen. It's an interesting evolution. Back in the dim, distant days of incandescent and HID lamps, it was normal for all manufacturers to use the same, or very similar, lamps. When we first moved to LED sources, however, those standard lamps were no longer available, so everyone had to make their own, using bare LED emitters. Next, complete light engines started to appear as products you could buy, and the industry has followed that trend for a while. That inevitably led to many products being very similar, perhaps too much so. Now, in a quest for product differentiation, manufacturers are returning to the custom light engine model—not just Robe, but others as well. I'm sure we'll see many custom LED-based light engines in these reviews over the coming year.

The subject this month is the Robe ESPRITE. As mentioned above, it uses a custom white light LED engine made by Robe. The company has taken the opportunity to add new features around the engine; we'll come to them as we go through the unit. The review follows my usual format, working through the Esprite from power in to light out, testing and measuring as I go, so you have the information to help you make your own mind up.

The results presented here are based on the testing, with the fixture operating on a nominal 120V 60Hz supply, of a single Esprite unit supplied to me by Robe North America (Figure 1). The unit is self-adjusting for supply voltage and will run on any voltage from 100V – 240V, 50Hz/60Hz.

Light source

The LED light engine in the Esprite marks the biggest difference from other Robe products. As already mentioned, it has been made by Robe from scratch. Figure 2 shows a view of the LEDs and heat sink after it's been removed from the unit. You can clearly see the 73 individual LEDs, along with associated circuitry and the large copper and aluminum heat sink linked by eight heat pipes. Robe is touting the feature that this module can be easily removed for replacement, or to match other luminaires on a show without having to dismantle the unit. It did indeed only take a few minutes to remove to take this photograph. What's significant, and different from some of the off-the-shelf light engines on the market, is that the LEDs are separate from their optical systems. The optics stay in the light when the LED module is removed. Figure 3 shows the rear of the Esprite with the protective cover removed. The LED module is clearly visible. Remove four more screws

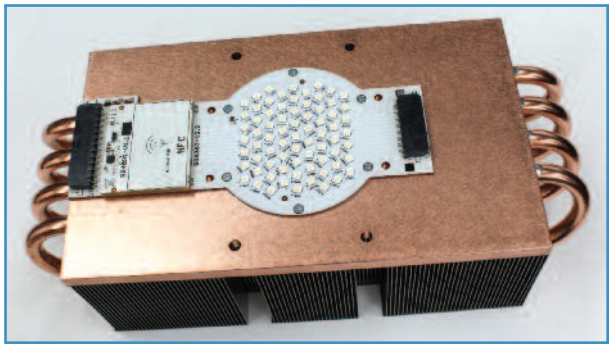

Figure 2: LED module.

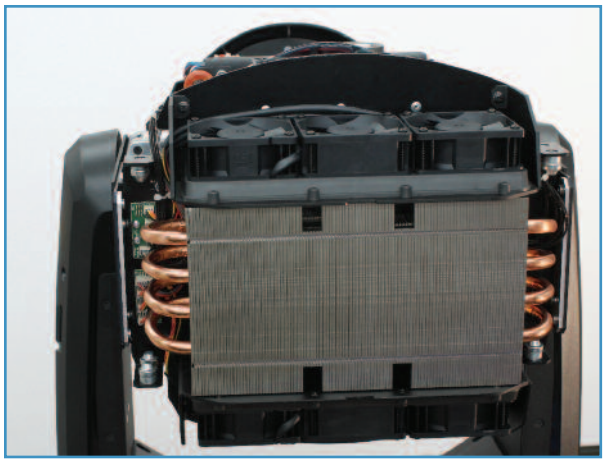

Figure 3: LED module in place.

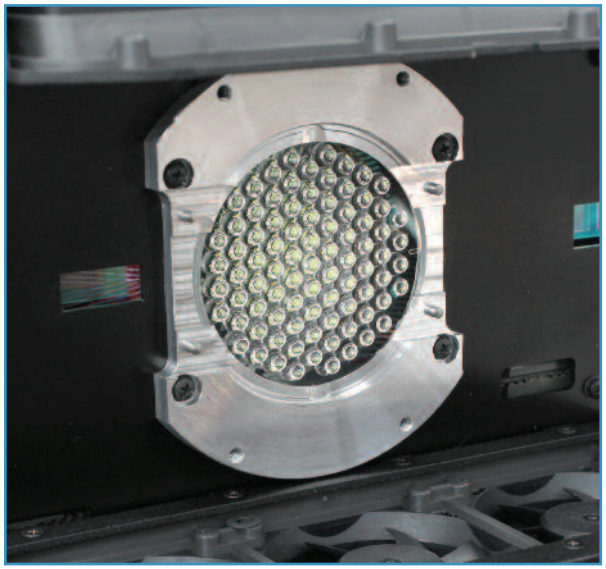

Figure 4: Collimating lenses.

