Martin Professional MAC Quantum Profile

By: Mike Wood

It's getting harder and harder to find small and medium-sized automated luminaires, apart from those with extremely narrow beams, that haven't switched over to LEDs as their light source. The days of the 250W, 300W, 575W, and, arguably, 700W discharge lamps as the workhorses of automated entertainment lighting seem numbered. The one change that happened much more quickly than I anticipated is that many units, such as the one we are looking at in this story, continue to use dichroics, for color mixing and color wheels, while using white LEDs as the light source. I can see the reasoning, and those highly efficient phosphor-converted white LEDs are undoubtedly very attractive, but it still seems slightly unusual to me. It's not very rational of me and I'm not really sure why!

This piece focuses on Martin Professional's MAC Quantum Profile, a product clearly aimed at the mid- to high-range market that the MAC 250, MAC 600, and their many successors have filled previously. This has always been a very successful market for Martin; can the new Quantum range help the company keep that position and move its customer base over to LEDs with a very familiar fixture?

I tested a unit supplied to me by Martin. I believe this was one of the final pre-production models that were shown at the LDI and PLASA trade shows at the end of 2014. It didn't have the final shipping software, so I was unable to test a couple of features—in particular, RDM; however, all those features are present in the shipping unit (Figure 1).

Fig. 1: Fixture as tested.

Light source

Martin hasn't used an off-the-shelf LED light module, instead building its own light engine using 90 white LEDs mounted in five concentric rows in a circular array. Each of the LEDs consumes approximately 5W and has its own molded lens mounted above it. Those lenses are tilted at increasing angles as you move further out in the array. Thus,

Fig. 2: LED lenses and cooling.

even though the LEDs themselves are mounted on a flat circuit board, the light from them is angled towards the optical axis, giving a result very similar to that from the reflector with a conventional light source. Figure 2 shows the molded array of lenses over the LEDs; you can clearly see the dished shape of the lenses, raised at the edges, and flat in the center.

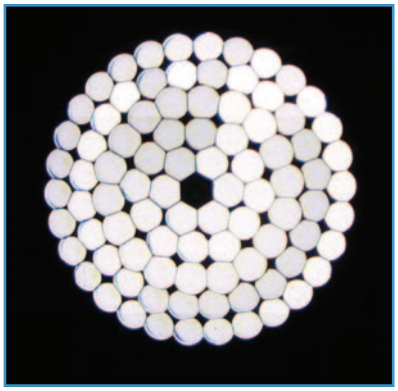

Fig. 3: LED array.

Also visible in Figure 2 are two fans, used for cooling the LEDs, and a large heat sink placed behind them. In normal operation, these are thermostatically controlled and fade in and out as needed; however, the user can choose to have them run at a constant speed if preferred.

Figure 3 is a shot down the front of the unit, which provides an excellent view of the LED array in operation (running at about 1% for this photograph!).

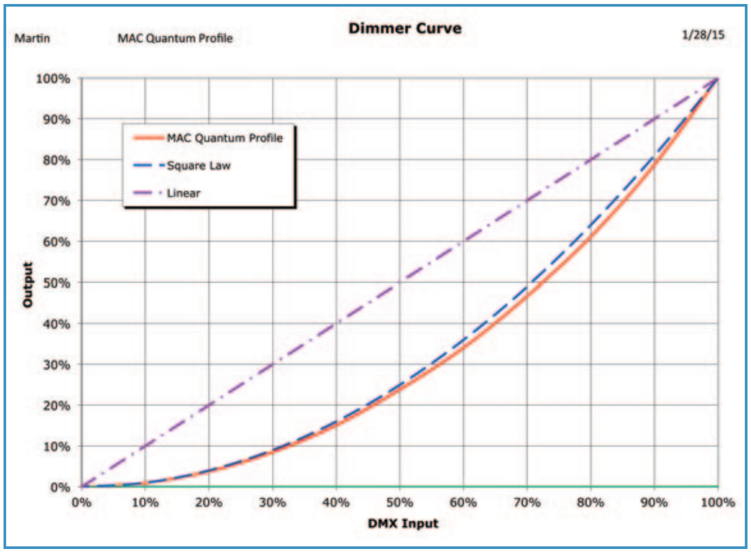

Fig. 4: Dimmer law.

