THE MAGAZINE OF THE ILLUMINATING ENGINEERING SOCIETY

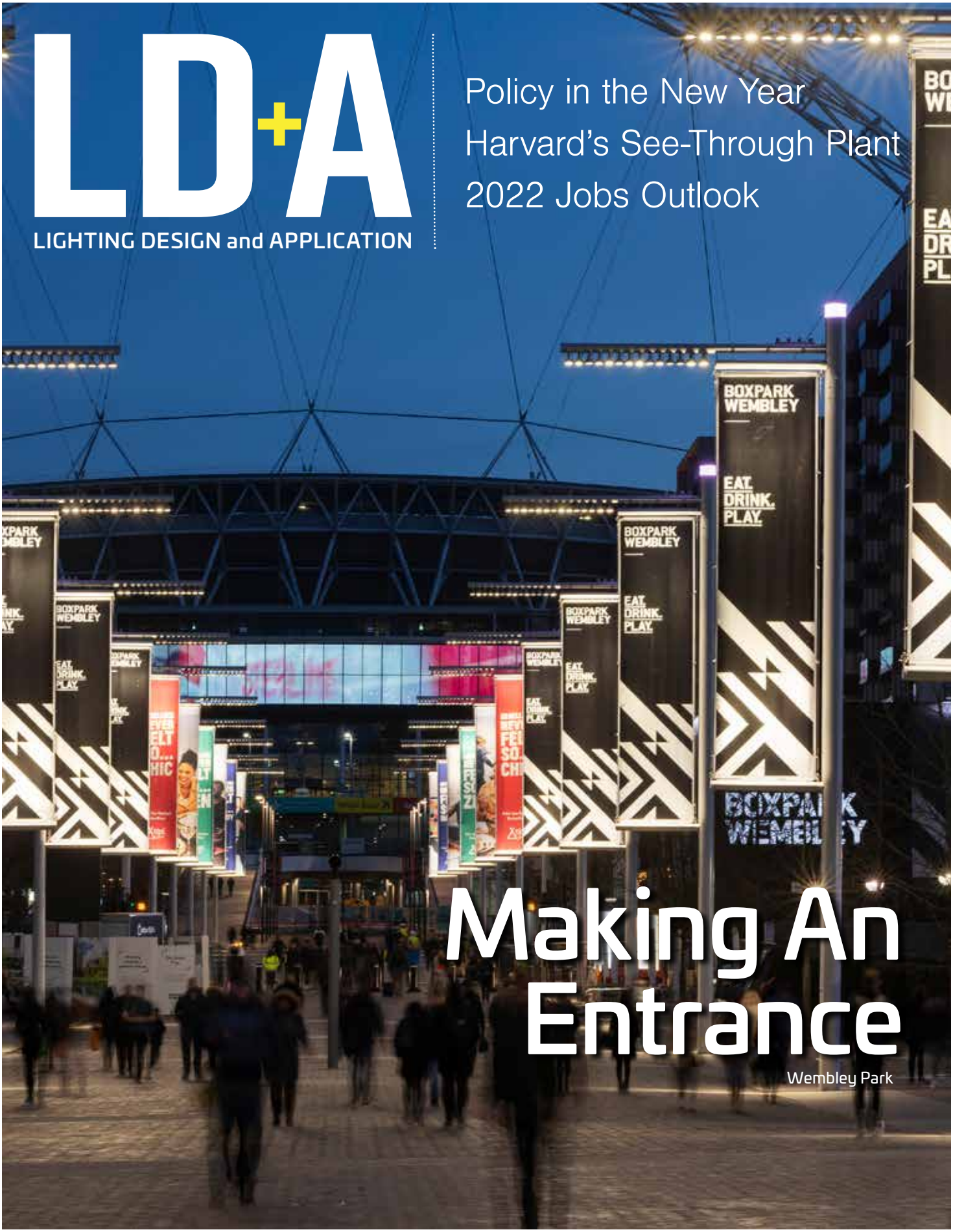
LD+A

LIGHTING DESIGN and APPLICATION

Policy in the New Year

Harvard's See-Through Plant

2022 Jobs Outlook



Making An Entrance

Wembley Park

Custom Architectural Lighting Through 3D Printing

By now, many of us have seen the news from around the globe showing off innovative homes built almost entirely by 3D printers. These massive printers are utilized in either fabrication warehouses or are brought directly to the construction site where the printer's robotic arm sweeps left and right repeatedly, depositing the material for the home's walls layer by layer. This concept has many benefits in terms of time, cost of materials and labor for constructing buildings. However, another—and possibly greater—advantage of 3D printing for building construction lies in the ability to fabricate interior architectural features and to integrate and customize these features, including lighting. At Rensselaer's Lighting Research Center, we recently embarked on a project to demonstrate a 3D-printed interior architecture with integrated lighting.

