TECHNICAL FOCUS: LIGHTING

# Casting a New Light on Niagara Falls

By: Sharon Stancavage

## One of the wonders of the world is enlivened with new technology

Niagara Falls, consisting of Canada's Horseshoe Falls and, on the US side, the American Falls and Bridal Veil Falls, was initially illuminated in 1860. "We found a program from 1925," explains Alan McIntosh, of Toronto, Ontario-based Mulvey and Banani Lighting, one of four firms involved in updating the falls' lighting. "At that time, it was done manually; each fixture along the shore had an operator or two, and they would respond to a blown whistle. One whistle meant they were to start a section of the program. Two whistles meant they needed to stop or move the fixture around in a pattern, creating motion. That's how they created effects." Over the years, the lighting was updated, the last time with Xenon fixtures. The results were still somewhat dim and inconsistent.

Nick Puopolo, president of Toronto-based Salex, a lighting and control manufacturing representative for architectural clients, says, "We approached the Niagara Falls people years ago, thinking that might be an opportunity to do something. We didn't have a

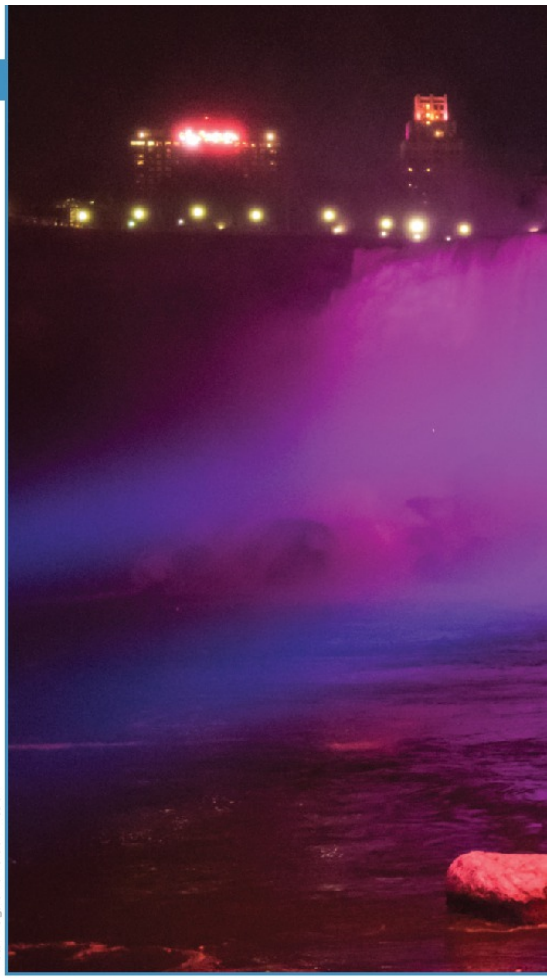

Photo: Niagara Parks Commission

The Illumination Board was primarily interested in using traditional white light on the falls.

Left photo: Niagara Parks Commission; Right photo: Light Monkey Photography

Baker and McIntosh were concerned with lighting the falls evenly, which, in the past, wasn't possible.

Using a Philips Strand NEO console, the team was able to create a variety of color effects.

Photo: Light Monkey Photography

The Horseshoe Falls and American Falls, seen from above.

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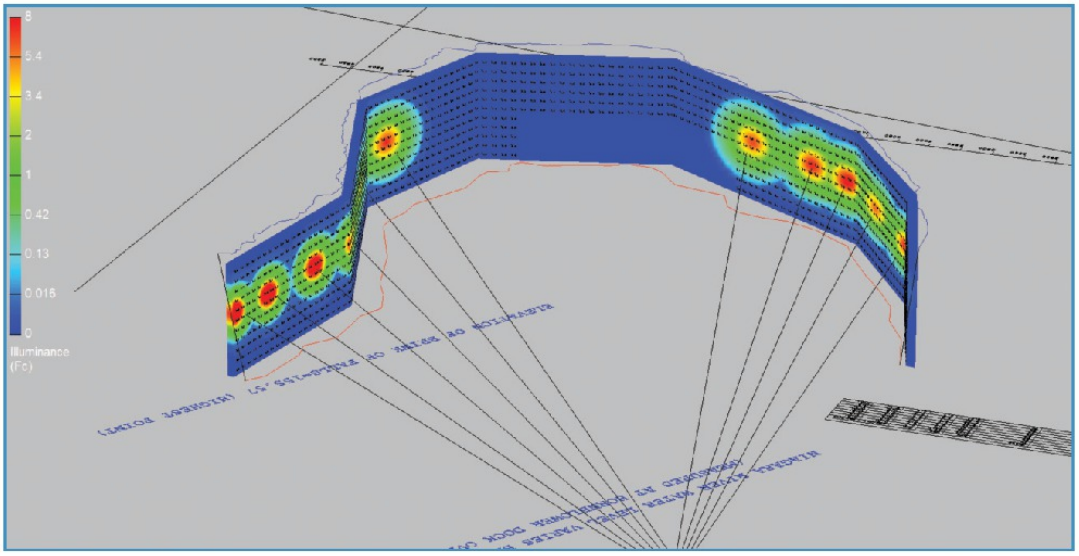