Strobe and dimmer

No mechanical dimmer or shutter are employed, of course; the LEDs and associated driver electronics do all that. The Mac Quantum Profile has excellent, smooth dimming. I could see no flicker or stepping, even down at the lowest levels of dim. For my tests, I ran the unit in its default mode, which provides a square-law output (my preferred choice); the unit also offers the options of linear, S-curve, and inverse square law through the fixture configuration. Figure 4 shows the good match of the output to the standard curve. I measured the PWM rate at 3kHz, which should be okay with most cameras. The strobe is variable up to 20Hz and offers the usual range of random and varying strobe types.

Color systems

As mentioned previously, the Mac Quantum Profile uses conventional glass dichroic filters for both color mixing and color wheel.

Subtractive color mixing is provided in a familiar manner by three pairs, one each in cyan, magenta, and yellow, of etched dichroic flags. Each flag is individually driven by its own motor, providing very smooth and controllable color mixing. I saw little evidence of banding or patterning. Figure 5 shows a pair of flags with the fine etched finger pattern as they close over the aperture.

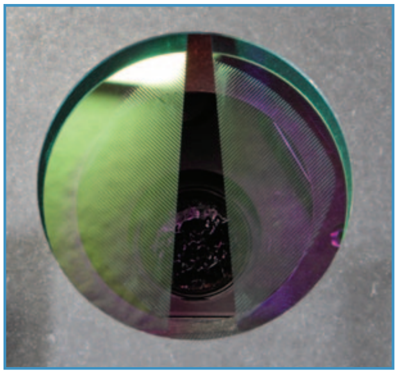

Fig. 5: Color mix flags.

COLOR MIXING

Color	Cyan	Magenta	Yellow	Red	Green	Blue
Transmission	16.2%	3.9%	85%	3.2%	9.4%	0.5%

Color change speed – worst case	< 0.3 sec

The mix colors are fairly saturated, with, as expected, low output in red from the LED source. (Phosphor-converted white LEDs have fairly low output in the deep reds.) Movement was very quick and precise.

Next in line, right behind the color mix flags, is the fixed color wheel. This has six fixed trapezoidal colors plus the open hole. These provide CTO correction as well as a range of standard colors, including a deep red and a Congo blue.

COLOR WHEEL

Color	Blue	Green	CTO	Magenta	Congo	Red
Transmission	2.9%	32%	63%	14%	0.3%	0.7%

I measured the color temperature of the Mac Quantum Profile at 6,718K with a CQS of 63 (CRI of 68) with no filters in place, and 3,309K with a CQS 72 (CRI 72) when using the CTO correction filter. Figures 6 and 7 show the spectra of the light in those two cases. The positioning of the color wheel in the optical train means that you can get good half-colors with a straight line cut between the two colors, as can be seen in the example shown in Figure 8.

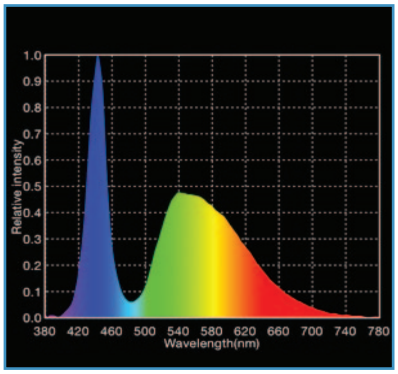

Fig. 6: Spectrum open.