Figure 5: NFC module.

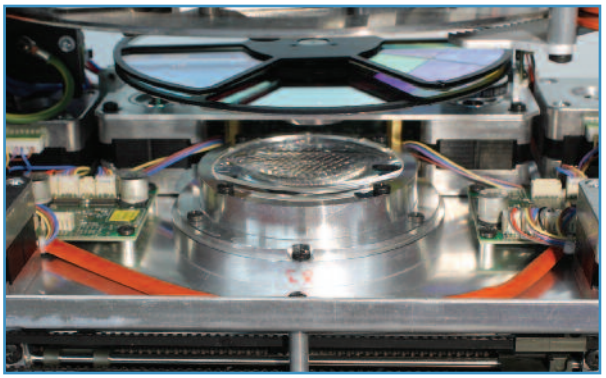

Figure 6: Fly eye lenses.

and unplug two electrical connectors and the LED module lifts off, revealing the array of collimating lenses shown in Figure 4. What you can also see in Figure 4 are the four pins that mate with four corresponding sockets on the LED module to align it accurately with the optics. The cooling fans are separate and stay in the unit. Three fans at one side, which push air, and three on the other, which pull, provide an air flow through the heat sink fins.

Also visible in Figure 2, and in more detail in Figure 5, is that part of the circuit board labeled "NFC." As I understand it from Robe (but was unable to test), each LED module will store its operating parameters internally—for example, data such as hours used and current light output. This information can then be read either by the main control system in the luminaire or by service staff using a smartphone with an NFC receiver. The idea is that, as an LED module ages and its output decreases, the user will be able to match light outputs from different modules and/or replace those that are unsuitable for the current show. I also understand that you will be able to interrogate the light to get this information through DMX channels from the control desk. More of that later in this review.

The LED optics are also interesting. The Esprite uses a combination of individual collimating lenses, one per LED, followed by tandem arrays of fly-eye lenses, and a final field lens. This is a familiar configuration that we've seen in other engines. The difference here is that Robe has put the dichroic color mixing filters in between the collimating array and fly-eye arrays. Figure 6 shows these lens arrays mounted after the color mixing flags at the bottom of the picture. Robe says that this arrangement helps with the homogenization of the subtractive color mixing and, indeed, the color mixing on the Esprite is extremely smooth.

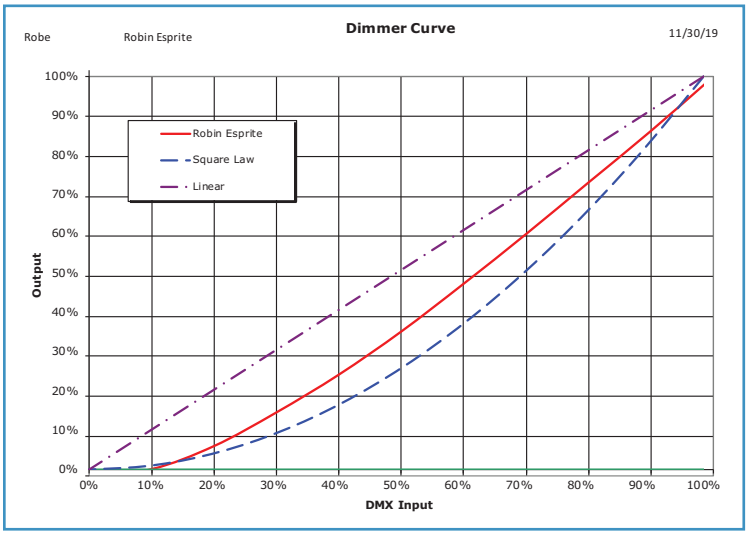

Figure 7: Dimmer curve.

Dimming and strobe

The Esprite offers a range of different selectable dimming curves; for this testing, I used my favorite, the square law. Figure 7 shows the resultant dimmer curve as somewhere between a linear and square law. Dimming was very smooth, with no visible steps at low dim levels.

The Esprite offers a number of options for PWM control. You can choose a center frequency of 300Hz, 600Hz, 1,200Hz, or 2,400Hz from either the fixture menu or from the desk though a DMX512 control channel. You can then tweak this up or down in small steps from a second control channel to find a frequency that doesn't interfere with video scanning.

Strobe range is adjustable from 0.5Hz up to a measured 18Hz. The Esprite took about seven minutes when running at full output to heat up to a stable operating temperature, during which time the output dropped by 10%. All the results I provide in this report are taken after the unit has reached steady operating temperature, to include the effects of the thermal droop. The results presented here are also when the fan was set to "auto" and the "boost" function was turned off.

Color systems

This is a standard Robe four-color dichroic mixing system using pairs of flags that open and close like pairs of curtains—one pair each for cyan, magenta, yellow, and CTO. The transmission of each color is shown in the table below. As you can see from the table, the mixed colors are very saturated.

