

Horticulture's History with Disruptive Technology: LED Lighting Takes Its Turn



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Our greenhouse industry has an impressive history of embracing disruptive change and each of us has a personal perspective regarding time and change. One reference point for all of us is measured in terms of century rather than decades; harnessing the principle of photoperiodism was transformative. It created market windows for year-round chrysanthemum production; allowed for precision control over a poinsettia program; and set the table for other photoperiodic crops to assume mainstream floriculture status.

In the 1960s, greenhouse crop fertilization was turned on its ear with a disruptive piece of equipment called a fertilizer injector. The concept of constant liquid feed swept across greenhouses from coast to coast making crop fertilization easier. I remember watching my mom and dad mix soluble fertilizer at final strength in a 50-gallon drum and pump it directly onto our geraniums. Mix a batch, pump ... mix another, pump some more.

The first injector my father bought had an injection ratio of 1:128. I was in high school at the time and couldn't appreciate that ratio. It wasn't until I taught greenhouse management at the university level that the 128-ounces-

in-a-gallon light bulb lit. Still, 1:100 became so much easier.

Plant growth regulators, plug technology and soil mixes that contained, well, no soil all qualify as disruptive ideas in their early traction days. Double layer poly, DIF and energy blankets lengthen the list.

Consider what's happening with robotics ... the very definition of disruption in a labor-intense industry. LED lighting technology has joined our list and is today's topic of discussion.

Joining me is Alex Bodell. Alex earned his bachelor's and master's degrees from Johns Hopkins University in mechanical engineering. His nine-year career in product development includes projects ranging from LED horticulture lighting to medical laboratory equipment. In 2015, he founded Horticulture Lighting Solutions as a way to support LED product development for companies interested in entering the controlled environment agriculture (CEA) market.

Alex, you and I have worked together on several projects spanning the past half dozen years. I'd like our readers to hear about how you became involved in our industry to start our discussion.

Alex: Thanks, Peter. In 2013, I helped a company develop consumer LED products for growing food at home. LEDs were capturing a lot of attention and there was considerable excitement for targeted (red/blue) spectrums and intensity control. We developed a broad portfolio of products ranging from fully automated kitchen countertop kits to commercial LED lights.

This initial contract design and manufacturing work allowed me to establish a global supply chain for LED products and gave me key insights into the types of fixture designs that promote both plant and business success. Today, we provide design

support for vertical indoor farms and produce an LED replacement for traditional High Intensity Discharge (HID) greenhouse fixtures.

Peter: Growers hear a lot about China when it comes to LED manufacturing. You've spent considerable time there, does your gained insight offer any guidance greenhouse and vertical farm operators would benefit from hearing?

Alex: Working within China to produce LED fixtures has been an exciting and eye-opening experience. For LED lighting, Southern China is the center of the action. Gigantic technology markets allow for fast sourcing, and there is an incredible supplier network producing the small parts that often go unnoticed but represent the key finishing touches to lighting fixtures. I really enjoy working in China and seeing firsthand how lighting products get produced on a mass scale.

Growers frequently ask me about purchasing lighting directly from China. Websites exist that make it easy and the prices are very compelling. The challenge with this process is twofold. First, it's very difficult to evaluate vendors over the internet. I personally tour all factories that we work with to ensure proper quality and product specifications.

Secondly, if there is a quality issue, it can be very difficult to get the problem resolved in a timely manner. If you're depending on the lights for commercial production, delayed warranty service is a risk to strongly consider.

Peter: Let's move to the technology of lighting. You have some high-level thoughts about LED versus HID. My position in the lighting debate questions why so many view it as a zero sum game where HID or LED must conquer to advance. Won't there continue to be places for each?



Figure 1. Broad spectrum white LED fixture designed to perform in the same setting as a traditional HID fixture.

Alex: LED fixtures are exciting. LEDs have created a new technology platform for designers and researchers, resulting in an expanding range of options for growers. LED technology is driving important conversations around spectrum, energy efficiency and advanced control systems; features that can improve business and crop performance.

LED technology is expensive. In contrast, HID pricing is at an all-time low. This has created a market where growers are hesitant to transition to LEDs. They are aware that the performance of LED fixtures is rapidly increasing while the prices continue to fall. But even with this awareness growers feel comfortable with the use and cost of HID fixtures.