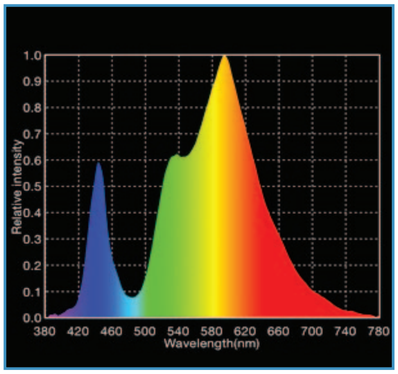

Fig. 7: Spectrum with CTO.

The color wheel movement is quick; it snaps between colors almost invisibly. It also provides slow, smooth rotations with very little steppiness or jerking.

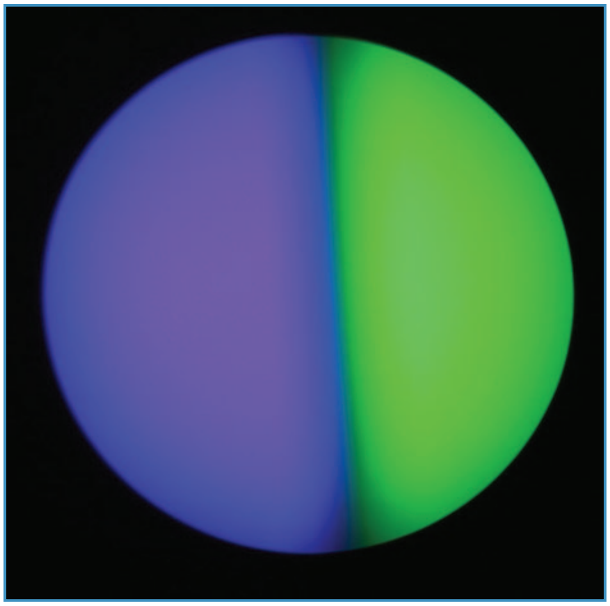

Fig. 8: Half color.

COLOR WHEEL MOVEMENT

Color change speed – adjacent	< 0.2 sec
Color change speed – worst case	0.3 sec
Maximum wheel spin speed	0.41 sec/rev = 146 rpm
Minimum wheel spin speed	194 sec/rev = 0.31 rpm

Gobos

Two gobo wheels, a rotating wheel with six changeable patterns plus open hole, and a fixed wheel with 10 non-changeable patterns plus open cut into a single wheel, are next in the optical train.

Gobos on the rotating wheel use a familiar cartridge snap-in system, as shown in Figure 9, and are easy to switch out. As can also be seen in Figure 9, each cartridge has a magnet for position alignment during initialization. Both wheels use quick-path algorithms minimizing the time needed to make a change.

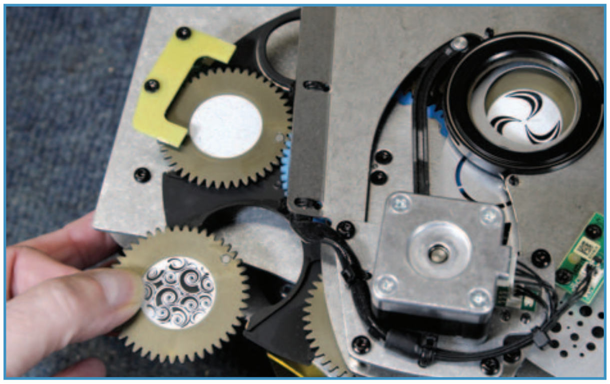

Fig. 9: Gobo replacement.

ROTATING GOBO

Gobo change time, adjacent apertures	0.3 sec
Gobo change time, max (Gobo 0 to 4)	0.7 sec
Maximum gobo rotate speed	0.61 sec/rev = 98 rpm
Minimum gobo rotate speed	318 sec/rev = 0.19 rpm
Maximum wheel spin speed	1 sec/rev = 60 rpm
Minimum wheel spin speed	6 sec/rev = 10 rpm

STATIC GOBO WHEEL

Gobo change time – adjacent apertures	0.2 sec
Gobo change time – max (Gobo 0 – 5)	0.5 sec
Maximum wheel spin speed	0.46 sec/rev = 130 rpm
Minimum wheel spin speed	215 sec/rev = 0.3 rpm

As with every motor in the unit, smoothness and positional accuracy of the rotating gobos was excellent. I measured hysteresis on the rotating gobo at 0.18° of error, which equates to about 0.7" at a 20' throw (31mm at 10m).