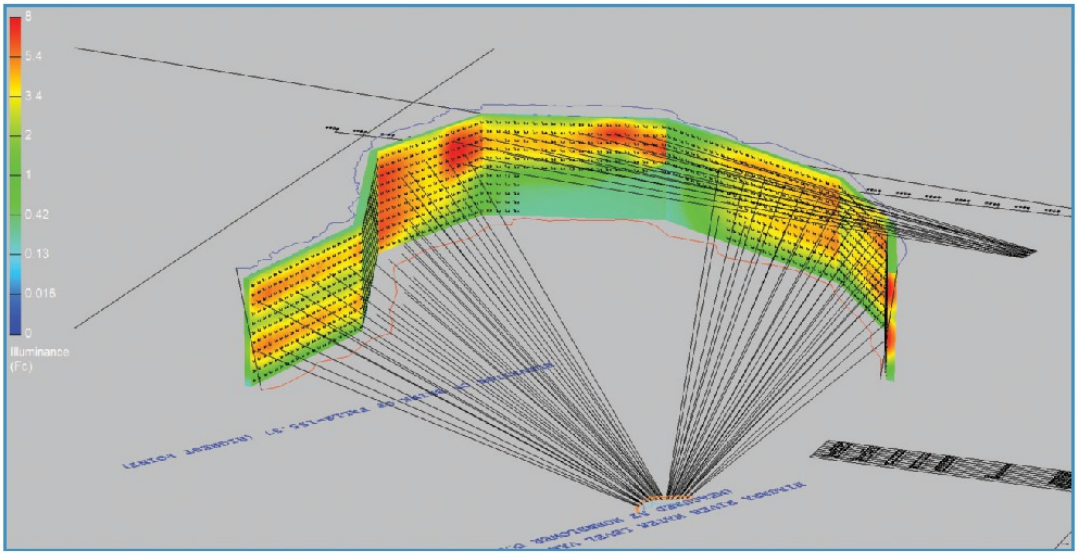

The illumination of the falls before the revision, done in the Lighting Analysts AGi32 lighting simulation program; the hot spots are in red.

product; we just thought it would be neat. I guess that got the ball rolling, and the [Niagara Falls] Illumination Board put together this request for proposal in October 2014 and we were invited to look at it." The RFP specified that the overall illumination was to be twice the existing white light [5fc], as well as the ability to demonstrate color.

Puopolo continues: "We represent the Stanley Electric Company, the largest manufacturer of automotive LED tail lights. They have a 10 x 10 fixture with a unique 2.5° beam; it's low-wattage, and we thought it would be an excellent product for lighting up building facades." The Salex team also thought the Stanley fixture would be good for the falls; photometric testing of the fixture came out positive.

The first stage of the RFP included 30 firms. "The first presentation was more of a concept," Puopolo explains. "We were lucky enough that Stanley had already done an installation on an island in Japan. In that case, the luminaires were in one building and illuminated an island that was almost the same distance away as the falls, so we had a sample of what they originally did, and a mock-up to show that we could do it." Next, he says, "The Illumination Board chose seven companies; we had a second meeting, and that's when we put the whole team together, and did the second presentation with sketches and drawings."