COLOR MIXING

Color	Cyan	Magenta	Yellow	Red	Green	Blue	CTO
Output	18%	5.9%	75%	5.4%	10%	0.3%	44%

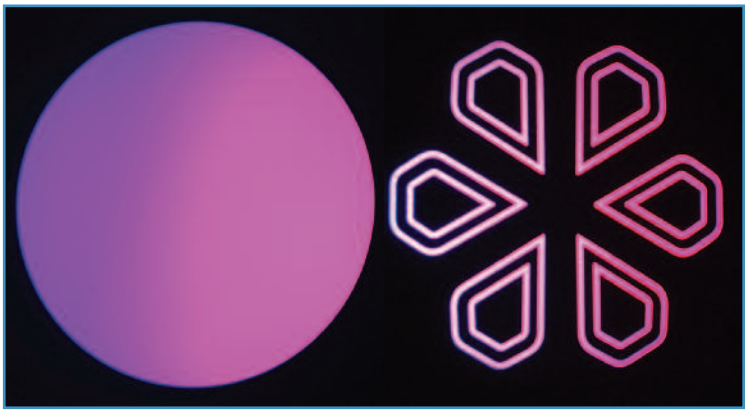

Figure 8: Split colors.

You can operate the color mixing either through normal CMY control or via a virtual color wheel channel that provides 66 premixed colors matching a range of standard gel colors.

As well as the color-mixing flags, the Esprite has two fixed color wheels, each with a range of dichroics and specialized filters that can be used alone or in conjunction with the color mixing. (Note that the color wheels are positioned after the final LED fly-eye optics.) For example, there is a multi-colored filter and a couple of high-color-rendering (minus green) filters on these wheels. Half or split colors are also possible, as shown in Figure 8.

COLOR WHEEL 1

Color	Deep Red	Deep Blue	Orange	Green	Congo
Output	0.7%	0.8%	19%	22%	0.2%

COLOR WHEEL 2

Color	Multicolor	Lime Green	Lavender	CRI 80 Filter	CRI 90 Filter
Output	N/A	67%	22%	79%	68%

I measured the spectrum and color rendering of the Esprite in open white both with and without the CRI 90 filter in place. The results are shown in Figure 9. The filter increased the TM-30 Rf from 62 to 79; Rg shifted slightly from 96 to 104 (CRI Ra from 69 to 85) while reducing output to 68%. (For more information, read my article in the Fall 2019 edition of *Protocol*, which described color rendering filters in detail.) In general, the Esprite oversaturates slightly in green and magenta. This isn't unusual for white LEDs, which are often lacking in deep reds and blues but have plenty of green energy. Overall, the Esprite color system works very well, and the new LED light engine certainly seems to help with color mixing. I didn't see anywhere near as much color edging on defocused gobos with pastel colors as you usually see with white engine LED luminaires.

