High End Systems Shapeshifter

By: Mike Wood

Recently, I've tested some unusual luminaires that have made working out sensible testing regimes difficult. Ultra-narrow beam effects luminaires, steerable optics, and LEDs present a whole new set of problems. How do we know what we are measuring is worthwhile and actually reflects how the product is used? Specifying and measuring a luminaire for a key light or a backlight is straightforward. Three questions get you most of the answers you want: How bright is it, how flat is the beam, and how good is the color rendering? However, none of those parameters may be useful when talking about aerial beam effects, gobos, or other effects luminaires. However, I stick to my guns, trying to provide some useful data on how the unit might work for you, and how it benchmarks compared to its competitors.

The luminaire I'm looking at in this review embodies nearly all the tricky-to-measure features I mention above, and so presents a bit of a challenge to classify. It's High End System's Shapeshifter. High End Systems has been in the automated lighting business for a long time, and has always been a respected player. The company's fortunes have ebbed and flowed over the years and, in recent times, it has apparently concentrated more on control systems (with the Wholehog range) than on luminaires. However, the arrival of LEDs seems to have spurred some new thinking. As a company, it has always liked being a bit different from the competition, and the Shapeshifter is definitely that. You could treat it as one luminaire, or you could treat it as seven semi-independent luminaires: It's a little bit of both.

Fig. 1: Fixture as tested.

High End Systems provided me with two different Shapeshifter models: the C1 RGB color mixing unit and the W1 white only. I've tried to measure everything, from light source to output, and present those results for you to use in your own decision-making. The Shapeshifter is fitted with a universal power supply rated from 100 – 240V 50/60Hz; however, for these tests the luminaire was run from a nominal 115V 60Hz supply (Figure 1).

Light source

The Shapeshifter W1 and C1 each contain 126 Cree XPE 2 LEDs. These are divided into seven modules of 18 LEDs. In the case of the C1, each of the seven modules comprises six red, six green, and six blue LEDs. In the W1, all 126 LEDs are white. The Cree XPE-2 is a nominal 3W device but, as you've heard me say many times before, no LED rating is absolute. The efficiency of cooling and the environment of the LEDs are the real drivers of power rating. The seven modules of LEDS are arranged with one central module and six surrounding. The central module is hexagonal in shape, and is fixed relative to the head. However, here's where the fun starts: The six surrounding trapezoidal modules of 18 LEDs are each mounted on its own independent pan-and-tilt system, providing a secondary movement option relative to the luminaire head and the center module. Each of the 126 LED packages is fitted with its own narrow-angle primary TIR optic. Figure 1 shows the seven modules clearly; in this photo, they are all positioned in a single plane facing forward. We'll come back to the movement system later; for now, let's look at the LEDs and their cooling.

Because the six outer modules move relative to the head, a single large heat sink wouldn't work; instead, each module has to contain its own cooling and heat sinks for their associated LEDs. Figure 2 shows the view from the rear of one of the modules and the die cast heat sink forming the rear surface of each module can be clearly seen. (A single large, thermostatically controlled, fan on the rear of the unit draws air through and over these heat sinks to keep them cool. Figure 3 shows the fan, along with the three circuit boards in the rear of the head. The largest of these boards (top and left in Figure 3) contains the LED drivers, while the smaller two

Fig. 2: Pan and tilt.

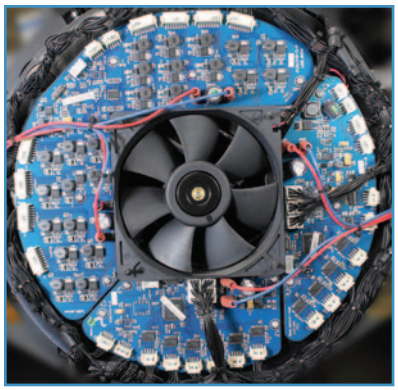

Fig. 3: Circuit boards.

boards (right and bottom) contain the pan-and-tilt motor drivers for each module. The cooling system, albeit a little noisy (more later), works well. In my testing, when running all LEDs at full power, I found that the light output dropped by only about 9% over 30 minutes as everything heated up. This is a good result; many LED luminaires lose much more than this as they warm up. (Note: All output tests in this review are measured after this 30-minute warm up time.)

