

Speed of light

Over the past 15 years, LED technology has developed at a breakneck pace – so fast that some designers struggle to keep up with the latest news. Now the race is on for the warm white light

BY ELIZABETH PAGLIACOLO

At last year's Light + Building expo in Frankfurt, a little-known Vancouver company called TTR Systems stole the show from behind the scenes. The prominent German lighting company Spectral suspended a futuristic new spotlight over its booth. Ledon (the brand new LED subsidiary of leading Austrian lighting manufacturer Zumtobel) lit up its entire space with sleek and super-bright Tempura spotlights. Both lamps employ TTR's cutting-edge Loxel technology.

Ledon managing director Ruedi Hug remarked, "Most customers didn't even realize the exhibit was illuminated entirely with [LED] fixtures." Such is the bright, white world of LEDs. Unveiled in 2005, TTR's Loxel increases the efficiency of 24 state-of-the-art light-emitting

diodes – semiconductor chips encased in plastic – via a few proprietary microchip technologies. The plug-and-play device, a fixture featuring RGB (red, green and blue) or white LEDs, excels where past technology failed. By better focusing overall luminosity, it emits and maintains a brighter light that's programmable from cool to warm tones, thanks to an innovative feedback loop. Most important, it produces ground-breaking intensity without self-destructing.

TTR Systems believes LEDs could unseat the Edison bulb as our primary lighting instrument. Loxel outputs 1,000 lumens (units of perceivable light) while consuming just 35 watts. By contrast, an incandescent bulb produces 1,700 lumens but uses 100 watts. "The high-value specification

markets will be the first to embrace Loxel-based products for lighting," says TTR director of product marketing Grant Harlow, referring to the museum, retail and hospitality sectors, which already favour LEDs because they don't damage the goods they shed light on. "Once the technology is proven and reaches an appropriate price point, the mainstream commercial markets will begin to use Loxel-based products." That's PR tech talk for a basic conundrum: retail costs still impede LEDs in the home and office markets. But that doesn't stop everyone, from semiconductor chip manufacturers to lighting retailers, from speaking of a revolution whereby LEDs become the most prevalent light source, taking a huge chunk out of energy consumption.



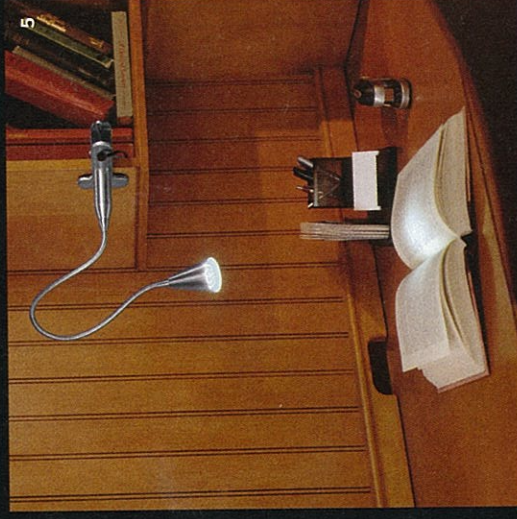
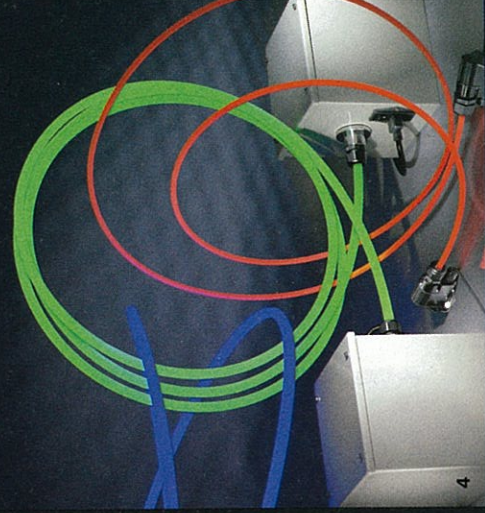
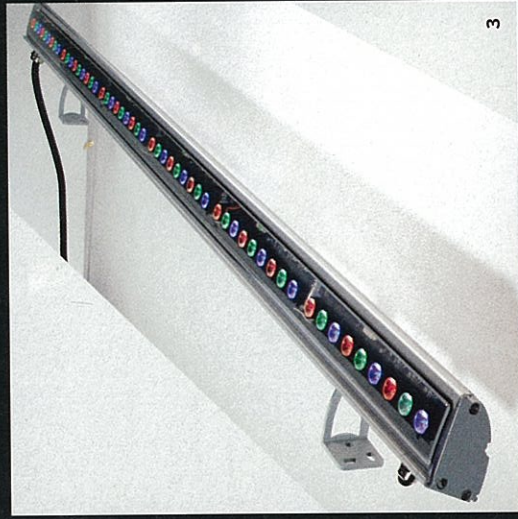
3. Lineos, a linear reflector manufactured and controlled externally to change colours.