Focus quality on the rotating wheel was very good, with just a little spherical and pincushion distortion. The fixed wheel isn't quite as good and shows increased pincushion distortion. Figure 10 shows four examples of the focused image. Top left is the open beam, top right and bottom left are two examples from the rotating gobo wheel, while bottom right is the fixed gobo wheel. It is also possible to pull focus between the two gobo wheels to perform a morph. Figure 11 shows an example.

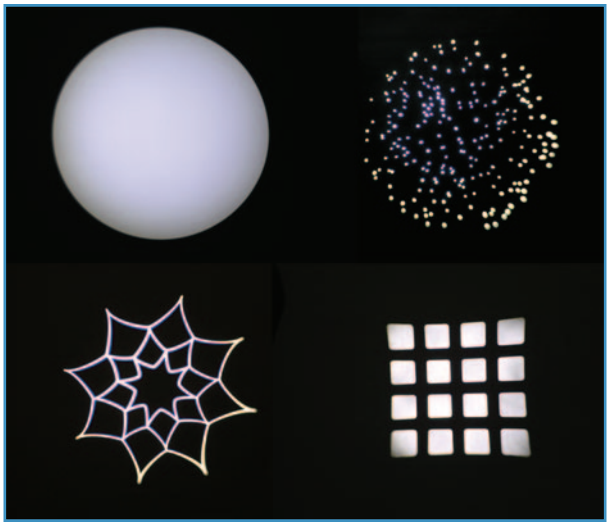

Fig. 10: Image quality.

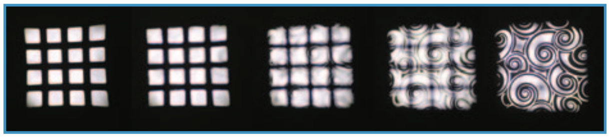

Fig. 11: Gobo morph.

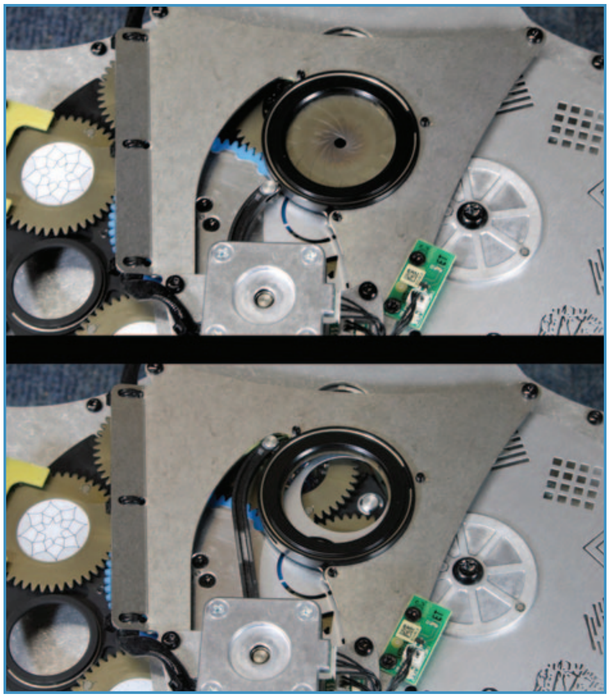

Fig. 12: Iris.

Iris

Last in the systems mounted on the main optical module is the iris, as can be seen in both closed and open positions in Figure 12. The Mac Quantum Profile iris reduced the beam size to 13.5% of the full beam and I measured opening and closing times at around 0.3 seconds It isn't possible to hard focus on the iris and gobo at the same time. (Almost no units can do this.)

