Progression or Regression?

What makes a moving light move and why progress apparently isn't always forward.

Automated lights have very definitely come of age in the last couple of years having gone through the same stages of growth any organism experiences:- First that infant stage where everyone adores you but you need constant attention to stop you from falling over and hurting yourself; then the 'terrible twos' throwing tantrums and breaking everything; learning to walk on their own without anyone holding their hand and gaining independence from the baby-sitters; they even got through puberty without too many psychedelic experiences. Now you could say they've reached a steady middle-age – solid and reliable, working a 9 to 5 job without complaining.

But does that solid reliability also mean they've become slow and staid? Does having a product that works first time every time inevitably mean it's also boring? Have we lost our excitement with automated lighting and could it be that it's the very fact that they are mature, commoditized products that's causing that ennui?

In those early, heady days of VL-1's and other 'rental-only' products there was an air of mystery surrounding moving lights. Only the select few were admitted to the inner sanctum of the maintenance area to learn how they worked and among the crew there was always that slight ripple of fear in the operation of a show – will everything work tonight? It certainly kept the adrenalin flowing.

And you couldn't buy the products – they cost too much to manufacture, the technology was expensive to get into and the learning curve was steep.

Nowadays we get upset if they don't work, the maintenance area has shrunk dramatically, and anyone can afford to buy an automated light. But have we lost something in the product itself to pay for this apparent progress?

I want to go through some of the issues surrounding manufacturing an automated light designed for mass production and mass use and point out where this may be both good and bad. I will also argue that this process is inevitable in a consumer driven market unless there are connoisseurs prepared to pay a premium for a performance product.

Let's start with control – those early moving lights used dedicated proprietary control protocols designed specifically for automated lighting and its needs and foibles. Nowadays everyone uses DMX-512, and for good reason – DMX-512 is ubiquitous, everyone speaks it, everyone knows how to deal with the cabling and distribution and the hardware is inexpensive. It also works reliably. So, what's wrong with that? Well – DMX-512 is really just too darn slow for automated lighting. It was designed to control dimmers feeding incandescent lamps with slow thermal rise times where a maximum refresh rate of 44Hz was just fine.

That same 44Hz is much too slow for controlling motors smoothly, a typical moving light using stepper motors might want to update those motors every millisecond – i.e. it needs updated data at 1000Hz, that's nearly 25x faster than the 44Hz offered by DMX-512! The motor driver needs to update this quickly so that the moves are smooth and crisp and acceleration ramps are natural looking – that way you can do a 5 minute slow move across the cyc or a snap across stage and the light will respond in an organic, non-robotic manner. In order to get round this mismatch in update rates the moving light has to interpolate values in between the DMX packets and try and predict what the next DMX command will be. *(Figure 1)*

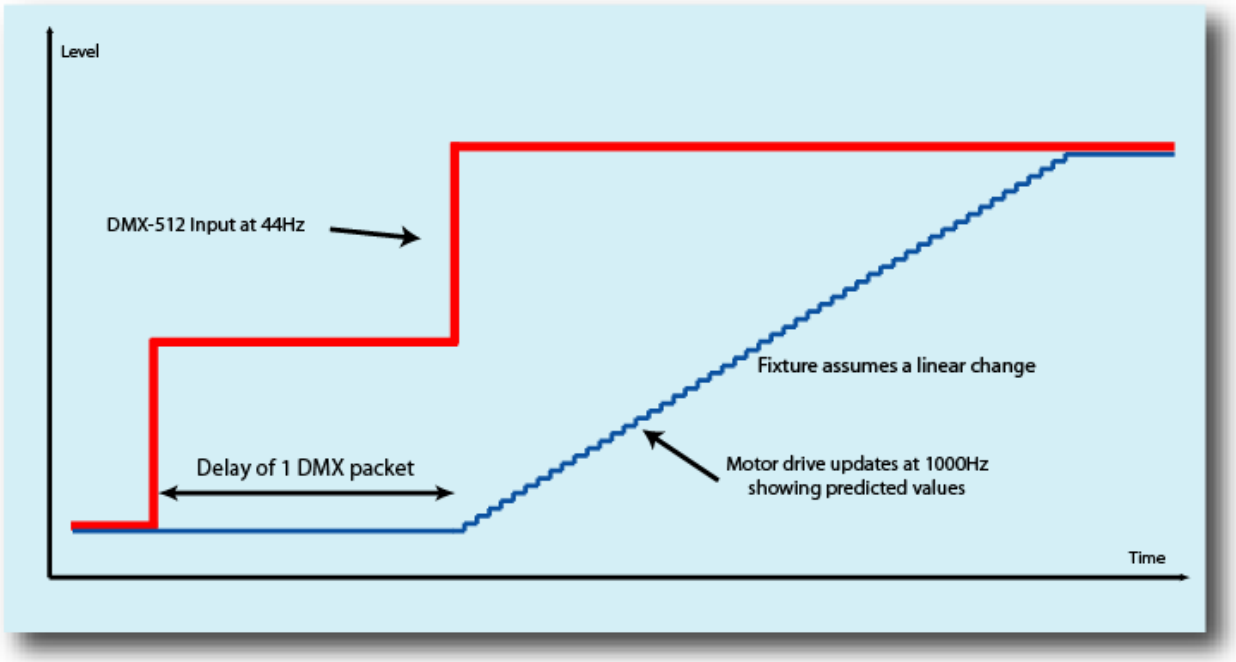

Figure 1: DMX-512 input and motor drive output using linear prediction showing delay

Those prediction algorithms are getting very good and you probably aren't aware they are there most of the time – but they inevitably introduce a small lag in the response. Until the fixture has seen at least two DMX packets it can't predict how fast it's supposed to move, that means at least one DMX packet delay. The alternative to that response delay is to use timing channels (variously called focus timing, MSpeed or Vector by different manufacturers) where the fixture calculates all the intermediate positions internally and just uses DMX for the end points. That works fine but introduces problems of its own. Using timing channels means more programming and forces the designer to use linear moves. You can't do a profiled move using linear timing channels.