4. LEDs can be combined in exciting ways. Opto Technology's LED illuminators. The first multiple LEDs lighting six to 24 metres of ca



1. A spotlight by Spectral, one of eight companies that have developed or are in the midst of developing lighting products using TIR Systems' Level. The LED technology produces a high luminosity at only 35 watts.

2. The Tempura spotlight, designed by Austrian firm Eos for Ledon (a Zumtobel company), is also based on Level's combination of light-emitting diodes and proprietary microchip technologies.



3. Lineos, a linear red-green-blue LED projector manufactured by Targetti, can be controlled externally or in a pre-set mode to change colours.

4. LEDs can be combined with other light sources in exciting ways, as in Endura Light, Opto Technology's LED-based fibre optic illuminators. The fixtures feature single or multiple LEDs lighting up anywhere from six to 24 metres of cable.

5. This LED clamp fixture is part of Osram Sylvania's new LED collection for the home and office. It emits a soft, cool white light.

6. Maantis, designed by Richard Rogers Partnership for Reggiani, combines different light sources, including an LED array along its spine.

Constant breakthroughs in solid-state technology (the industry term for LEDs) back up such projections. Eggheady online trade publications devoted to the subject – including Ledsmagazine.com and Solidstatelighting.net – trumpet leaps in the lumens-per-watt race as frequently as they announce patent-infringement lawsuits. These milestones are especially noteworthy in the realm of the ultra-important white LED, infinitely more practical than coloured light for urban and general room lighting. Standard LEDs – seen in softer lighting applications and traffic lights – run at lower currents, and produce lower levels of very efficient light, up to 30 lumens. Anything brighter is considered a power LED. At the moment, semiconductor manufacturers are developing super-power white LEDs with efficacies that exceed 70 lumens per watt. Philips subsidiary Lumileds and North Carolina company Cree boast two of the brightest on the market, with Luxeon K2 (140 lumens) and XLamp 7090 XR-E (95 lumens), respectively. In the R&D world, the numbers reach euphoric levels, with prototypes exceeding 100 lumens per watt, outperforming the brightest fluorescents. Until now, fluorescent bulbs, at around 75 lumens per watt, were the most practical alternative to incandescents. But LED fixtures could surpass them. Besides low electricity consumption and long life (with high-end estimates of 100,000 hours, more than 11 full years), their tiny size, rugged nature and capacity for digitized colour and lumen control (and that, unlike fluorescents, they work well in the cold) peg them as the wave of the future.

The major hurdle in advancing LED technology is still heat management. Brighter light requires a bigger heat sink (the metal attachment that draws heat away from the LED chip so it doesn't burn out), resulting in a huge, clunky fixture. Gerald Lue, founder of Toronto LED lighting supplier Illumineer, offers an extreme example: "I saw a single LED at the experimental stage that uses 27 watts but outputs 4,000 lumens. Its heat sink is the size of a motorcycle engine."

Designers working with LEDs turn the problem into a creative opportunity. For instance, even though the Tempura spotlight's Lexel technology is programmed at the chip level to dissipate heat, the Austrian design firm Eoos devised a special rib pattern on the inside of the fixture for ventilation. And when creating the Leaf task light for Herman Miller (see sidebar, page 92), designer Yves Béhar punched holes on the top of the lamp head and above the LED array, which act like chimneys to naturally diffuse heat.

Such ad hoc innovations exemplify the most recent history of LEDs' application in ambient lighting. Just 14 years ago, Shuji Nakamura, working for Japan's Nichia, invented the first bright blue LED, completing the red, green

and blue triangle that allows for an infinite array of colours, including white. When this blue semiconductor was coated with a yellow phosphor, it produced the first cool white LED, setting a new benchmark by eliminating the need to combine RGB chips in equal proportions to deliver consistent white light. It wasn't until 2002, however, that Nichia announced its first white LED capable of emitting the warm light preferred for indoor environments.