Prism

The single three-facet prism is mounted in between two of the output lenses and is inserted and removed using an arm mechanism. Figure 13 shows the prism and its mechanism

Fig. 13: Prism.

while Figure 14 shows an example of the image separation it provides. I measured insertion / removal time at approximately 0.4 seconds, and, once inserted, the prism can be rotated at speeds varying from 114rpm down to a speed so glacially slow I didn't attempt to measure it!

Fig. 14: Prism separation.

The DMX512 control offers extended macro channels that coordinate the various systems, including the prism, to provide pre-programmed effects.

Lenses and output

The proof of the claims of the Martin Mac Quantum Profile to replace 700W HID units is, of course, in the output. It uses the usual three-group lens system: two moving groups providing zoom and focus, and a fixed final output lens group. I measured the output with all emitters at full and no colors in place at 13,523 lumens at a wide angle of 31° remaining almost constant as the unit was zoomed to 13,256 lumens at 11.2° at the narrow end. That clearly vindicates Martin's claims, as the output is very comparable with other 700W HID spot units. (Looking back through my reviews, I measured the MAC 700 at around 14,000 lumens in 2006.) Figures 15 and 16 show the beam profiles at maximum and minimum zoom, respectively. The beam, as is so often the case with LED-based units, is very smooth and

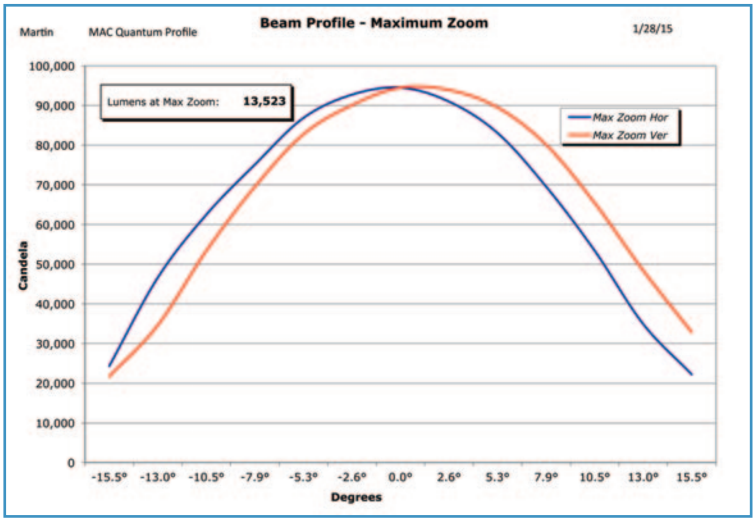

Fig. 15: Beam profile – maximum.

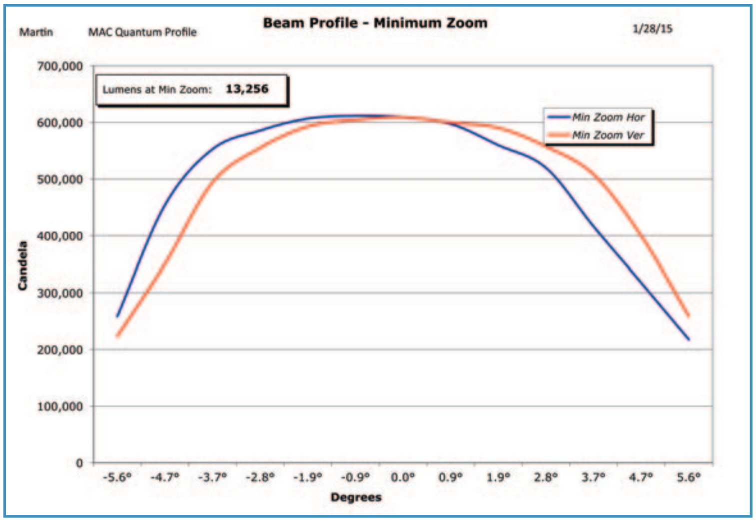

Fig. 16: Beam profile – minimum.

