White Paper:  
LED Layout Design and Best Practices

Abstract:

Even though LED lighting has taken over from neon for channel letter applications, there are still challenges for sign shops in creating complete and accurate LED layouts. Neon had decades to establish best practices in the sign industry, but LEDs are still relatively new. The LED suppliers helped to usher in this new technology by doing layouts for customers, which was necessary early in this market. Although this practice has endured, sign companies are realizing that they can be faster to market and have better control of their jobs by doing their layouts in-house. The choice of software for LED layout design ranges from generic design software to specific LED layout software, LED Wizard 7. This white paper discusses the history of this market, where we are today, options for LED design using generic software vs. LED Wizard 7, and best practices for LED layouts.

The Transition from Neon to LEDs

Many years ago when LED’s first came on the scene in the sign industry, there was a considerable backlash against the technology for use in channel letters and sign cabinets. Neon and fluorescent had been used successfully in the industry for decades, which means that there were well established best practices for how to lay out the products to achieve optimal lighting. There was a large group of folks in the industry who were trained and very experienced in the art of creating neon signage. Furthermore, standardization across suppliers in both neon and fluorescent technologies made it easy for sign companies to switch brands and not have to start from scratch.

But with this new LED technology, suddenly everything was different. Each supplier was making various claims about attributes like brightness, power usage, color temperature, long life, etc. Each LED system therefore had to be laid out differently in terms of the number and position of modules to achieve a favorable result when compared to neon or fluorescent. Sign companies were eager to try the new technology, but did not have the knowledge or tools to make accurate layouts. So the LED suppliers stepped in and said “We’ll do the layouts for you” at no cost.

While this was a practical way to encourage the adoption of the technology, it did not educate the sign companies on how to create these layouts. Instead, it created a kind of “black box” situation, where the sign company sends the file and gets back the result. And any changes needed to go back through this process again, since the sign company did not have the means to make any layout changes directly. So this process, while technically “free” to the sign company, did have costs, namely in response time to the customer, lack of knowledge of the particulars of the job, and limited flexibility in any changes.
Here is a summary of the workflow of a typical job in the early days of this market, as shown in the graphic below:

1. A local retail business is opening up and they need a sign for the storefront. They identify a few local electrical sign companies and send out Requests for a Quotation.
2. The electrical sign shops design the sign with the requested size of the letters and copy. Each shop takes that design, along with specifications such as the letter can depth, face material, etc. and sends it to their trusted sign supply dealer to get a quote on the LEDs, power supplies, and other materials needed to produce the sign.
3. The sign supply dealer can estimate and fulfill everything for the job except for the actual LED layout and associated module count and power supplies. So they forward the design file to the specified LED supplier, which may have been determined by the sign company or the dealer.
4. The LED supplier creates the LED layout, according to their specifications for module density based on can depth, stroke width, and other design considerations. They combine that with the Bill of Materials and send it back to the sign supply dealer.
5. The sign supply dealer takes the layout and provides an estimate back to the sign shop.
6. The sign shop puts everything together and presents the layout and estimate to the new retail business.
7. The retail business chooses the bid they like best and buys the sign.
This process has many steps and it may well be several days if not weeks before the retail business has a few bids that they can evaluate.

Here is a summary of the market conditions that led to this workflow across the industry:

<table>
<thead>
<tr>
<th></th>
<th>Neon</th>
<th>Fluorescent</th>
<th>LEDs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maturity of technology/application</td>
<td>Mature</td>
<td>Mature</td>
<td>Immature</td>
</tr>
<tr>
<td>Decades of design “best practices”</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Number of suppliers to the industry</td>
<td>Few</td>
<td>Few</td>
<td>Many</td>
</tr>
<tr>
<td>Standardization across suppliers</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Pool of experienced employees</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Suppliers providing most layouts</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**The Market Today**

Fast forward to today, and this is changing as more sign companies are realizing the benefits of making their own LED layouts in-house. Furthermore, the sign supply channel is also creating layouts for customers, effectively acting as a middle-man between the sign company and the LED suppliers. There are a number of compelling reasons for sign shops to make their own LED layouts in-house:

**Faster Response Time**

One of the main benefits of creating your LED layouts in-house is simply the faster response time to your customer. LED suppliers can be inundated with layout requests at any given time, limiting their ability to get your layout back quickly. During this waiting period, your competition could be creating layouts in minutes instead of waiting days. As a result, by the time your estimate gets in front of the customer, it could be third in line instead of first, or the job could be lost.