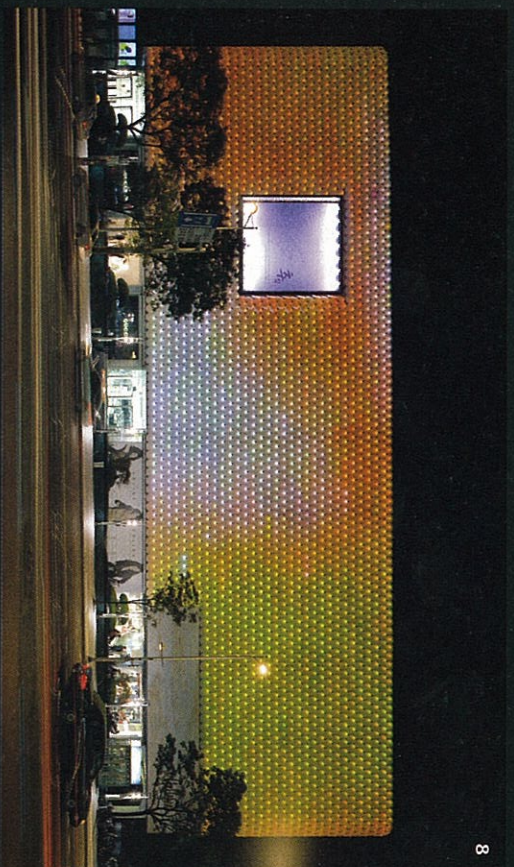
That's where the development of ever more practical LEDs hits another snag. Warm-white LEDs still can't achieve the luminosity of their cool white counterparts. That's because the most common method for producing a warm white LED involves coating a blue one with red-yellow

phosphor to render it warm – which compromises luminosity. There is no warm white version in Cree's XR-E series. And Scott Sawicki of Nichia says, "Our most efficient warm white light produces 46 lumens per watt. Our brightest cool white produces 55 lumens per watt." He adds that both of these very bright lights are still mostly used in cellphones and other backlit gadgets. They have yet to break into the general lighting market.

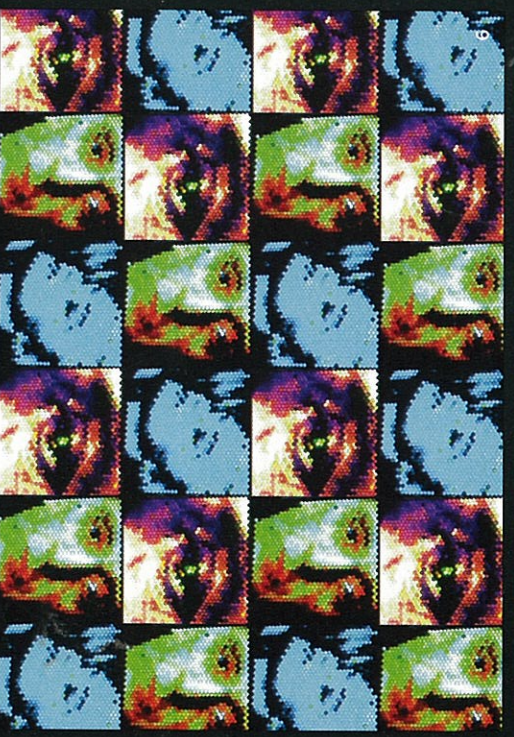
Variable white light, however, is making huge strides in street lighting. LEDs capable of emitting white light at a range of colour temperatures have shown up in such industrial design feats as Philips' CityWing and LEDtronics' M400. Meanwhile, Leotek manufactures a luminaire that uses the previous, cool white version of



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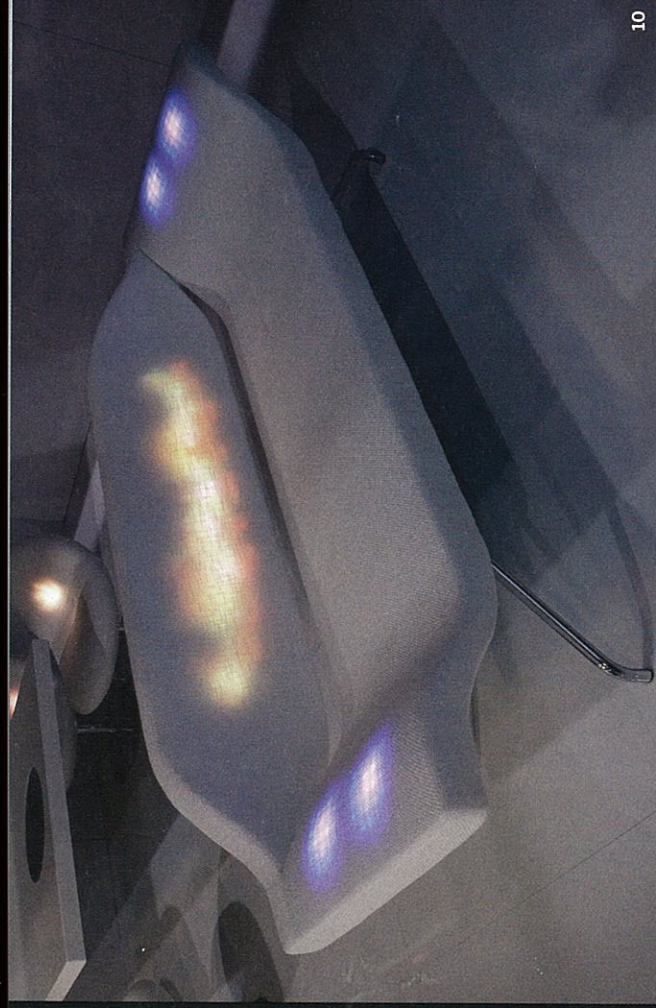
7. This demo structure, at the 2006 Venice Biennale of Architecture, was built with Smartslab. The LED-embedded polycarbonate and steel panel is strong enough to build with, while providing the additional function of a media or decorative device.