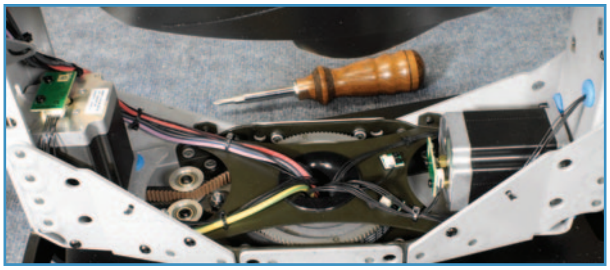

Fig. 17: Pan and tilt motors.

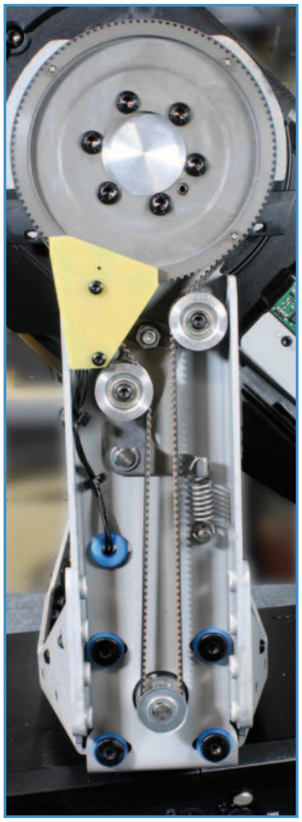

Fig. 18: Yoke arm.

flat. Both zoom and focus operated well; I measured zoom at 0.8 seconds from end to end, while focus took one second. (Note: Light output was measured after 30 minutes running at full output, when the unit had reached full operating temperature—output was approximately 13% higher immediately after the unit was powered up.)

Pan and tilt

I measured the movement range of the Mac Quantum Profile as 540° in pan and 260° in tilt. In the default "smooth" mode, pan time over that angle was measured at 3.8 seconds with 2.1 seconds for 180°. In tilt, the figures were 2.6 seconds for 250° and two seconds for 180°. In the optional "fast" mode, the full movement times were reduced to 2.6 seconds for pan and 1.4 seconds for tilt. That's pretty fast for quite a large unit. In smooth mode, I measured the repeatability accuracy for both pan and tilt at a very creditable 0.03° which is about 0.1" at a 20' throw (5mm at 10m). Both pan and tilt motors are large, two-phase steppers mounted in the base of the yoke arm as can be seen in Figure 17; Figure 18 shows the layout for the tilt belt in the yoke arm.

Noise

In smooth mode, the noise levels are controlled by LED cooling fans, which are the most apparent noise producers when running at full speed. In that mode, only zoom was noticeable above the fan noise. In fast mode, pan and tilt are much louder, particularly tilt, which gives out a very objectionable whine. The levels reported here are all taken with the unit running at full power on all emitters after reaching thermal equilibrium.

SOUND LEVELS

	Normal Mode
Ambient	<35 dBA at 1m
Stationary	39.3 dBA at 1m
Homing/Initialization	57.3 dBA at 1m
Pan (Smooth mode)	47.6 dBA at 1m
Pan (Fast mode)	55.1 dBA at 1m
Tilt (Smooth mode)	42.7 dBA at 1m
Tilt (Fast mode)	60.26 dBA at 1m
Prism	40.2 dBA at 1m
Gobo	39.5 dBA at 1m
Gobo rotate	40.1 dBA at 1m
Zoom	53.5 dBA at 1m
Focus	40.5 dBA at 1m

Electrical parameters and homing/initialization time

The Mac Quantum Profile is rated for auto-switching operation on 120V – 240 V, 50Hz/60Hz. For these tests, it was run on a nominal 120V, 60Hz supply and measured as follows.