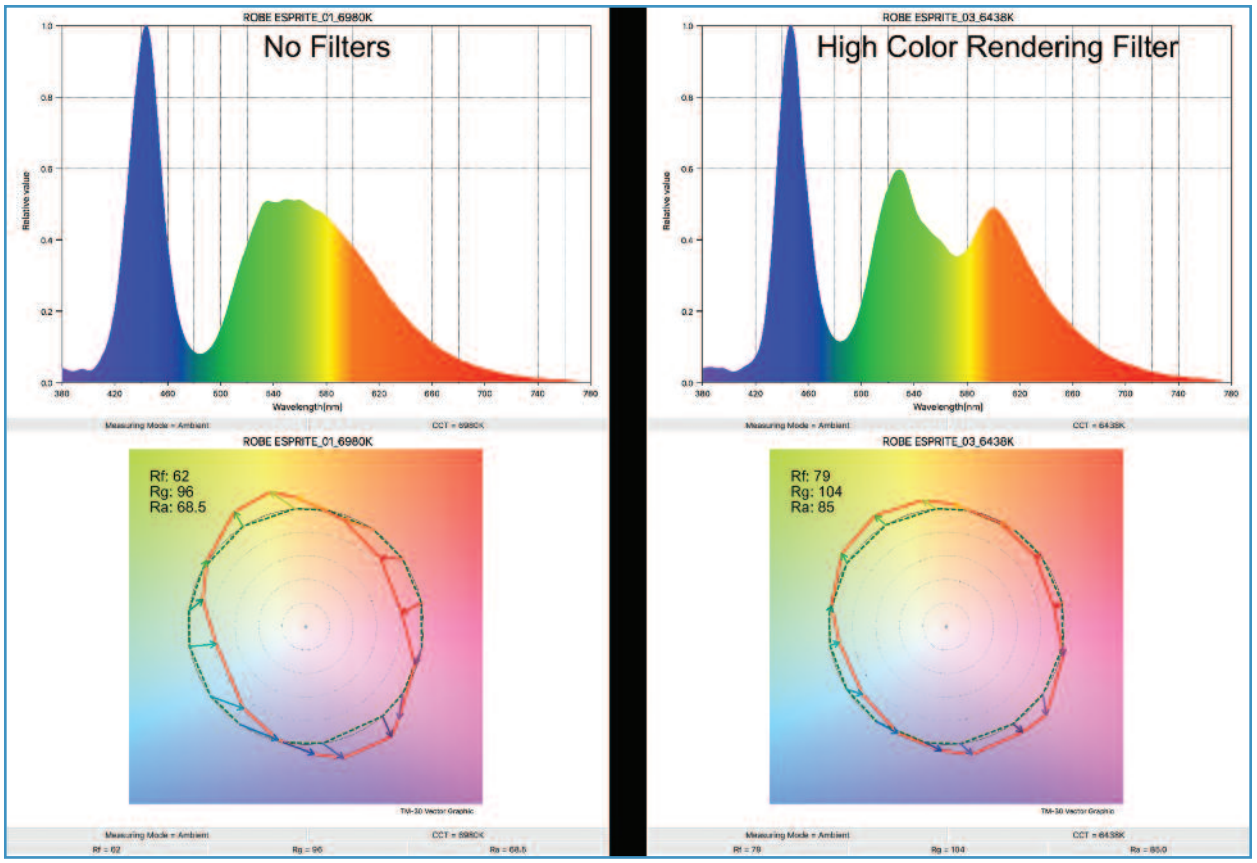

Figure 9: Color rendering filter.

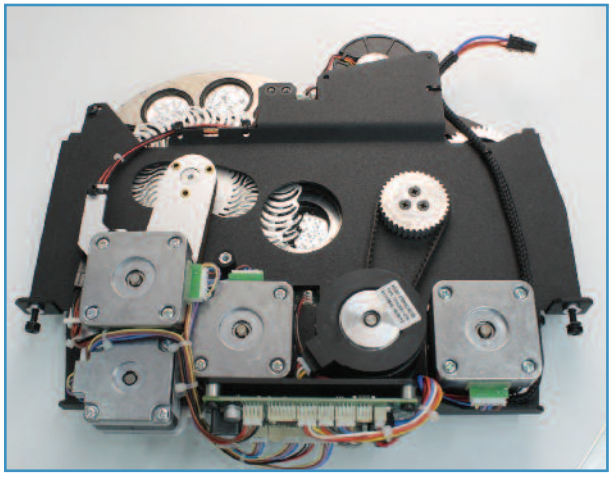

Figure 10: Gobo module rear.

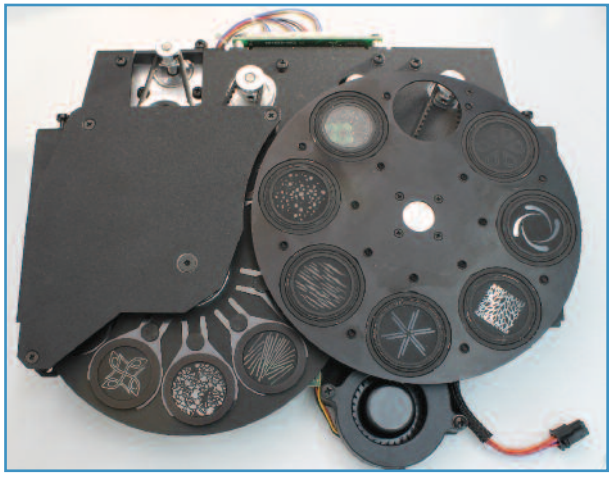

Figure 11: Gobo module front.

Gobo module

The imaging section of the Esprite is very familiar: two gobo wheels, an animation wheel, iris, and framing, all mounted on two removable modules. Figures 9 and 10 show the front and back of the gobo module.

First in line is the animation wheel. This is the usual Robe design, with a large aluminum breakup pattern that can be moved across the beam and then rotated off-axis to give a pseudo linear motion. It takes 0.25 second to insert or remove the wheel and, once in place, it can be rotated at speeds varying up to 36rpm. The animation system is quite a distance from the gobo wheel, but it is still possible to get overlaid effects from the three wheels. Next to this is the fixed gobo wheel. This has nine replaceable patterns plus open hole.