8. The Galleria department store in Seoul, designed by UN Studio, boasts a facade comprising 4,330 glass discs illuminated by programmable RGB LEDs.

9. Smartslab, made and distributed by Targetti, provides a low-resolution image.

10. Using the Philips' Artlino programmable of several pieces of station mode Kortrijk show manufacturer cially available pieces in the

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10. Using the Lumalive technology by Philips, Artfort embedded computer-programmable diodes into the upholstery of several pieces of furniture as demonstration models during Belgium's Interieur Kortrijk show in 2006. The Dutch furniture manufacturer hopes to develop a commercially available line of LED-illuminated pieces in the near future.

11. New York-based architecture firm Peter Marino has been using LEDs as decorative devices in its projects since 2001. This staircase, in the Louis Vuitton showroom in Hong Kong, features LEDs embedded into the treads and landing, to create dynamic, programmable displays.



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Cree's XLamp, XR, which outputs 57 lumens at 47 lumens per watt. All exemplify well-designed urban lighting that not only exploits all of solid state's strengths (digitized colour and temperature variability, dimness control and feedback) but also beams a wide white light across an impressive distance.

In a more expressive fashion, colour-changing LEDs are lighting up everything from fixtures to fabrics. Their compactness allows designers to combine them with other light sources or encase them in shapes – from ultra-slim profiles to super-flat panels – afforded by no other lamp. Undoubtedly, the biggest trends spurred by RGB LEDs are in animated architecture and urban landscapes (see "The Wow Factor," page 67). Now the Smartslab, designed and engineered by Britain's Tom Barker and manufactured and distributed by Italian lighting company Targetti, ups the ante. Strong enough to withstand the weight of an elephant, the polycarbonate and folded steel panel is embedded with state-of-the-art LEDs. Measuring 60 by 60 centimetres, it features hexels, or six-sided lenses, that collect the coloured light emitted within and project it evenly on the panel's surface to create smooth imagery rather than the usual distinct dots. Says Pto Nahum, director of Targetti's digital lighting division, "It's a tool for modifying the perception of architecture." He distinguishes Smartslab from the high-resolution plasma screens used for advertising. "Instead of the impression of a TV image, it gives more of an emotional, low-resolution image."

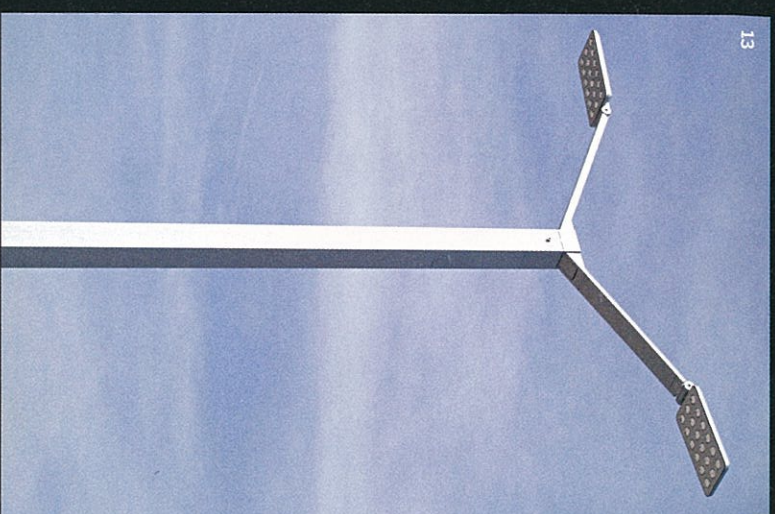
While Smartslab is Targetti's most decorative device, Nahum advocates LEDs for the mainstream and tunes in to the latest developments (the company currently carries around 15 fixtures that incorporate Lumileds' high-power K2). "The president of our company, Paolo Targetti, went to the LED Leadership Summit in San Diego [last November]. It was predicted that the technology will be capable of replacing standard lamps within five years," he says. "Now, this is a shock for manufacturers such as Targetti. We have a lot of LED fixtures, but they represent only five per cent of our share. I'm talking about white light: the demand is growing every day, and it's something no one can avoid."