Output

I measured the Shapeshifter C1 with all three colors at full power, as providing 9,195 field lumens from the seven groups of emitters (Figure 4). Now here comes the first of the complications: How do we define the field angle of a unit like this where the modules can move? I decided to measure and report both the total field angle when all the modules were in a single flat plane and the field angle of an individual module. There is no conventional beam angle control as such—each module is a fixed focal length—so that seems a reasonable approach. I measured the field angle for the C1 with all modules planar at 16.5°. The field angle of a single group, and thus approximately the minimum field angle for the entire luminaire when converged to a single spot, was 15°. The wide angle is very much up to you! As the outer six modules can be tilted outwards, the effective field angle increases, however, at some point as the modules diverge, and those seven beams will separate into individual beams. The point at which the one beam becomes 7 is very much a matter of opinion.

Note: There is an interesting issue here when reporting beam and field angles. For these figures to mean anything, we have to be outside of the near field and into the far field where the inverse square law applies. With a normal luminaire, this is relatively straightforward, the rule of thumb is to make sure all measurements are taken at a throw of at least ten times the diameter of the light source, and you can be reasonably confident you are in the far field. In a luminaire like Shapeshifter (and other luminaires using multiple ultra-narrow angle sources), this is a difficult problem. As you could adjust the Shapeshifter module positions to have an external beam crossover point a great distance in front of the luminaire, the far field could also be a very long way away. With a luminaire like Shapeshifter, it isn't practicable to measure in the far field in my workshop; it's just not big enough. The way around this, as I did above, is to measure just a single emitter or module and scale up from there. A single module behaves conventionally and the far field is only a few feet away. If you'd like to know more about this topic and the issues of near and far field measurement, I recommend reading Karl Ruling's article in the Winter 2015 edition of Protocol.

Note 2: As always in my reviews I use standard field lumens to report the total light output. In its literature, High End Systems uses its own proprietary version of lumens, which is not comparable.

Color homogenization at the longer throws was good; however, this is an effects luminaire, so things like colored shadows are not of much concern. With the white-only W1, performance was slightly different. The total light output, as expected, was much higher, at just under 15,000 field lumens (Figure 5). The planar field angle was the same at 16.5° (this is constrained by the geometry of the system as much as anything); the individual converged field angle of each module was less than the C1, at 12.3°.

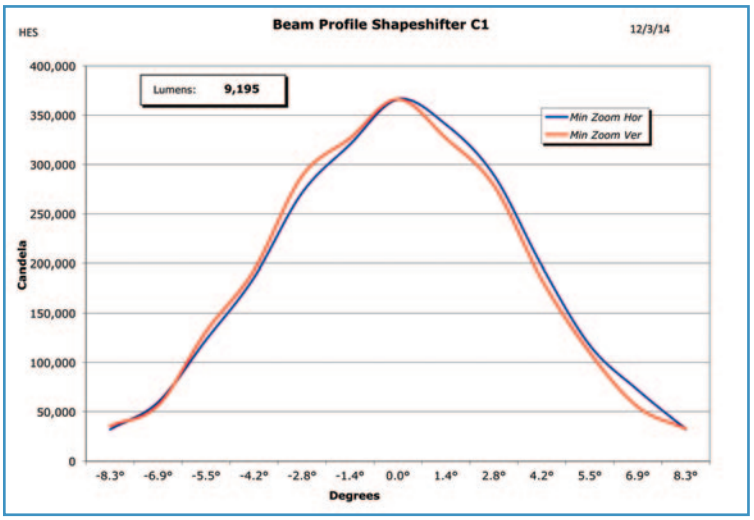

Fig. 4: Beam profile - C1.

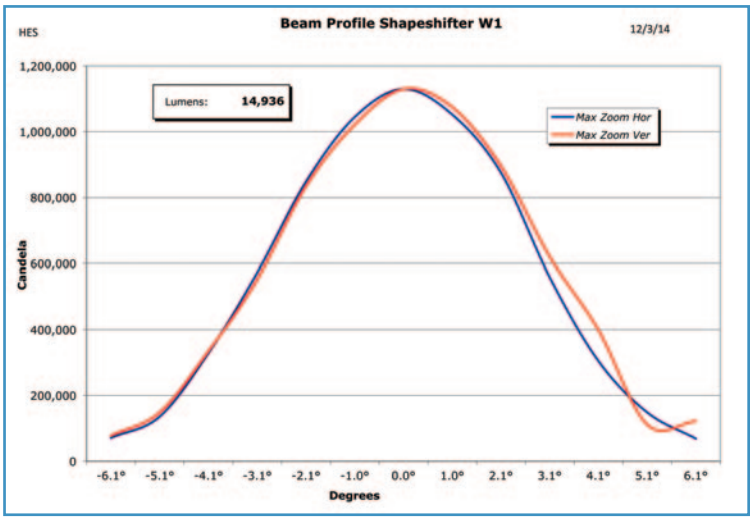

Fig. 5: Beam profile - W1.