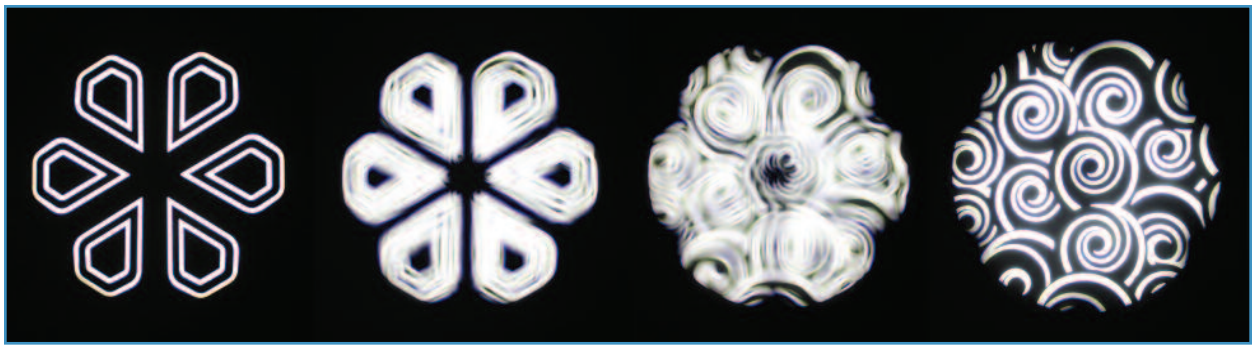

Figure 12: Gobo morph.

FIXED GOBO SPEEDS	
Gobo change speed – adjacent	0.1 sec
Gobo change speed – worst case	0.5 sec
Maximum wheel spin speed	0.96 sec/rev = 63 rpm
Minimum wheel spin speed	158 sec/rev = 0.4 rpm

Last in this module is the rotating gobo wheel, which has seven replaceable glass gobos and an open slot. The slot-and-lock system for gobo replacement is identical to other Robe products.

ROTATING GOBO SPEEDS	
Gobo change speed – adjacent	0.3 sec
Gobo change speed – worst case	0.7 sec
Maximum gobo spin speed	0.31 sec/rev = 194 rpm
Minimum gobo spin speed	996 sec/rev = 0.06 rpm
Maximum wheel spin speed	12 sec/rev = 5 rpm
Minimum wheel spin speed	Very slow!

Rotation and indexing on both wheels were smooth, with a good range of rotation speeds apart from the main gobo wheel spin, which seems a little slow. Movement was clean when changing direction, with very little hysteresis. I measured the accuracy at 0.09° of hysteresis error, which equates to 0.4" at a throw of 20'. Both gobo wheels use a quick-path algorithm to minimize change times. Figure 12 shows an example of a gobo morph, pulling focus through from one gobo to the other. (Note: I was asked why I show these gobo morph images in these reviews. Aren't they always the same? No, they aren't. I've found that the gobo morph is a good way of showing how the optical system defocuses edges, and whether or not you get multiple edged images. It often also shows up any oddities in the color mixing in additive color systems.)

Framing module

Figures 13 and 14 show both sides of the framing module and the iris. The shutter system mechanism is the same as on previous Robe units. Each shutter blade has approximately +/- 25° of rotation and can move in to cover about

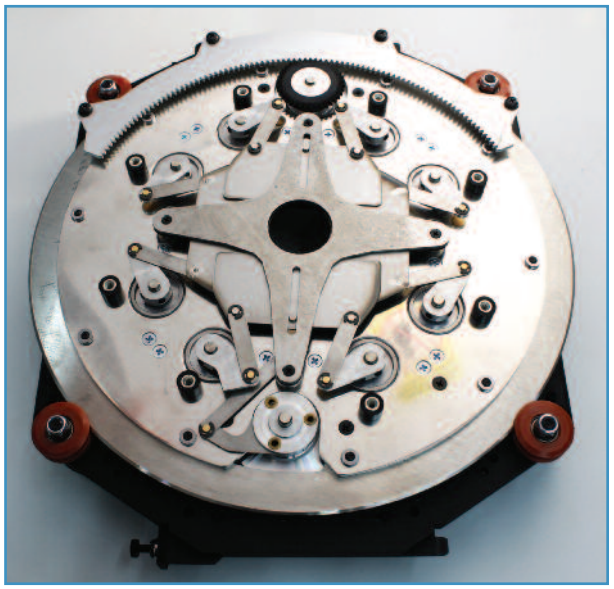

Figure 13: Framing module rear.

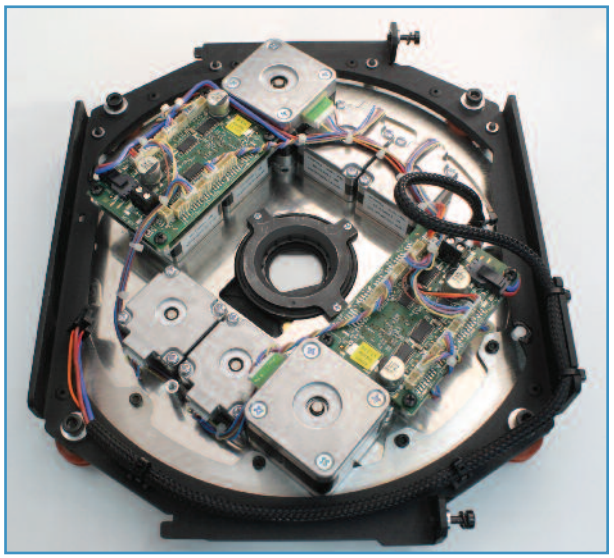

Figure 14: Framing module front.