AUTHORS

JENNIFER TAYLOR

NADARAJAH NARENDRAN

INDIKA PERERA

JEAN PAUL FREYSSINIER

The traditional approach to building construction separates each step during the interior finishing process. First, the interior is framed. Electricians then add wiring for recessed or ceiling-mounted lighting, outlets and switches. HVAC specialists add ducting for ventilation, and insulation may be installed. Finally, the sheetrock is put up, and holes are cut to accommodate the electrical wiring and HVAC vents. Throughout this process, the architect or building owner goes in search of light fixtures to illuminate the space, relying on where electrical outlets were anticipated to be needed. Lighting manufacturer catalogs are perused for a product that provides the right aesthetic look and illumination level for the intended use of the space.

But when the right lighting can't be found, the choice becomes to either make do with what's available or to find a manufacturer to produce a custom fixture, often at a very high price. This has been the way for a very long time. 3D printing, however, has the capability to redefine this paradigm in favor of an integrated and easily customizable solution with minimal errors and waste.

However, 3D printing interior walls on demand and on, or close to, the construction site can offer a cost-effective and sustainable solution for custom features. In terms of lighting, 3D-printed walls allow custom lighting to be integrated from the start rather than added on at the end. The use of digital design tools allows architects and interior, lighting and electrical designers to integrate their concepts into one element, rather than the sum of multiple, separate elements.

Figure 1 depicts a prototype, scale-model sized wall printed at the Lighting Research Center. The wall was printed from PLA (polylactic) material, resembling sheetrock. A decorative surface texture and crown molding were included in the wall's design. The wall sconces in this case were printed separately and attached to the wall during the final assembly, but it is possible to print the wall and sconce together in one step. A non-functioning electrical outlet was included to show how it could be integrated. **Figure 2** is a close-up of the lighted wall sconce. An LED module package was added after the sconce was printed. The wall design included routing space for the wiring to be run through the molding, although eventually we think it will be possible to print electrical conductors directly into the wall during the printing process.

In a separate 3D printing project, we explored how to inte-

grate lighting within or behind the wall rather than as a fixture. **Figure 3** illustrates how decorative wall tiles can be 3D printed with LED backlighting to create a wallpaper-like appearance. One feature of this wall decoration is that it can be activated by turning on the LED backlight; when the backlight is off, the tile will appear as a plain wall. The options are truly endless for creating interior architecture with 3D printing.

Figure 1. Prototype, scale-model sized 3D-printed wall with integrated lighting created at the Lighting Research Center.

Figure 2. Close-up of the 3D-printed lighted wall sconce.

While 3D printing for lighting and architectural construction is still in its infancy, research is showing its potential for the future. Manufacturers of 3D printers and printing materials are advancing their products to accommodate the needs of many industries, including lighting. For example, new 3D printing materials are being developed by several manufacturers for thermal and electrical conductivity. Additionally, manufacturers are producing recycled and recyclable printing materials to make 3D printing more sustainable. Using polymer printing materials made from recycled plastic can also help reduce the amount of waste in the environment. On the 3D



Figure 3. Decorative wall tiles 3D printed with channels to accommodate LED backlighting.

printer side, specific printing processes and print parameters are being explored to produce the right thermal regulation and material longevity.

In the future, it will be possible to employ a custom combination of printing materials and processes to 3D print walls with the electrical, mechanical and thermal components all integrated, reducing the labor-intensive interior finishing process. And because 3D printing jobs are built from computer-aided design models, these models can be easily customized for different types, styles and sizes of lighting, as well as other decorative and mechanical features. From an economic standpoint, 3D printing allows for the growth of local manufacturing, which can increase jobs and reduce costs for transportation and storage.

In 2019, the Lighting Research Center established the *ASSIST 3D Printing for Lighting Consortium* to explore many of these research activities (*https://www.lrc.rpi.edu/programs/solidstate/3DConsortium.asp*). Together with the consortium's sponsors, we have been exploring various aspects of 3D printing, including materials, printing methods, print parameters, post processing, surface finishes and longevity for several components used in lighting fixtures.

Overall, 3D printing holds promise for revolutionizing the lighting and building construction industries, making it easier, faster and cheaper to customize lighting. With future advances in printers, materials and print processes on the horizon, the possibilities will be limited only by the imagination.

For details and publications about the Lighting Research Center's 3D printing for lighting program, visit *https://www.lrc.rpi.edu/programs/solidstate/3DPrinting.asp*. ◎

THE AUTHORS | Nadarajah Narendran, Ph.D., is a professor and director of research at the Lighting Research Center at Rensselaer Polytechnic Institute.

Jean Paul Freyssinier is a senior research scientist with the Lighting Research Center at Rensselaer Polytechnic Institute.

Indika Perera, Ph.D., is a research scientist with the Lighting Research Center at Rensselaer Polytechnic Institute.

Jennifer Taylor is a senior communications specialist at the Lighting Research Center at Rensselaer Polytechnic Institute and works primarily in the fields of solid-state lighting research and 3D printing for lighting.