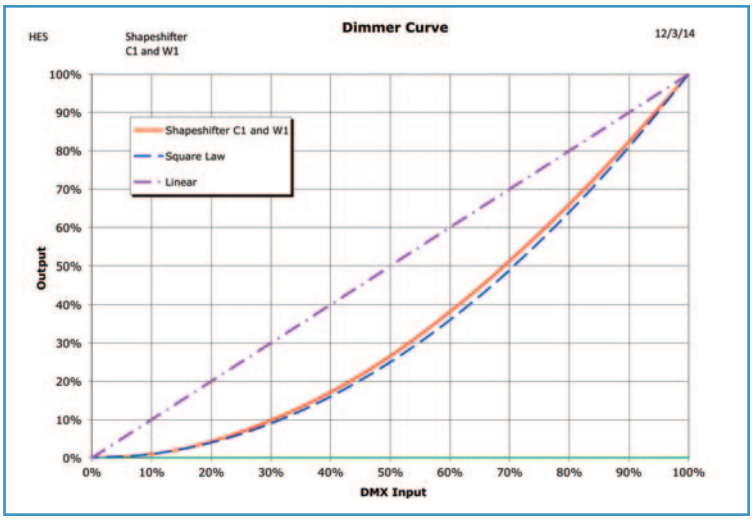

Fig. 6: Dimmer law.

Dimming

The dimming curve for the Shapeshifter is shown in Figure 6. It's almost a perfect match for the theoretical square law line. Dimming performance was good in the top 85% of the curve; however, even though the unit utilizes 16-bit control for dimming, the bottom 15% was visibly steppy. Color consistency throughout dimming was good, with all three color channels tracking together well and mixed colors remaining constant as the unit was dimmed.

The Shapeshifter has a separate strobe channel that provides a range of different strobe types, including ramps and snaps. I measured a speed range with a regular strobe from 0.2Hz up to 13Hz.

I measured the PWM frequency of the Shapeshifter at 1.95kHz. This should be fast enough to cope with most TV systems.

Note: In general, the faster the better with PWM. Modern CMOS video cameras with rolling shutters are very sensitive to any flicker at all. However, as frequencies rise, there is a new "gotcha" that can bite you: In attempts to avoid these camera issues, we are getting into the kHz with PWM frequencies, and this is causing a new problem where the PWM becomes audible as a singing or ringing from the luminaire power supply or drivers, particularly noticeable around 5kHz – 10kHz. It may be that, in the quest for better and better PWM, we have to skip the audio range and jump straight up to 20kHz or more.

Color system

The Shapeshifter C1 offers a conventional three-color RGB additive color system and behaved as expected. Figure 7 shows the spectrum of the C1 with all emitters at full, as the measurements were taken. The emitters peak at approximately 450nm, 515nm, and 635nm. In this mode, the light is not a pure white; instead, it has a distinct blue tint. Adjusting the mix by reducing the blue until we get to a true

white on the black body line, we get maximum output at around 10,000K with an output about 80% of maximum.

The output in the main primary colors as a percentage of full output was as follows.

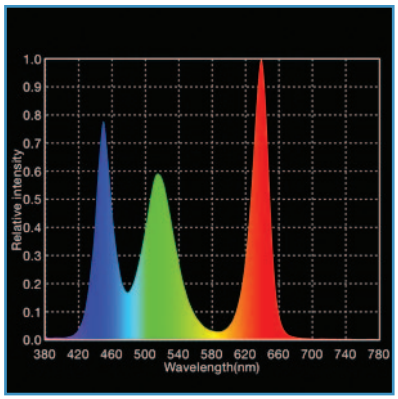

Fig. 7: C1 spectrum.

COLOR MIXING

Color	Red	Green	Blue	Cyan	Magenta	Yellow
Output	29%	63%	8.3%	71%	37%	91%

(As I have mentioned before, the perceived blue level appears higher to the eye than these figures imply.)

This is a rather simplistic color analysis, as it ignores the independent module control; in practice, I suspect you are less likely to use overall colors with the Shapeshifter C1 and more likely to create color effects with the modules. The Shapeshifter C1 can be run in a number of different color modes where you can take individual control of each of the seven modules, or run macros that generate color patterns. Figure 9 shows some examples of the color patterns generated by the color macro channel. Many of these are provided, or, if you have the time and enough DMX512 channels, you can build your own.

