How has lighting control technology evolved with respect to the wider entertainment industry, 1930-1980?

Belle Winn

Introduction

Computing history has always interested me, and now I've become more interested in the world of lighting, these interests have dovetailed rather nicely.

The most obvious way these two interests have combined is through my work on Rob Halliday's Classic Gear Live at PLASA. It is through this work that I got my first real taste of just how weird and wonderful (and heavy) the history of stage lighting is, and I started to see connections between the consoles we were displaying and the next generation of consoles being shown by ETC, MA and Avolites.

When I received my brief for this essay I knew there was only one topic I could reasonably write about, so here is a brief history of the first fifty years of lighting control, and how this history influenced the consoles we know and get endlessly frustrated at today.

Frederick Bentham and the Light Console

Stage lighting used to be a gruelling job. Teams of operators had to change the lighting states without seeing the stage at all, as they needed their own light to be able to read their cue sheets[1]. There was never much space to move around each other, and they needed to communicate silently so they didn't disrupt the show (Redmond, 2020). The system they used would be something like the behemoth, and entirely mechanical, Strand Grand Master, the best for its time. It could control multiple dimmers simultaneously, and even multiple groups of dimmers with the eponymous grand master wheel, through a complicated gearing and clutching system. The dimmers, often carrying as much as two kilowatts of power, would produce a lot of heat (Halliday, 2013). All these factors combined to create, to put it mildly, a suboptimal working environment.

---

[1] Interestingly, cue sheets for the Grand Master and similar systems most likely introduced the n+ notation to indicate a number between n and n+1. For example, to notate dimmer 8 at 4.5, the cue would read 8/4+. This notation is still used in Eos for things like gobo and colour wheel indexing, where an intermediate position between colour 4 and 5 is shown as colour 4+.

Enter Frederick Bentham. Frederick Bentham joined the Strand Electric and Engineering Company in 1932, and already had ideas in his head about abstracting the control surface away from the physical dimmers (Pilbrow, 2001). Bentham was inspired by the electric action organs used in cinemas, especially the preset keys that allowed the organist to set multiple different stops at once. He convinced the directors at Strand to let him create his ideal lighting control, with him getting £1,000 (£60,122 adjusted for inflation) of R&D money towards the project (Herbert, 2021).

By all accounts, the Light Console was not a massive success. Only seventeen were known to have been manufactured over a 20 year production run, with one that amazingly still works at the University of Central Venezuela (Morales, 2018). Despite its limited production run, I think the mark of the Light Console is still felt because of where it was installed. The Light Console saw use at some of the biggest venues in the UK, such as the London Coliseum, the Theatre Royal, Drury Lane and the Royal Festival Hall (Primrose, 2021).

The internal workings of the Light Console are quite obscure, as elaborated on in *The Technology of the Light Console* by Brian Legge (1996). In this work, Legge says that Strand Electric didn't keep any schematics or technical drawings for the Light Console, not because of "commercial secrecy or deliberate mystique", but because they were manufactured by two different companies. Strand handled the electrical internals of the system while the John Compton Organ Company created the "hardwood". Often, these two parts didn't ever meet until installation into a venue.

The Light Console worked on a similar principle to the Grand Master. An operator would use the stop keys, coloured white, red, green and blue for the different circuits, to select the dimmers they wished to control. These keys had an aftertouch which if used would show the current value of the circuit on a small dial. The dimmer control was provided by the incredibly strange looking manual, consisting of 17 keys to an octave with a 5:1 black key ratio! The 5 central black keys controlled automatic colour filters on lights which had them. Each coloured circuit has three different keys, the B.O/down key, the up/down key and the on/up key. The B.O/down key will blackout the selected dimmers on that colour circuit on first touch, while fading them down until the key is released on second touch. The up/down key is similar but fades the dimmers up on first touch until the key is released. The on/up key will put the dimmer at full on first touch or fade the dimmers up until the key is released on second touch. This would allow an operator to, for example, very easily fade white circuit dimmers up while fading red circuit dimmers down. The swell pedal had five or seven discrete positions which mapped to different fade times, from three seconds to forty seconds (Strand Electric, 1949). Nothing amazingly revolutionary, apart from the fact that it was the first time one person could control hundreds of channels simultaneously. And that was a massive revolution.