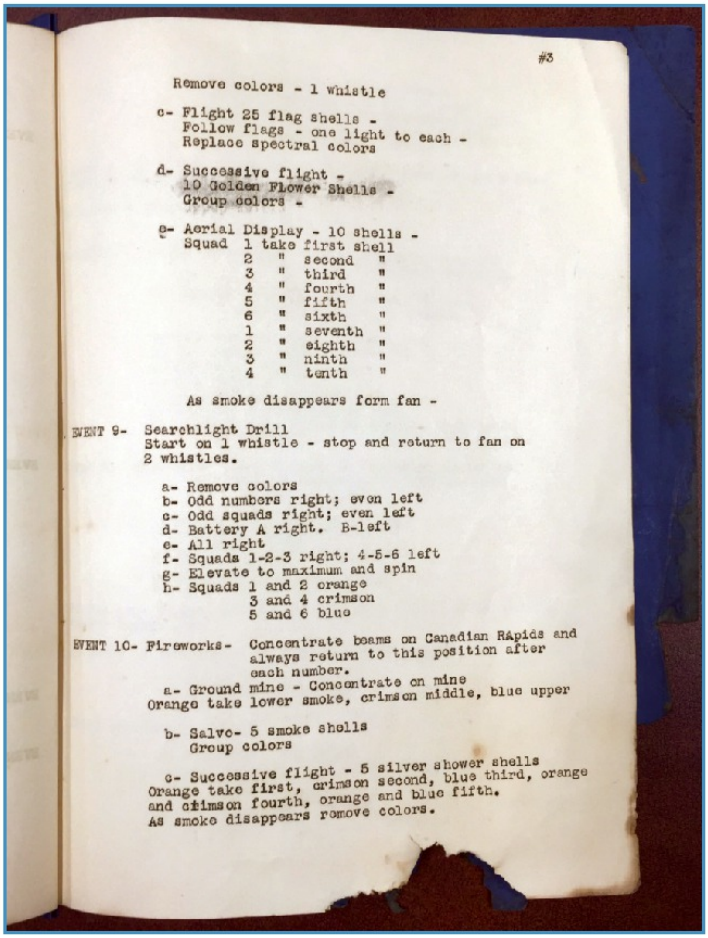
Salex spearheaded the team, which included Toronto-based lighting designers McIntosh and Paul Boken, of Mulvey and Banani Lighting; St.




The new illumination of the falls, sans hot spots.

Catherine's, Ontario electrical contractor Ecco Electric, represented by owner Ed Gesch; and specialty control integrator Scenework, headquartered in Guelph, Ontario, which was represented by president Ron Foley. Puopolo adds, "We then did a second presentation with sketches and drawings; for the third phase, the seven teams had to put together a one-to-one replacement mock-up. We had to build a fixture in rough form, bring it to the falls, and mount it next to one of their existing fixtures." The documentation stated that each team was required to produce at least twice the existing light level in white light. The board had conducted its own level test, which produced a light reading of 5fc – 6fc, providing each team with a benchmark. The bar had been set and the team knew the task ahead. McIntosh notes, "Based on the reading provided by the Illumination Board, we knew we needed to reach the 10fc – 12fc minimum in order to even be considered for the bid." If the team passed the technical requirements, its bid would be opened and reviewed by the board.

Puopolo says, "The fixtures that we had were Stanley's first development, so the fixture was about two years old, and LEDs continue to change and improve. We searched for the most up-to-date chips for the fixture.



#3

Remove colors - 1 whistle

c- Flight 25 flag shells -
Follow flags - one light to each -
Replace spectral colors

d- Successive flight -
10 Golden Flower Shells -
Group colors -

e- Aerial Display - 10 shells -
Squad 1 take first shell
2 " second "
3 " third "
4 " fourth "
5 " fifth "
6 " sixth "
1 " seventh "
2 " eighth "
3 " ninth "
4 " tenth "

As smoke disappears form fan -

EVENT 9- Searchlight Drill
Start on 1 whistle - stop and return to fan on 2 whistles.

a- Remove colors
b- Odd numbers right; even left
c- Odd squads right; even left
d- Battery A right. B-left
e- All right
f- Squads 1-2-3 right; 4-5-6 left
g- Elevate to maximum and spin
h- Squads 1 and 2 orange
3 and 4 crimson
5 and 6 blue

EVENT 10- Fireworks- Concentrate beams on Canadian Rapids and always return to this position after each number.

a- Ground mine - Concentrate on mine
Orange take lower smoke, crimson middle, blue upper

b- Salvo- 5 smoke shells
Group colors

c- Successive flight - 5 silver shower shells
Orange take first, crimson second, blue third, orange and crimson fourth, orange and blue fifth.
As smoke disappears remove colors.

A page from the falls illumination program from 1925.