Figure 15: 120° Framing rotation.

75% of the beam. The entire assembly can then be rotated a further +/- 60° as shown in Figure 15. The small blades can move quickly, a maximum of about 0.4 second from fully open to fully closed. Shutter cuts were straight, with very little pincushion or barrel distortion at most beam angles except the widest zoom. As with the animation wheel, the focus for the framing is quite a distance from that of the gobos. However, it is possible to get a reasonable soft-focus framing cut on top of a gobo. Figure 17 shows an example. There are some multiple edges visible on the framing, but nothing too objectionable.

Finally, in this module, the Esprite has an iris. This reduces the aperture to 15% of its full size, which gives equivalent field angles of 0.8° at minimum zoom and 6.6° at maximum zoom. I measured the opening/closing time at around 0.25 second.

Prism and frost

The final optical effects are the prism and frost flags. There is a single six-facet, rotatable prism mounted to the output side of the rear lens group and two frost flags mounted to the input side of the front lens group. Both prism and frost travel with their associated lens groups. Figure 17 shows a view from the rear of the unit with the prism on the left, and the 1° and 5° frost flags on the right.

The prism can be inserted or removed in about 0.6 second and then rotated at speeds up to 120rpm in either direction. Image separation is about 40% at mid zoom angles.

Turning to frost, as already mentioned there are two flags. The rear flag is a 5° heavy frost and is mounted on a magnetically attached arm for easy replacement. The second is a light frost, labeled 1°. I won't dig too deeply into the way these frosts work, as it is extremely similar to the Robe T1, which I explained in detail a few months ago. Suffice to say that I like the 1° frost on a breakup gobo, and the heavy frost is really for wash effects, not soft edges.

Figure 16: Shutter cut on gobo.

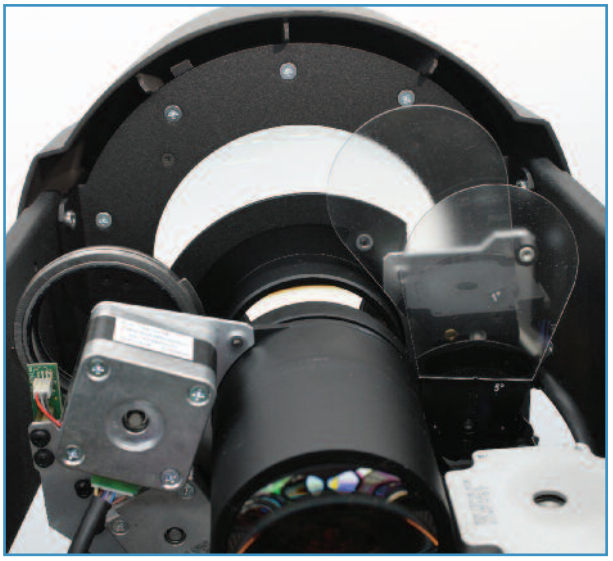

Figure 17: Frosts and prism.

Lenses and output

Before we start, let me say again that I took these measurements when the unit was in standard output mode (boost turned off) with the fans on auto. The Esprite has the typical three-group system, two groups that move for zoom and focus, and a fixed output group. I measured the zoom group as taking 0.85 second to travel from end to end with the focus group taking 0.65 second. I measured

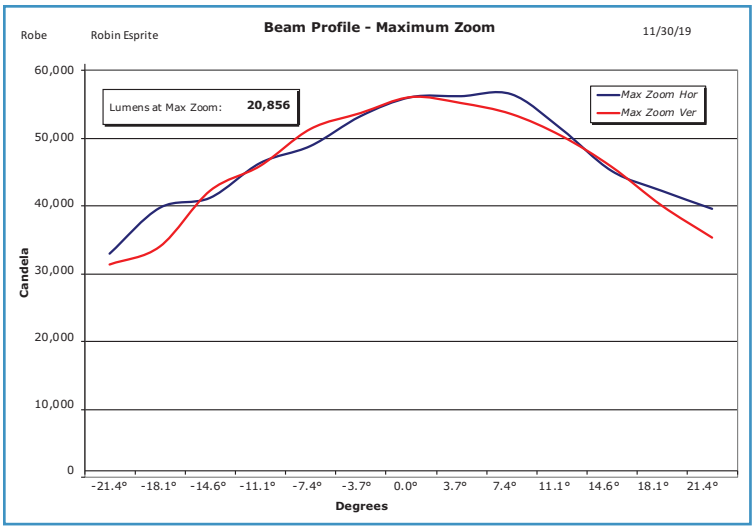

Figure 18: Output maximum zoom.