The Light Console and its successor, the System CD (who's main difference is the use of wheels rather than keys to control the masters) remained in use throughout the 1950s and 60s, but by the 70s, a new frontier was opening up…

Memory and more: the computer revolution

A major downside of the Light Console and its ilk was that there was no way to record cues to memory. Of course, this is because such an installation would be prohibitively expensive in the 1960s and theatres only aspired to generate the sort of profits which would allow them to purchase those systems[2]. As no theatrical buyer could buy a memory lighting system, no seller manufactured them.

The Thorn Q-File, then, was not borne out of the theatrical lighting industry, but rather lighting for television. The BBC was investing heavily in brand-new studios for colour television, and needed a small but effective, memory-based lighting control system to kit them out with. The Q-File was named for its key feature, the ability to 'file' cues into core memory and play them back. The TV influence is most obviously seen in the use of "Studio" as one of the preset names instead of the "Stage" name used in theatre (Jones, 1967). Thorn also brought one other major innovation to the table, the replacement of banks and banks of faders or circuit selectors with a singular, motorised fader. You would enter the channel number on the keypad (arranged in vertical columns for the units, tens and hundreds) and the fader would jump to the current level, allowing for adjustments. This is the foundation of modern channel control (Halliday, 2012). The Q-File was a lot more popular in the US than in the UK, where a lot of theatres stuck with their Light Consoles. But for a long time, if you wanted memory, that meant Q-File.

Strand's offerings, the IDM and DDM, saw little use. The DDM was only installed in 18 venues as it neared the end of its production run, according to Rank Strand (1978) in *Memory Control Worldwide*, despite using an innovative design based on a general-purpose computer, the PDP-11. This meant that all DDM features were implemented in PAL-11R assembler rather than using bespoke electronic circuits (Wright, 2024), increasing versatility in . Also present in *Memory Control Worldwide* was a list of installations of the Strand MMS.

Released in 1973, the Strand MMS was a massive hit. A total of 208 desks were sold and it ran the original West End run of *A Chorus Line*. It was even installed in the Pyongyang Congress Hall, the seat of the People's Assembly of North Korea! It brought two revolutionary ideas to the table.

The first was the channel control. Strand did away with the layout of the Q-File and used a standard keypad, like you would find on a calculator of the time to select the channels. The level was then adjusted using an infinite-travel fader wheel rather than a motorised fader, which was a novel idea for the time but is completely ubiquitous now.

The second was the cost efficiency. Strand had been experimenting with using general-purpose minicomputers in the DDM, but this was prohibitively expensive for most customers. For the MMS they decided to use bespoke transistor-transistor logic circuits,

[2] To illustrate this point, 64GB of memory would currently cost about £100. In 1960, a single byte cost $53.96 and 64GB would cost $3,408,640,000,000, both adjusted for inflation (McCallum, 2024). That is about 1/36 of the net worth of the United States of America (Federal Reserve, 2017). Which is insane.

based around MOS shift registers to act as working memory, which cut costs down drastically.

Lightboard

There was one other light console from this period that was so ahead of its time it seems out of place and that is Strand's Lightboard. Venerated lighting designer Richard Pilbrow was contracted to consult on the lighting installation for the brand-new National Theatre. He specified (1971) a control system that could handle over 800 separate channels while being easy and quick to repatch. It needed to be powerful and versatile while being yet simple enough that the operator never needed to look away from the stage. Pilbrow described this as "head up, fingertip control within forearm reach", worlds away from the complicated mess of disparate surfaces that preceded the Lightboard. It even needed to be able to handle controlling Strand Pattern 243s mounted on Pani remote yokes with colour changers, in essence a moving washlight!