Stanley put the chips in the fixture and shipped it to us, and we tested them in our warehouse." The perfect chip was eventually found; however, it didn't fit the fixture and Stanley had to shave the lens to accommodate it.

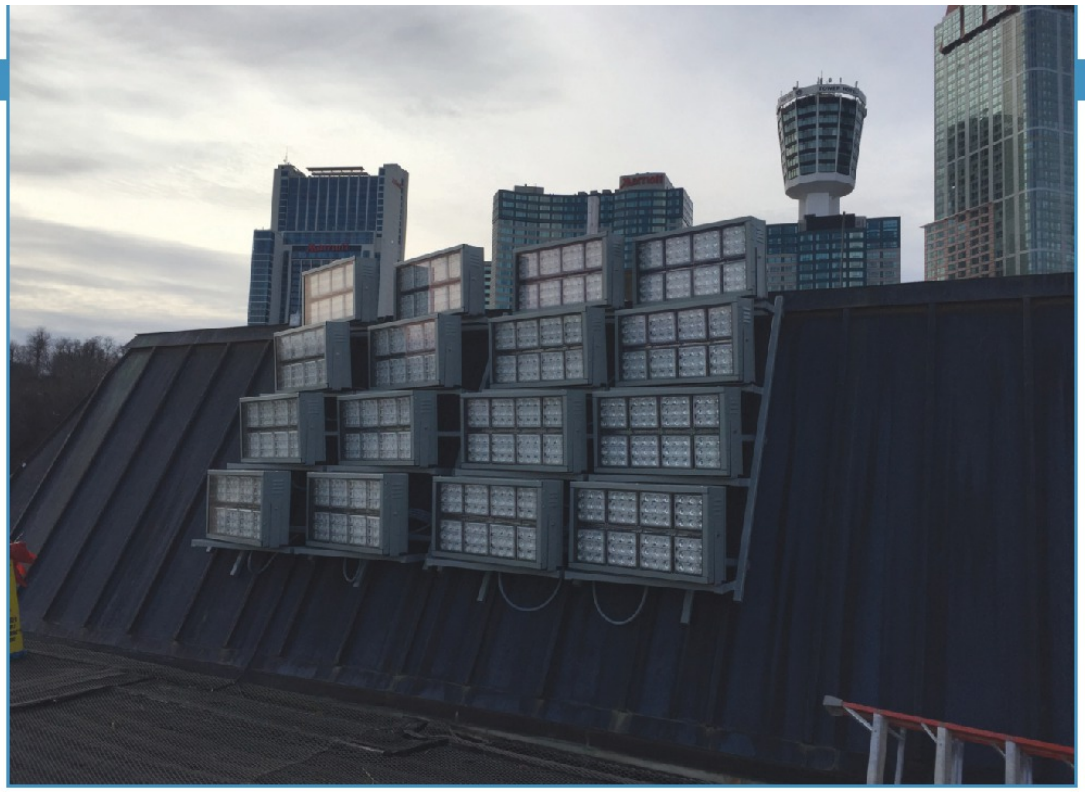
The Salex team needed to duplicate the falls in a simulation program without knowing any specific dimensions. "We'd build the simulation in the computer," Puopolo explains, "and then we'd run to the falls at night to take readings of certain areas, comparing that with what we were getting on our computer simulations, until we finally got them both to match." This was done using the Lighting Analysts AGi32 lighting simulation program. "AGi has never been used to do this before. We were doing things that even AG said was impossible for this program to do, but we got it done," he adds.

Also, McIntosh says, "Because we needed to cast the beam over 2,000', we needed white modules in the fixture to get our light levels up. Our modules are RGBW; that white gives us that extra push. The colors are brilliant on their own, but you can't really measure color properly. The white allowed us to demonstrate the power of the Stanley product and to help us achieve the levels we needed to and provide color."

The ratio of color LEDs to white LEDs also had to be determined. McIntosh explains, "Paul [Boken] and I took the LED fixtures to a marina just north of Toronto; I set up on a dock and he went across the lake to a boat platform about 2,100' away. I had a white module, as well as a red, green, and blue module. I also had the Rosco gel colors used to light the falls at the time. I put the Niagara Falls Rosco red gel in front of the white light, which was on at full, and Paul took a light reading on the other side. Then I'd turn on the red LED, and he would take a second reading; that's how we compared 100% output versus light loss through a filter. It was also how we were able to do our math and determine the number of color and white LEDs we needed for the mock-up. We took all levels that the red, green, and blue were giving us, and were to figure out what our final foot-candle level would be in an array of 72. Through the lake test, we were also able to figure out how many whites we needed to pass the mock-up test, but also how many red, blue, and green modules we could use to replace a white module, allowing us intersperse color modules in order to demonstrate color."