POWER CONSUMPTION AT NOMINAL 120V, 60HZ

	Current, RMS	Power, W	VAR, VA	Power Factor
Quiescent (LEDs off)	0.78 A	90 W	94 VA	0.95
LEDs at full	4.88 A	584 W	585 VA	0.99

Initialization took 40 seconds from either a cold start or a DMX512 reset command. Homing is well behaved in that the fixture fades up after pan and tilt have finished moving to their final position.

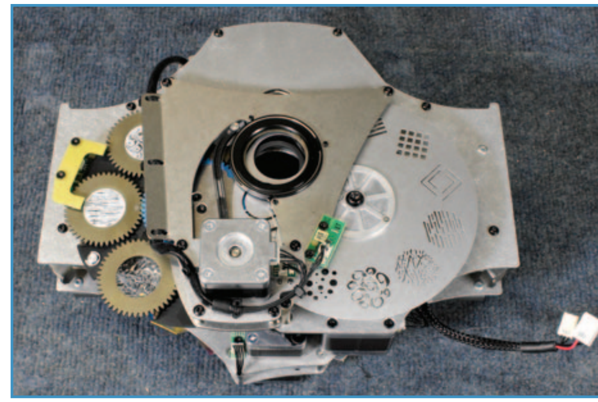

Figure 19 - Optical module.

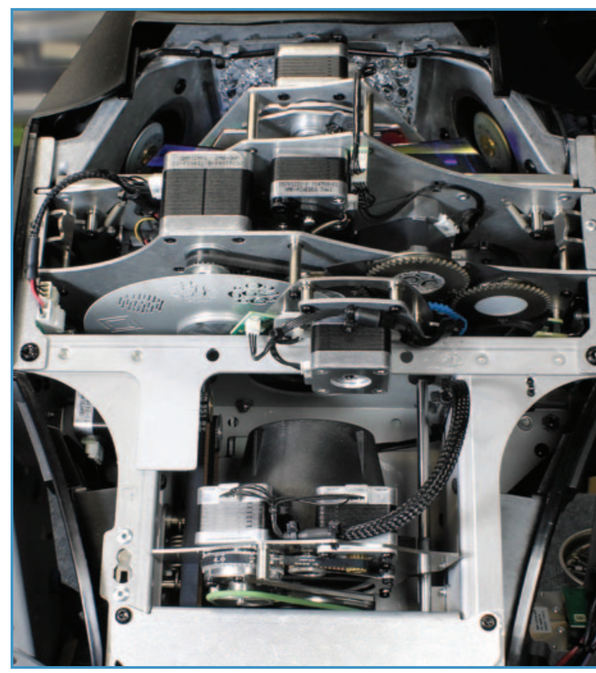

Fig. 20: Optical train.

Fig. 21: Top box.

Fig. 22: Menu system.

Fig. 23: Connections.

Construction, electronics, and control

Martin has moved over to using the CAN bus standard for communication within the unit. Originally designed for the automotive industry, it is now used in many automation and industrial products and is well-supported. It's a good choice for sending relatively low-speed motor and sensor data around an automated light. The LEDs and LED drivers are both in the head along with the motor and sensor drivers. These all connect, through the CAN bus, back to the main control board in the top box of the unit. The color and gobo systems are mounted on an easily removable optical module shown in Figure 19. Unplug the two connectors, power and CAN bus, release two catches, and this just lifts straight out of the unit—very simple for cleaning and maintenance. Figure 20 shows the head assembly with the module in place. Everything is visible in this photograph, from the LEDs at the back to the lenses at the front. (Service note: Martin uses Torx fasteners throughout their products.)

The top box contains two power supplies as well as the menu and main control electronics (Figure 21). The menu and connectors are shown in Figures 22 and 23. The connection panel is very straightforward, just a Neutrik powerCON for power and five-pin DMX512.

That's about it for the Martin Mac Quantum Profile. It seems to meet its claim to have an output comparable with prior 700W HID units. How do its other parameters work out? As always, I've provided the data, but only you know if it's suitable for your venue.

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