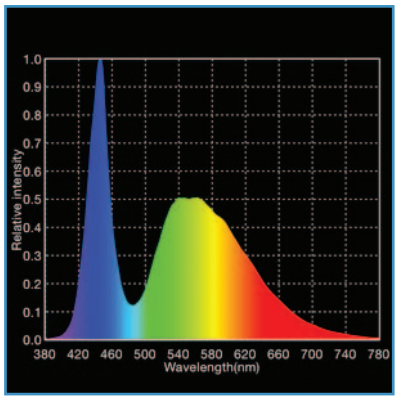

Fig 8: W1 spectrum.

Turning to the Shapeshifter W1, the spectrum, shown in Figure 8, is that of a conventional phosphor white LED with a blue spike at 445nm and a broad yellow peak centered around 550nm. (I measured the color temperature of the W1 at just under 7,000K, with a CRI of 74 and a CQS of 68.

Module movement

Module movement is the Shapeshifter's claim to fame. As mentioned earlier, each of the outer six LED modules is mounted on a pan-and-tilt arm, very reminiscent in design of those on a scanner. (See Figure 2.) Pan (tangential, or X axis movement, as High End Systems calls it in

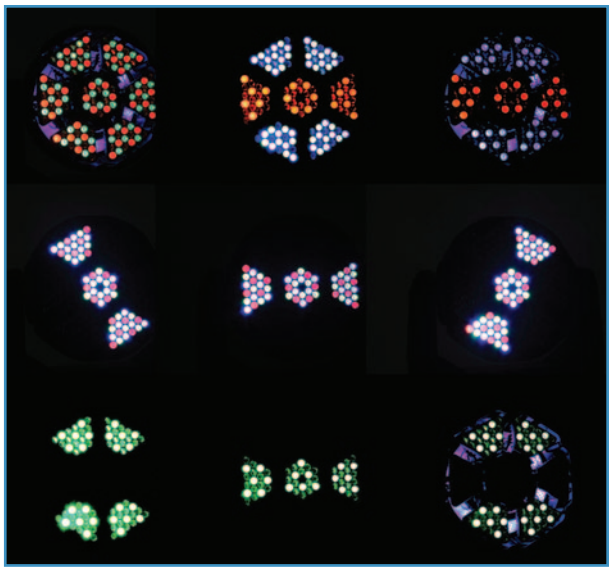

Fig. 9: Example patterns.

Shapeshifter) is a single stationary stepper motor driving the rotation of the module, while tilt (radial or Y axis) is driven through a belt from a second motor that travels with the module. Substitute a mirror for the LED module and you would recognize the scanner mechanism. The interaction between these axes, as with a scanner, is complex. Figure 10 shows the range of each plane of movement.

The advantage of this type of system, with the relatively lightweight LED modules, is speed of movement. I measured the X movement as having a total range of 32° and the Y at 28°, with both of them capable of moving end-to-end in approximately 0.4 seconds. This is much faster than the overall pan and tilt yoke can move. As with the color control of the modules, you have the option of moving all the X and Y channels together, or driving them individually. Again, as with color, there is a good range of movement macros provided to get you started. In fact, more than with other luminaires I've used, the built-in macros are really essential for programming Shapeshifter in a reasonable time.

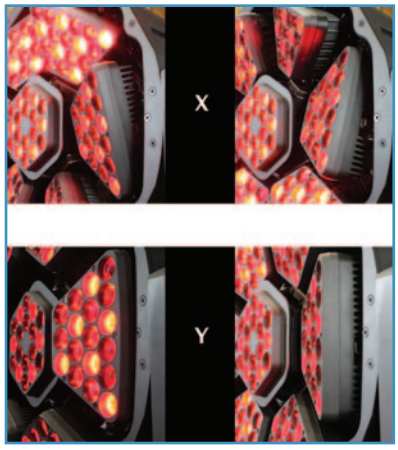

Fig. 10: Shapeshifting.

Pan and tilt

The Shapeshifter C1 and W1 have a pan range of 540° and tilt range of 270°. A full-range pan move took 3.6 seconds, while a more typical 180° move finished in 1.8 seconds. Tilt took 2.1 seconds for a full move and 1.5 seconds for 180°. Movement was very accurate. Positional repeatability on pan was 0.09°, which is approximately 0.4" of error at a 20' throw (16mm error at 10m). Tilt error was 0.07°, 0.3" at a 20' throw (12mm at 10m). The mechanical system was well-damped, so moves are smooth with just a small amount of overshoot.