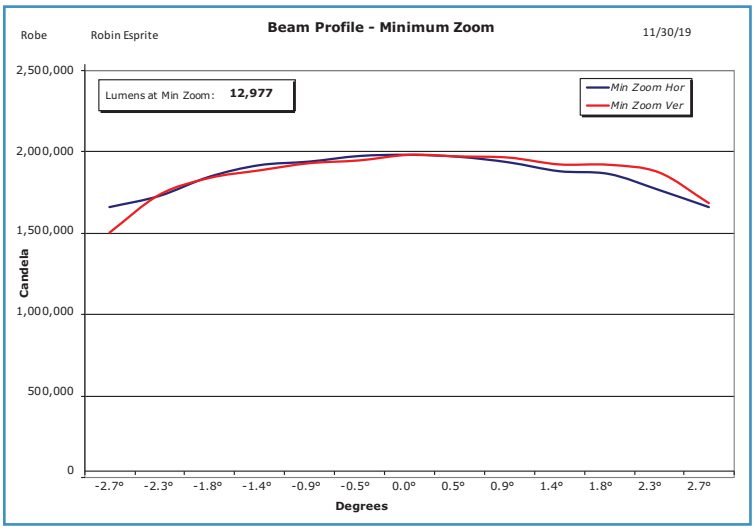

Figure 19: Output minimum zoom.

the output in wide angle at just under 21,000 lumens at a field angle of 42.7°, ramping down to 13,000 lumens at a 5.5° field angle. These figures increased by approximately 4% when the fans were switched to high-speed mode, and by 8% when the unit was in boost mode. I was also testing an early preproduction unit, and Robe tells me the output has been increased for production models. As can be seen from Figures 16 and 17, the beam distribution is extremely flat and smooth.

A note about measuring beam angle, in particular the very wide zoom angles that many fixtures, such as the Esprite, are capable of: In theory, it is a simple calculation based on the diameter of the beam on a wall and the throw distance. However, there's a question about measuring the throw. Where do you measure from? It's common in conventional photometrics to measure from the front of the output lens. However, that isn't the throw distance that shows on a plot in a theatrical production. More likely, the throw is indicated as the distance measured from the hanging point or bar that the luminaire is attached to. This small change doesn't make much difference at long throws, but at short throws, where you might be using the wide angle zoom position, this can make a noticeable difference. In these reviews, I've always measured from the hanging point, which will always underreport wide beam angles compared to measuring from the front lens. For example, in this review I've reported the wide beam angle as 42.7°. However, if I were to measure from the front lens that angle increases to over 50°. Which is correct? Well, both are!

Pan and tilt

I measured the pan and tilt range of the Esprite at 540° and 264°, respectively. A full-range 540° pan move took 4.5 seconds to complete, while a more typical 180° move finished in 2.8 seconds. Tilt took three seconds for a full 264° move and 2.7 seconds for 180°. Movement in both axes is very precise, with no visible ringing or wobble on stopping. I measured hysteresis on pan at 0.1°, equivalent to 0.4" at 20'. For tilt the hysteresis was 0.03°, equivalent to 0.1" at 20'.

Noise

As usual with LED units, the LED cooling fans provide the primary background noise. The noisiest movement was the framing overall rotate system (not the framing blades themselves), followed by zoom and focus.

SOUND LEVELS

	Normal Mode
Ambient	<35 dBA at 1m
Stationary	47.6 dBA at 1m
Homing/Initialization	53.5 dBA at 1m
Pan	49.3 dBA at 1m
Tilt	49.6 dBA at 1m
Gobo	48.0 dBA at 1m
Gobo rotate	48.1 dBA at 1m
Zoom	50.5 dBA at 1m
Focus	49.8 dBA at 1m
Animation wheel	48.2 dBA at 1m
Framing	52.4 dBA at 1m
Frost	47.6 dBA at 1m
Prism	47.6 dBA at 1m

This was with the fans running in auto mode. With the fans in high mode, the fan noise increased to 56.9dBA at 1m, and in silent mode, with the fans as low as they can go, the noise reduced to 40.2dBA at 1m. High mode gives you 4% more light output, while silent mode set to minimum reduces light output to 73%.

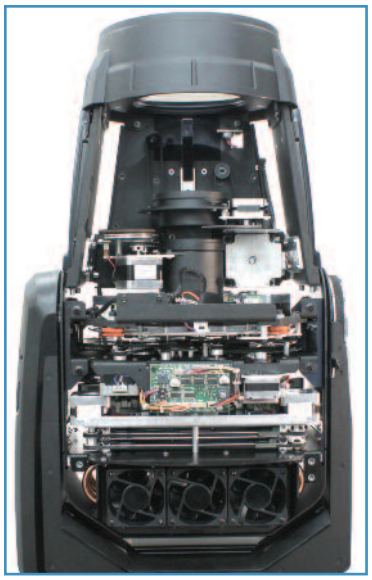

Figure 20: Head.

Figure 21: Yoke.