I do, however, see a change coming. The LED market has traditionally been dominated by red/blue diode fixtures. We are now seeing companies move toward designs that contain broad spectrum white diodes. An advantage of white diodes is that they are more cost effective than discrete color diodes.

This design transition is an encouraging sign that lighting companies are working to find a balance between plant specific spectrums and price.

I think of this as an inflection point in how we think about light. When LED pricing aligns with HID, I'm confident we'll see a full market transition. I now see a general market consensus where growers acknowledge that "LEDs are the future," but the pricing is holding people back.

Peter: An analogy that resonates with me is how quickly I approached and crossed the inflection point you cite in thinking about my residential lighting. It took a couple years for me to convert my incandescent bulbs to compact fluorescent bulbs a decade ago. It was the high cost of the new bulbs relative to cheap incandescent bulbs that slowed my transition. A couple years later, I replaced every compact fluorescent bulb, long before its performance expired, with an LED to complete my upgrade. Once I crossed my inflection point the second transition occurred in the blink of an eye, no turning back.

Your point is a crucial one in the debate and speaks directly to LED technology versatility and application flexibility. In just a few years we've progressed from being mesmerized by LED potential for tailored spectrum and variable intensity to understanding its capability to deliver basic, white light economically (Figure 1).

In an earlier Duets article with Erik Runkle (<https://gpnmag.com/article/supplemental-and-sole-source-led-lighting-fast-and-furious-change/>), I

referenced your engineering perspective of how LED fixtures offer adjustable spectrum. You helped us understand that manipulating the red-blue ratio requires one or both of the following features. Either extra red and blue diodes need to be on board a fixture for occasional use to maintain overall intensity or diodes of the 'other' color need to be powered down lowering the fixture's overall efficiency. Both options are wasteful as diodes are either not in use or powered less than optimally.

Alex: This continues to be an ongoing design challenge for adjustable spectrum fixtures. Eric Runkle has offered great advice when considering targeted (red/blue) fixtures versus broad spectrum (white LEDs). For indoor growing without sunlight spectrum matters for plant health. For greenhouse growing, spectrum is less compelling because the primary photosynthetic driver is the sun. In my opinion, this advice applies to the adjustable spectrum feature. Value of adjusting colors can be derived indoors, in a greenhouse system it's more difficult to justify given our current knowledge.

Peter: I sit on a technical advisory board for a medical cannabis operation and our semi-annual meetings continue to include discussion about how the growers should be looking at LED technology to enhance or replace traditional HID use. What are you seeing in the cannabis industry?

Alex: The price of cannabis is dropping. Growers are feeling the pressure to lean-out operational costs and deliver unique, high value product. LEDs can help in a few ways. First, the improving efficiency of LEDs over HID will allow indoor operations to reduce their lighting and HVAC electrical demand. Secondly, LED fixtures can give indoor cannabis growers a new tool kit to promote high value characteristics from their crops. This will be done through LED spectrum selection and intensity control. While indoor cultivation will always be a segment of the cannabis market, I see the majority of future cannabis being grown in greenhouses or fields. In those production environments, broad spectrum white will work.

Peter: You're also working with vertical farms. How does that sector's inflection point compare to cannabis?

Alex: That's an interesting comparison. Pre-legalization, cannabis cultivation was primarily an indoor activity. Cannabis growers in legal states can now transition to greenhouse and field operations as ways to reduce cost. In contrast, the vertical farm sector, by definition, is indoors, adding to the production costs. The primary justification I see for adding this expense is food security. During the short time, I've been working with vertical farms, the U.S. has encountered multiple incidences of e coli where all of the field grown crops had to be removed from grocery store shelves. I think the interest and market for indoor grown food will continue to grow in a way that complements traditional agriculture, but does not overtake it.

Peter: Thanks for sharing your experience with us Alex, having a lighting engineer's perspective is valuable, especially one who's made the effort I've seen you make to understand the horticulture industry. Growers appreciate hearing that they can avoid the confusion that spectrum adjustment and intensity control bring to their business decision. Until those features are fully researched broad spectrum, basic white LED light offers them an attractive opportunity. [gpn](https://gpnmag.com)