Such statements from the high end of the lighting market give hope for a growth in general uses for LEDs – a prospect already showing promise. At the consumer level, such uber-manufacturers as Permlight and Osram Sylvania have introduced home and office lines. While Sylvania's are for tasks (such as reading) that call for cool blue-white light, Permlight offers a wider temperature range, with cool and warm white LEDs that output 40-plus lumens per watt in pendants to hang, say, over the kitchen table. Toronto retailer Eurolite is even marketing LEDs for condo projects and refitting existing products for LEDs.

Lighting designers on residential and corporate projects are more likely to suggest LEDs than other sources as decorative points of light (along staircases or for a garden's in-ground lighting), and for areas that require softer light or are hard



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to reach, such as high ceilings and coves, since LEDs last so long. Suzanne Powaduk, an award-winning lighting designer based in Toronto, brings the latest products into her projects, among them a residence where white LEDs enliven a glass-sheathed staircase, and a city gateway whose LEDs are activated by wind and motion to vary in colour and intensity. "The technology is growing at a phenomenal rate," she says, "but we need to make fixtures more cost effective."

Gree's Paul Theiken echoes her sentiment, saying that for widespread indoor use – other than in garages and warehouses, where "maintenance avoidance" makes them desirable even at a higher cost – the high-power warm white LED would still need to come down in price. "I'm looking up at a fluorescent trougher right now, in my office, and it's hard to imagine replacing it. It costs \$30 and can produce 7,000 lumens with

three or four bulbs. We're not quite there yet with LEDs, but we will get there."

Powaduk also believes homeowners will open their minds to using LEDs for general lighting once they become more prevalent. "Lighting manufacturers need to put LEDs in more typical housings, such as table lamps or recessed downlighting – vocabularies homeowners are familiar with." She's already seen a few examples of such fixtures. One, an Edison Price downlight, costs around \$500, more than most people are willing to spend. But she's keen on a version by Optolum, a purveyor of well-designed LED fixtures, retailing for one quarter of that price. In the most hopeful of forecasts, better, more affordable LED fixtures will appeal to the majority of consumers. And in choosing the greenest alternative to Edison's invention, they will spearhead the real revolution. **AZ**

12. Philips leads the way in providing urban lighting solutions. The floodlighting of this Glasgow bridge was achieved with the LEDline lighting product, by Philips LED subsidiary Lumileds.

13. CityWing is a street light manufactured by Philips with Lumileds LEDs. The high-intensity LEDs shine a white light (variable from warm to cool) over five metres. Several of the luminaires are installed in Ede, the Netherlands.



Brought to task

Task lighting doesn't require generous light distribution or a warm colour temperature, making it the ideal entry point for designers seeking to experiment with the latest LED technology



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Introduced in 2005, Knoll's Halley desk lamp, designed by Richard Sapper, didn't just raise the bar when it came to LED task lighting; it set the bar. To keep the lamp's 16 LEDs cool, Sapper used a tried-and-true laptop technology: heat is carried by a pipe to the aluminum fins that are cooled by its fan. Collaborating with Herman Miller, San Francisco-based Yves Béhar designed the dramatically thin Leaf. Its user-controlled detachable head blends 10 warm white and 10 cool white LED chips to achieve a variable colour temperature. The fixture's sandwiched aluminum construction – as well as the holes on the top of the head – naturally dissipate heat. Luxo's latest task light, ESOL (Eternal Source of Light), produces more light than a 40-watt halogen bulb, thanks to its three triple-watt Lumileds Luxcon K2s. The company's proprietary lens array converts pinpoints of light into a wide, glare-free asymmetrical beam spread. Naoto Fukasawa's creation for Artemide, Itis, contains one five-watt LED in a cut-out of its circular casing; the light is diffused through the thin polycarbonate edge. For total flexibility, the fixture's stem tilts from zero to 90 degrees, and the head rotates 180 degrees.

1. Halley by Richard Sapper for Knoll
2. Leaf by Yves Béhar for Herman Miller
3. ESOL by Luxo
4. Itis by Naoto Fukasawa for Artemide