**Control over Entire Job Workflow**

Another primary benefit of keeping the layout design process in-house is to maintain control over the entire workflow of the job. This is not because signmakers are “control freaks,” but rather for practical design, estimating, and production reasons. Any part of the workflow that is out of the control of the shop can lead to unforeseen changes and delays. If changes are required in a layout, then making them directly in the shop is obviously better than getting back in the queue of the LED supplier.

**Better Knowledge of the Job**

If a designer has created an LED layout in-house, then he or she has detailed knowledge of that design and can directly address questions from the client and/or the production floor about why certain decisions were made. These decisions may include which module was chosen, how many power supplies are used and how they are wired, how many runs a certain stroke contains, the
linear density of the modules on the run, etc. You never want to be in front of a customer and not have the answers to basic questions like these. And if the customer requests a simple change, it should not take days to complete.

Offer the Customer Choices

Another important business advantage of creating layouts in-house is that you can present options to your customers in a consistent format. So if you want to present one layout that is the least expensive, one layout of a product that is the brightest, and another layout for a product that requires the fewest number of modules/powers supplies, you can do all of this in a format that lets the customer compare “apples to apples.” However, if you send out the job to three LED suppliers for three estimates, you will likely get three different formats and you risk confusing customers instead of informing them.

<table>
<thead>
<tr>
<th></th>
<th>Send layouts out</th>
<th>Do layouts in-house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response time to customer</td>
<td>Days</td>
<td>Hours/Minutes</td>
</tr>
<tr>
<td>Control over entire job workflow</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Knowledge of layout details</td>
<td>Limited</td>
<td>Complete</td>
</tr>
<tr>
<td>Ability to make revisions</td>
<td>Delayed</td>
<td>Immediate</td>
</tr>
<tr>
<td>Easy to compare multiple supplier estimates</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Consistency of layouts across suppliers</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Now that we have established the benefits of creating your LED layouts in-house, let’s look at the software tools available for this task.

Generic Design Software Solutions

In the early stages of this market, there was no specific software to lay out LED modules. Generic design software and/or sign design software was being used, such as Corel Draw, Adobe Illustrator, and AutoCAD. This made sense because these programs are common in larger electrical sign shops, but they lack any real specific design and layout capabilities for LED modules.

Module Placement

The most important aspect of an LED layout is obviously the position of each individual LED module. The more automated this procedure the better. There are two main ways that this is done with generic software solutions: 1) individually placing modules or distributing modules along a simple inline and 2) setting up a grid system and positioning modules at each intersection point. A variation of the second approach is to determine the area of a letter and then identify the number of modules that should cover that area, such as 10 modules per square foot. None of these approaches is very accurate except in the simplest of cases.
Module Editing

When modules need to be re-positioned to achieve optimal, even lighting, or when modules need to be added or subtracted from the layout, these are manual, individual tasks with a generic solution. Each module needs to be moved/added/subtracted, and then other modules may also need to be adjusted to maintain proper spacing. There is no concept of making selections of multiple modules in order to add, subtract, re-space, or rotate.

Power Supplies

Power supplies are a requirement of a complete LED layout. A generic software solution can go as far as importing a power supply object and positioning it in the layout, and then making some kind of rectangular or polygonal selection of modules to include on that power supply. This would involve manually counting all of the modules to include on that power supply, and adding the wattages of each module and ensuring that it doesn't exceed the power supply's capacity. There is no concept of wiring the modules or loading a power supply. This can be very time consuming and error prone since this counting is a manual process, especially with larger letters and/or cabinets.

Summary Statistics

Somewhat similar to power supplies is the requirement of summary information about each letter/cabinet and the entire job. If the layout is for an estimate, this is ultimately the information that you'll need: how many modules are in the layout and how many power supplies are needed? But beyond this basic information, the density of the modules is also important, since this will determine the amount of light to illuminate the sign. So additional questions would be: how many modules are there per square foot (square meter) and how many modules per foot (per meter) are there on the string?

For these and other reasons, these generic software options are limited in their potential. There is just too much tedium in the process to lay out any job of sufficient size/complexity at a profitable pace.