The final test to clinch the bid took place in October of 2015 at Bridal Veil, the smallest of the falls. The team, leaving nothing to chance, did a test at an abandoned airport in the region. McIntosh explains: "We went there one night with our mock-up fixture loaded onto the side of a glass truck, brought it to the airport, measured 2,100' and turned this thing on in the middle of an empty field." The team got 14fc.

The team met the board, along with lighting consultant Linus MacDonald, at midnight one night in October 2015. "Around 1am, we were getting ready to turn our fixture on," Puopolo says.

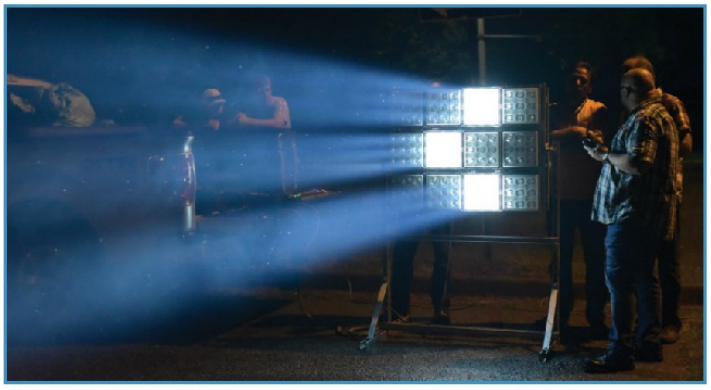


A8 fixtures were used on the Table Rock location, which requires a shorter throw.

"Linus turned to me and asked 'How are you going do it?' I said, 'We're going to get 14 foot-candles.' He just looked at me in disbelief." Puopolo let MacDonald know about the test mentioned above. "Linus said, 'What do you mean you tested it last week?' I said, 'We don't do anything unless we test it first. Do you think we're going to come here without testing the fixture?' With this shocked look in his eyes, he said, 'OK. Let's just turn the fixture on'." The test commenced, and light levels—coming in between 13fc and 14fc—were reported across the American Falls. Puopolo concludes, "Linus turned to me and said, 'I don't know what to say.' He was very skeptical until he saw with his own eyes what we had done, and he knew that it was the turning point of lighting the falls." The Salex team alone passed the test and was awarded the bid in January of 2016.

The RFP morphed into a request for quotation that specified a one-to-one replacement; the Salex team members knew they could do better. "The falls

All three lighting positions are the Canadian side of the falls.



For focusing, the team had to create a custom mounting bracket/yoke.

All photos: Niagara Falls Illumination Design Team

originally had basically 21 pixels, because they had 21 fixtures that were only hitting 21 spots," Puopolo explains. "Our RFQ was to do the same; 21 large fixtures shooting across the falls. Paul [Boken] wanted to improve the design; according to him, it would be better if we could break the 21 fixtures up to modules of 12 and aim them in slightly different locations, therefore increasing the number of pixels on the falls." More calculations were done, and in the end, he adds, "We've broken the fixtures down to 350 pixels, so there are 350 sections aiming at different parts of the falls."

To focus the fixtures, McIntosh says, "We developed a mounting bracket that the modules were mounted on; through the torquing of a screw and a spring, we're able to adjust each module's angle. If you turn it one way, it angles the top corner or bottom corner out, and the reverse if turned the other way. This gave us the ability to calibrate the modules, ensuring they were all oriented in the exact same spot. When you're dealing with over 2,000' of throw, the slightest diversion in the placement of the chip, or manufacturing of the fixture, or metal of the Unistrut on which the fixture is mounted could mean that the aiming is off by 10' when shining across."

For the best possible coverage, the Stanley LED fixtures were configured in two separate modules: A12s and A8s. Puopolo explains, "An A12 is made up of 12 Stanley fixtures; each Stanley fixture form is 10" x 10" with nine LEDs in it; the A8 is a smaller group of eight fixtures." There are three horizontal rows of four in the A12; the A8 is comprised of two horizontal rows of four fixtures. In total, there are 1,400 Stanley fixtures used on the project.