This was a mammoth task for the minicomputers of the time. Strand had to innovate, as even the fastest PDP-11 available (the PDP-11/35, which ran British air traffic control for twenty-five years) wasn't fast enough to calculate moves for 1,000 channels while scanning all the inputs and updating the dual displays that showed the level of channels as well as a representation of the rig (also now standard practice on most lighting desks). To solve this, Strand's engineering team, led by Martin Moore, designed a bespoke co-processor to handle the channel processing that ran at 6MHz, six times faster than the PDP-11/35 (Bertenshaw, 2020). The operating system was written in assembly language, taking eight years to program fully (Halliday, 2016).

The Lightboard was a tour de force in lighting control, and brought so many crucial ideas to the mainstream. It predicted our future, a future of infinitely configurable moving light rigs which could create amazing looks on stage with no need to move lights between shows.

Conclusion - Where do we go from here?

The answer to that question is obvious – all the rest of lighting history not yet covered. I imagine dissertations can be written on this exact topic, and there are many parts of this history that I couldn't cover for fear of massively overrunning my final deadline.

I chose to cover this earlier time period rather than technology closer to today because it shows how all these disparate technologies joined together to help create the lighting consoles of today. Lighting consoles that were all the rage 90 years ago still have a measurable impact on the consoles of today! I hope I managed to show how the technology of the past influences the way we work now, and maybe inspired you to learn more about these consoles and their histories.

Bibliography

Bertenshaw, D. (2020). *The Workings of Lightboard: Notes on the System Design and TCS Drawings*. https://www.theatrecrafts.com/archive/documents/The-Workings-of-Lightboard_v1.0.pdf

Electronic Theatre Controls. (2024, August 2). *Founding ETC Consoles*. https://blog.etcconnect.com/founding-etc-consoles

Federal Reserve. (2017, November 1). *Z.1: Financial Accounts of the United States*. United States Federal Reserve. https://web.archive.org/web/20171101095229/https://www.federalreserve.gov/releases/z1/Current/z1.pdf

Halliday, R. (2012, August). Classic Gear: Thorn Q-File. *Light and Sound International*, *2012*(Aug-Sep), 142.

Halliday, R. (2013, February). Classic Gear: Strand Grand Master. *Light and Sound International*, 47.

Halliday, R. (2016). *Inventing the future: The National Theatre's Lightboard*.

Herbert, K. (2021). *The Compton/Strand Story: From sound to light!* https://www.theatrecrafts.com/archive/documents/Compton_Strand_Story_KH_2021-2.pdf

Jones, R. E. (1967). 'Q-File'-A Unique Electronic System for the Control Of Stage and Studio Lighting. *The Royal Television Society Journal*, *11*(12), 267–270.

Legge, B. (1996). *The Technology of the Light Console*. https://www.theatrecrafts.com/archive/documents/light_console_technology_brian_legge.pdf

McCallum, J. (2024). *Historical Memory Prices 1957—2024* [Dataset]. https://jcmit.net/memoryprice.htm

Morales, M. (2018, October 22). *Aula Magna – Caracas at 450*. https://web.archive.org/web/20181022090854/http://caracasen450.com/2017/07/11/aula-magna/

Pilbrow, R. (1971, June). *National Theatre Production Lighting Control System: Specification and schedules*.

Pilbrow, R. (2001, May 31). Frederick Bentham obituary. *The Stage*, 11.

Primrose, J. (2021). *Theatrecrafts—Equipment—Light Console*. https://www.theatrecrafts.com/bhc/equipment/strand-light-console

Rank Strand. (1978). *Memory Control Worldwide*. Rank Strand. https://www.theatrecrafts.com/archive/documents/1978_memory_control_installations.pdf

Redmond, A. (2020). *Farewell to the steam age of stage lighting*. https://www.theatrecrafts.com/archive/documents/Farewell_to_the_steam_age_of_stage_lighting.pdf

Strand Electric. (1949). *Strand Light Console instructions*. Strand Electric. https://www.theatrecrafts.com/archive/documents/lightconsoleinstructions.pdf

Wright, J. (2024, September 22). *Comment on post in PDP-11* [Comment]. PDP-11. https://www.facebook.com/groups/dec.pdp.11/posts/10161915534778979/?comment_id=10161916975418979&reply_comment_id=10162026970053979