Indigo backlighters

As we've seen in a few other High End Systems products recently, the Shapeshifter is fitted with an auxiliary illumination system using indigo LEDs. In this case, the documentation refers to them as backlighters. There are six circuit boards, each with three LEDs mounted around the head that fire backwards into a dimpled aluminum diffusing reflector. Figures 11 and 12 show the LEDs and reflector. These backlighters can be controlled independently of the main LEDs or linked with them to dim up and down with the main output. The result is visible if you look directly into the luminaire head, not as a projected effect. Three of the examples in Figure 9 show the indigo backlighters in use.

Noise

The fan can make the Shapeshifter quite a noisy unit. With the luminaire in full power, the thermostatically controlled fan gets up to full speed and becomes the noisiest component.

Fig 11: Indigo.

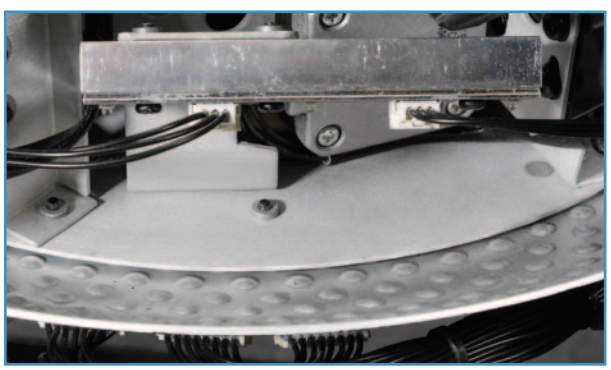

Fig 12: Indigo reflector.

SOUND LEVELS

	Normal Mode
Ambient	<35 dBA at 1m
Stationary	52 dBA at 1m
Homing/Initialization	59 dBA at 1m
Pan	52 dBA at 1m
Tilt	53 dBA at 1m
Module X and Y	52 dBA at 1m

Electrical parameters

The Shapeshifter is rated for operation on 100 – 240V AC 50/60Hz supply, auto switching. At the nominal 115V I was using, I measured a static power consumption of 497W at full output at a power factor of 0.99. Quiescent power consumption with all LEDs off was 47W at a power factor of 0.86. This power consumption equates to an efficacy in full output of 18.5lm/W for the C1, and 30lm/W for the W1.

Initialization time from power up was 63 seconds, and from sending a reset command through the DMX512 control channel, was around 50 seconds. The unit is badly behaved when reset live: It fades back in again before the movement reset has ended.

Electronics and control

The majority of the electronics for the Shapeshifter are in the head, as shown in Figure 3. DMX 512 electronics and power supplies, along with the menu system and its display, are in the base unit. The unit has a color LCD display and menu buttons that allow setting all the usual parameters and options, including modes for programming standalone operation. Figure 13 shows the display and menu buttons. The Shapeshifter can also be fitted with a battery to allow setting the DMX address and fixture parameters before the unit is hung and power is available. The units I was given didn't have these batteries fitted, so I was unable to test this feature. The Shapeshifter provides both five-pin and three-pin XLR connectors on the top box along with a powerCON connector (Figure 14).

Construction

The Shapeshifter head is built around the three large driver circuit boards and seven LED modules. Disassembly to that level was simple, requiring only the removal of a few screws

Fig. 13: Menu.

Fig. 14: Connectors.


Fig. 15: Yoke arm.

to remove the main cover. After that, replacing a module looks straightforward. I imagine there is not much low-level servicing that a regular user would want, or be able, to do themselves. The yoke and top box assemblies were pretty standard for current units. Figure 15 shows one of the yoke arms with the pan-and-tilt drivers and pan motor.

Conclusions

The six moving modules are what the Shapeshifter is all about. Each produces a reasonably narrow, bright, beam, and the ability to move them independently, while still controlling the overall fixture pan and tilt opens up possibilities, for aerial effects and direct view patterns. This is a fixture designed for effects into and over the audience, not for lighting the performers. Other manufacturers are producing similar results in different ways, but the Shapeshifter offers interesting alternatives because of the fully independent control of each module. It's a bit like rigging and controlling seven smaller LED scanners in one go. How far you go with it is then up to you with the programming. This is a unit where, love them or hate them, (and I have to admit I normally dislike canned effects) using internal macros is essential to rapid programming but if you have the time, you have the tools to finesse all the patterns yourself. High End has done a good job of providing a good range of these essential macros; it has broken them up into separate movement, intensity, and color, thus improving the number of options. Will the High End Systems Shapeshifter C1 or W1 fill a slot in your rig? That decision is yours and yours alone.

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