"All the lights are located on the Canadian side," states McIntosh. There are three positions: the Illumination Tower, the bunker, and Table Rock Restaurant, which is owned by the Parks Service. Currently, there are 11 mounting structures each with six A12 units, containing 792 Stanley modules on the Illumination Tower focused on the Canadian Falls.

The American Falls is lit with forty A12 units, containing 480 Stanley modules and located in the bunker, a traditional position that has been recently relocated, "further down in the Niagara Gorge on the Canadian side," McIntosh says.

The final lighting position on the restaurant contains sixteen A8 units housing 128 Stanley modules. "The back of the falls was not part of our RFQ," Puopolo says. "However, they came to us and asked if we could light the back of the falls behind the mist [specifically the back of the Horseshoe]. We went to the restaurant, saw a platform we could mount some fixtures on, did some design work, and realized we could light the back of the falls from there." McIntosh adds: "We chose A8s because it was a closer throw distance; we didn't need the power of the A12.

"The board was sold on the image of Nick Wallenda walking across the falls with that bright white metal halide light washing the falls behind him," McIntosh continues. Although color was specified in the RFQ, he adds, "They didn't want rock and roll, they didn't want Vegas Strip. We needed to be very careful about how we described what the lights were going to do, because 'color-changing,' 'effects,' and 'dynamic' were red flags for some people." Instead, the focus was on natural scenes. A midnight programming demonstration of the American Falls took place prior to the unveiling to allay any fears, selling the board on the concept.

For programming, Ron Foley, president of Scenework, brought programmer and Philip Strand lighting product specialist Bobby Harrell onto the project. "Scenework provided the engineering and the installation of the LED drivers [1,400; one for each Stanley 10 x 10 fixture] for the LEDs as well as the control system, which was comprised of two Strand Rack NEOs—one as a main, one as a backup," Harrell explains.

The project required a console with a variety of effect engines, which made NEO a good choice. However, Harrell thought that it could be improved for this particular application. He explains, "I worked with the developer of the software, Martin Searanacke, of [New Zealand-based] Dream Solutions; he and I came up with a new effect engine called Paint Box. It allowed me to create dynamic color path effects more quickly. Paint Box also allows a user to insert points of color and opacity onto a color path, which then applies it to a matrix,

which on other consoles is called a pixel map. This color path with all these color points can then be applied to the matrix; the thing that makes it unique is we can go in many different directions." These include left/right, right/left, bottom/top, top/bottom, inside out, and four diagonals.

"Essentially," Harrell says, "I built two matrixes, one for the American Falls, which was four rows high by 40 columns wide; for the Canadian side, it was 82 wide by four high. The Canadian Horseshoe Falls is more involved, because it's bigger and there are more fixtures. I created a Paint Box effect with all of the colors along the color path, then I would apply it to whichever matrix I was building, and I'd say, 'OK, run bottom to top.' We had a time parameter to determine how fast, and also a spread parameter, which allows you to essentially apply a delay as the color path moves across the matrix."

The effects created for the falls include sparkle, sunrise, sunset, and aurora borealis; recently added are water drops and fire. "I built the aurora borealis, using a step-based effect," Harrell says. "I essentially created a serpentine path over the top half of one falls going in one direction and a serpentine path going over the bottom half of the falls in another direction—and I played with color, which seemed to work fairly well." All static colors have been changed to subtle dynamic waves using the Paint Box effects engine.

NEO can be triggered remotely, using a program called My Interface. Harrell explains, "There is an IOS and Android version of My Interface, but we extended its operational ability to PCs. My Interface and the Paint Box effect engine were targeted developments for this project, and they will be officially released with the next software version, which will be out in the second quarter of 2017."

Harrell also programmed in advance, using NEO's offline editor. "NEO allows the user to put matrixes directly onto the magic sheet [layout]," he says. "That way, I could send the show file to the designers and they could run it themselves and see the replication of the effects on the falls. I did preprogramming from my studio for a few weeks and then was on-site for opening plus a few days prior to opening." The project opened in December 2016, and the show is run manually; in May, some late-night cue lists will begin running automatically for after-midnight viewing of the falls.

Harrell adds, "It's a great time to visit Niagara Falls."

It was a team effort that paid off for everyone; the lighting of Niagara Falls has never looked better. McIntosh concludes, "It's a legacy project for everybody involved and we wanted to make sure we did it right."