Neon Wizard

Aries Graphics International’s Neon Wizard was a logical choice as a starting point for laying out LED modules because it had sign-specific design and layout tools for neon tubes, including accurate linear measurements of the neon tubes. Neon Wizard had been established for many years as the industry-standard neon layout tool. Customers began creating estimates by doing the math for the number of modules per foot from a neon layout. This was a fairly accurate approach, but it ignored the desire to place modules in the corners and the inevitable variation of the actual linear density to achieve this. It also lacked the important summary reporting data upon which to base cost estimates.
It became evident that an LED-specific set of tools were needed, and this was the beginning of the LED Wizard module that ran with Neon Wizard and Sign Wizard. Based on the approach of Neon Wizard for creating the tubes, now a vector path was created instead and the modules were evenly populated on this path, with a priority of placing modules in corners. The LED Wizard 6.5 module was launched in 2007 with a few dozen supported LED suppliers.

This product was quickly adopted by many Neon Wizard customers who were looking for more specific LED layout features. Some of the layout tools were familiar, and this was a big leap forward.

**LED Wizard 7**

In the subsequent years, as the LED technology continued to advance on traditional neon and fluorescent for channel letters and sign cabinets, it became evident that a tipping point was coming. Aries Graphics International made an investment in creating LED Wizard 7, a standalone design program specifically for LED layouts that was completely independent from Neon Wizard and Sign Wizard. This opened up new doors for design and editing tools that were far more capable than what was previously available.

**Design Goals**

The first goal of the new LED Wizard 7 was to dramatically increase productivity in the process of creating an LED layout. Aries Graphics International did extensive customer research and analyzed every step in the design workflow to figure out where the process could be streamlined. Second, we wanted to produce complete LED layouts, including power supplies, summary data, and title block templates. Third, we wanted to support a wide range of fonts and sizes with automatic layout routines and editing tools. Finally, the fourth goal was to support and engage our LED supplier partners.

<table>
<thead>
<tr>
<th>Design Goal</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dramatically increase productivity</td>
<td>Improved import filters and data clean up tools</td>
</tr>
<tr>
<td></td>
<td>New auto population routines</td>
</tr>
<tr>
<td></td>
<td>PowerFlow Editing Tools</td>
</tr>
<tr>
<td>Produce complete LED layouts</td>
<td>Complete Power Supply Support</td>
</tr>
<tr>
<td></td>
<td>Merge with Company Title Block Templates</td>
</tr>
<tr>
<td></td>
<td>Density information as part of Summary Data</td>
</tr>
<tr>
<td>Support a wide variety of fonts and</td>
<td>Auto Population: Symmetrical, Serifs, Round</td>
</tr>
<tr>
<td>graphics</td>
<td>Parallel LED Layout</td>
</tr>
<tr>
<td></td>
<td>Hybrid LED Layout</td>
</tr>
<tr>
<td>Engage and support LED suppliers</td>
<td>LED Wizard 7 Supplier Edition</td>
</tr>
<tr>
<td></td>
<td>Density Guidelines</td>
</tr>
<tr>
<td></td>
<td>Custom Module Drawings</td>
</tr>
<tr>
<td></td>
<td>Direct access to module and power supply data</td>
</tr>
</tbody>
</table>
LED Wizard 7 Workflow Summary

The basic workflow for LED Wizard 7 is as follows:

1. **Import/Clean up** – bring in design files as vector and/or bitmap files and clean up the data if necessary for population with LED modules.
2. **Auto Populate** – using a set of rules from the LED suppliers and inputs from the user, lay out the modules inside the letters, logos, and/or shapes to provide even lighting through the sign face.
3. **PowerFlow Editing** – edit the position of individual or selections of modules, including increasing and decreasing the density of a run, evenly spacing modules, rotating modules, and routing the wiring.
4. **Power Supplies** – select, insert, position, and load power supplies into the layout. Options are available for optimal power supply loading, including one power supply per letter or one for all letters.
5. **Summary Data** – generate summary information for each letter and the overall job, including module count, wattage, density, and power supplies.
6. **Title Block + Export** – merge with a standard title block template and export the completed file to a common industry format.

LED Wizard 7 is designed to work within your overall job workflow and perform the tasks that are specific to laying out the LED modules and creating finished layouts.
LED Layout Best Practices Overview

As part of the process of working with many sign companies and LED suppliers, we’ve had the opportunity to come up with some best practices in the design of LED layouts. Here are a few of them:

Using Module Rotation

In some cases, a stroke width is somewhere between an ideal layout of one run and two runs. One run is just not enough light and two runs is too much. You can adjust the linear module spacing, but this will only get you so far: one run will still not be spaced widely enough, and two runs will be limited by the max distance allowed by the wire. The answer is to Rotate the modules, which achieves two goals at the same time: 1) increases the density of modules in the stroke, and 2) spreads the light out.