Homing/initialization time

Full initialization took 53 seconds from either a cold start or a DMX512 reset command. Homing is well behaved in that the fixture fades out smoothly, resets, and keeps the LEDs off before fading up again after all reset movement is finished.

Construction

The Esprite follows the standard Robe model and is of modular construction with the vast majority of the head components on the main modules. These modules are straightforward to remove, with two captive screws and power and data connectors for each module. Figure 20 shows the overall head layout.

Figure 21 shows the tilt control yoke arm with the tilt belt and encoder. Figure 22 is just a small component I noticed that covers cables as they enter the head from the other yoke arm. What on earth are you showing this for, I hear you ask? It's just a small piece of plastic. Yes, all that's true. However, looking at it, it occurred to me how much more mature our industry (and its manufacturing) is than it was only a short time ago. A few years back, this would have been a zip tie or, at best, a piece of bent aluminum. Now it's a carefully engineered injection molding that protects the wiring. It's not just with Robe that I'm seeing this general improvement, it's with every manufacturer. Parts are being tooled and made for purpose, rather than fabricated.

Electronics and control

The Esprite uses the familiar Robe color touch screen system used in many of their products. This provides access to a comprehensive array of setup and service functions (Figure 23). This includes RDM, Ethernet protocols, optional wireless DMX using the LumenRadio CRMX system, stand-alone operation, and self-test modes. I tested RDM using the City Theatrical DMXcat and it behaved well, offering the normal RDM service and control features. I mentioned earlier that Robe was introducing a system into the Esprite to allow querying the light output from the desk. As I understand it (it wasn't in the early unit I had), this will work as follows: The user can employ a special control channel (Channel 9 in the published DMX512 map) to request the fixtures to indicate their light intensities relative to their value when the units were new. They do this by showing a color that relates to the output. For example, a unit that is still at full original output will show a white beam. One that has dropped by 6% – 10% will show a red beam, one that has dropped 11% – 15% will be green, and so on. That way, the user can get a quick and easy look at the rig and see which units are at what output level in their lifetimes. Further, the user can set a fixed offset for

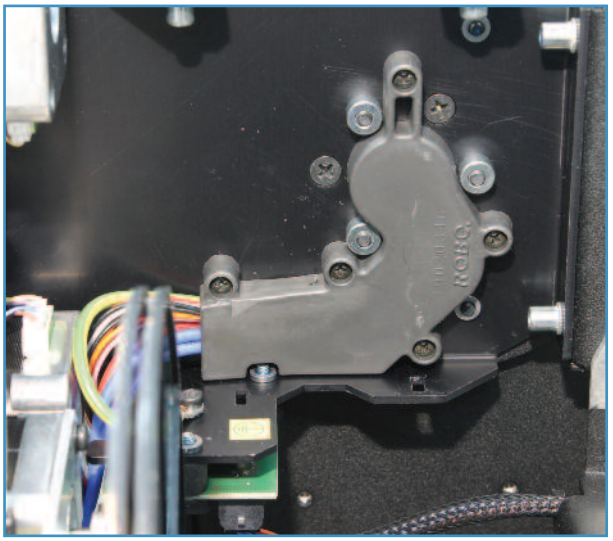

Figure 22: Sign of a mature industry.

Figure 23: Display.

Figure 24: Connectors.

any fixture to make them all match. As I said, this feature wasn't operational in the unit I tested—Robe kindly let me see an early unit at short notice—but I look forward to seeing it when the unit is in full production.

The connector panel on the opposite side of the top box contains Neutrik True-1 power input along with standard five-pin and three-pin DMX512 connections and an Ethernet port (Figure 24).

I measured power consumption when running at full output open white as 6.72A, 804W, 808VA, a power factor of 0.99. The quiescent load with all LEDs off was 0.68A, 80W, 84VA, power factor of 0.95.

That about covers it for the Robe Esprite. The main new feature to look at is clearly the in-house designed and built LED light engine. Does it interest you enough to try it out? Then do it. Don't take my word for anything; all lighting and vision is relative and you must test fixtures in your own manner with your own eyes. All I can hope to do is to give you some pointers to assist that process.

Mike Wood provides design, research and development, technical, and intellectual property consulting services to the entertainment technology industry. He can be contacted at mike@mikewoodconsulting.com.

UPCOMING EVENTS

Music Inside Rimini
March 8-10, 2020
Rimini, Italy
https://en.musicinsiderimini.it/

Prolight + Sound
March 31-April 3, 2020
Frankfurt, Germany
https://pls.messefrankfurt.com/frankfurt/en.html

LEDucation
March 17-18, 2020
New York, NY
https://leducation.org/

USITT
April 2-4, 2020
Houston, TX
https://www.usittshow.com/

CITT Expo-Scene
March 25-26, 2020
Montréal, Canada
https://www.citt.org/ExpoScene.html

NAB
April 19-22, 2020
Las Vegas, NV
https://www.nabshow.com