The inevitable result of rotation is that the modules begin to tighten up on the wires and additional modules are needed to cover the same distance in the letter. LED Wizard 7 will automatically add new modules as needed when using the Rotation features. If you want to use a perpendicular rotation (the modules are perpendicular to the stroke), then you can also alternate the wires, a feature called Alternate Perpendicular Rotation.

Hybrid layouts

For very large letters and sign cabinets, there are a variety of layout options available to the designer. The default option is to lay out concentric inlines, each with the proper Run Gap spacing values. In some cases a better solution is to simply lay out straight parallel lines, either in a vertical, horizontal, or angled orientation, whichever better fits the design. And still in other cases, the Hybrid layout is best.
A Hybrid layout is one inline at the defined Clearance value, and then parallel runs inside. The benefit of this layout is that you get nice clean light around all the edges of the design or cabinet, and then a simple straight run approach on the inside. This might have the most benefit on a large, irregular shape, where straight lines might not line up well on the edges, and concentric inlines would be unnecessarily complex.

**Density Segments**

With designs that have large variations in the stroke width of the letters, or are otherwise complicated to the point where it is difficult to visually discern whether the module density is consistent from one section to the next, it is valuable to measure the modules per square foot (meter) for specific sections of the letter. In LED Wizard 7, these are called “Density Segments,” and each segment shows the actual density against a “target” density.

For example, if the target density for a set of letters is 10 modules per square foot, and the “Tolerance” value is 0.5, then any value between 9.5 and 10.5 modules per square foot would be considered within the target range. Any value below 9.5 would be under-populated and any value above 10.5 would be considered over-populated. To ensure that these delineations are clear, the software color codes each condition with an outline around the segment: Green is within the target range, blue is under-populated, and red is over-populated.

Considering that one of the primary goals of an LED layout is to ensure even and consistent lighting through the sign face, these density segment analyses are very valuable in the layout process.

**Power Supply Wiring**

A critical piece of a complete LED layout used for production is the wiring of the power supplies. It is not sufficient to simply say that if there are 600 watts of LEDs that ten 60 watt power supplies will drive the sign. Although for some estimates, an approximation is appropriate, a layout that shows what runs/letters go to which power supplies is expected.

There are several approaches on how to load power supplies, but two main methods are the most common: 1) loading by runs, and 2) loading by section. Loading by runs, or loading by entire
letters, is the most common for small to mid-size channel letters. Loading by section, such as a square or rectangular section of a letter or sign cabinet, is common for letters and cabinets that have multiple power suppliers per letter or cabinet.

In this example, there are four power supplies, organized in general sections. The lower middle power supply is currently overloaded and should be adjusted. The runs are automatically broken when you select modules by section.

**Edge Lighting**

LED suppliers are constantly coming out with new LED modules that have various characteristics for specific signage applications. For example, there are “mini” modules for thin strokes and/or shallow cans, very bright modules that mount to rails for fluorescent retrofits, RGB modules that can change colors as directed by a controller unit, and many more. One such category is the “Edge” module, which is designed to mount very near or even directly on the letter return and throw light across to the other side of the letter or cabinet.

These modules are always required to be on or near the return, regardless of the stroke width (up to some maximum), so the layout rules must obey this requirement. LED Wizard 7 contains a database of “Density Guidelines,” as determined by the LED suppliers, which define how a certain
module is laid out in a given letter or cabinet. So an edge module would be defined as having a Clearance value of say 0.5” and two runs for every can depth and stroke width range. Every time that module was selected, the software would default to these values, ensuring that the module was used correctly as it was engineered.

Conclusions

The market for lighting channel letters and sign cabinets with LEDs has steadily grown in the industry compared with traditional neon and fluorescent technologies, and today it is safe to say that LEDs have largely won. The process of generating LED layouts necessarily started out in the domain of the LED suppliers, who possessed the knowledge and experience to create accurate layouts. But over time, requirements of control and quick turnaround have led electrical sign companies to bring the LED layout task in-house.

Traditional, generic design software is sometimes used to create LED layouts, but these solutions lack the application specific capabilities that are required for a complete and accurate final design. Aries Graphics International’s LED Wizard 7 is an industry-specific software program that focuses solely on the task of laying out LED modules in channel letters and sign cabinets, and creating complete and accurate LED layouts that can be used for both estimation and production. Through market research and feedback from customers, Aries has developed certain “best practices” for LED layouts, including module rotation, “hybrid” layouts, density segments, power supply wiring, and edge module positioning, among others.

For More Information

Please visit Aries Graphics International online at www.ledwizard.com or call 800 294-7273.