Arguably using a control protocol designed specifically for moving lights could alleviate some of these issues but that was the situation before we all chose to adopt DMX-512! The pluses of universal control perhaps outweigh the minuses.

Although most noticeable in pan and tilt – the same argument applies to every parameter in the fixture. If you want to be able to smoothly rotate a gobo from one position to another then 44Hz doesn't cut it.

These problems arise whatever kind of motors you use and that brings us to the next point of discussion. Servos or steppers? Each has their advantages and disadvantages – some early moving lights used DC servos motors and with good reason – they are inherently smooth and, because they usually have an integral feedback mechanism, always know where they are. This feedback mechanism can be either *absolute* or *relative*. *Absolute* mechanisms report the precise position of the system at all times while *relative* systems, as their name suggests, report the position relative to some point – usually the 'Home' position. If they are the *absolute* type (such as a potentiometer) then the fixture will not need a 'homing' or initialization process whereas the *relative* systems (such as optical encoders) need some kind of physical 'Homing' to establish their fixed start point. With either type of feedback the fixture will automatically correct any errors if the unit gets knocked out of position. Servo motors are designed for exactly this kind of application and, you would think, are the obvious best choice.

However stepper motors also have their advantages – they are much simpler and more reliable, they are easier to make tolerant of high temperatures and, probably most significantly, they are dramatically less expensive than servo motors. That difference in cost can't be ignored; it can be a factor of 10x – 20x or even more. There's a penalty to be paid for this though – stepper motors, as their name implies, step (surprise!) and we don't want to see steps – we want to see smooth, silky movement. The most common use of stepper motors outside of the entertainment industry is in printers, photocopiers and fax machines and the users of those devices don't care about smooth movement – they just want cheap and reliable. That means a lot of work behind the scenes by the automated light manufacturers trying to smooth out those steps so you can't see them.

These problems get worse as the fixtures get heavier – we started out with 250W and 400W moving lights but now the most common workhorse products are 1200W units with a corresponding increase in size and weight. In addition they have more gadgets and gizmos inside – more gobo wheels, more color wheels, more everything giving another increase in overall weight. All these extra features are positive and useful additions to the LD's arsenal – but now we have a 60lb head that we would like to move as quickly and as accurately as the old 30lb one without breaking anything. The manufacturer has to err on the side of reliability and repeatability and so we see an inevitable reduction in movement speed.

The need for higher and higher output has other side effects too – as the light source gets bigger the size of the optical systems has to increase proportionally – thus gobos and irises get larger and lenses have to increase in complexity to try and obtain the same quality of focus. Bigger gobos can mean slower gobo changes and slower gobo spins – add to that size increase the increase in gobo weight caused by going from static to rotating, from metal to glass, from single color to full color and you have an assembly that you just cannot move as quickly as you used to. But would we be happy with a return to small, static, metal patterns just to get those snappy changes? Some would say yes, however many more would disagree.

Another area worth mentioning is color – Mats Karlsson's article in the August issue of this magazine described the development of color mixing mechanisms. You can see from the photographs in that article how complex some of these mechanisms are – especially when compared to a simple color wheel. Again, are we willing to put aside the ability to mix any color we want in order that we can change between limited numbers of colors nearly instantaneously? Pretty much nothing can bump colors as quickly as the early moving lights with their simple fixed color wheels – but would we buy something that limited today?

Large light sources + large apertures + large wheels = slower movement

So now we have reached a point in the evolution of automated lighting fixtures where there is an expectation of a certain performance and quality – no matter who the manufacturer is. A few years ago one valid reason for choosing Manufacturer A over Manufacturer B was that Manufacturer A produced a product that you knew would work and would survive the tour while Manufacturer B's product would fail the first week. Nowadays you can reasonably assume that every manufacturer has reached a certain quality level – they all work and they will all survive. What's more they will all do a very reasonable job at lighting your production!

As in any emerging industry demonstrably bad ideas have been discarded while the good ones have perpetuated and spread. It's very much a Darwinian evolution – only the fittest survive. This means an inevitable leveling out of fixtures – they all work pretty much the same way and offer similar basic functionality honed down by this natural selection to suit 95% of the user population 95% of the time. This is a symptom, good or bad, of a maturing commodity industry. Of course each manufacturer and product has something to distinguish it – but those distinguishing features quickly get evened out.

To take an analogy with consumer level cars – we expect all cars to work. They all have the same basic functions and they all perform those functions well. We have a level of expectation with reliability that just about all cars meet. They all look much the same and they are in many ways interchangeable. And, frankly, most cars are boring!

Where this analogy breaks down is that you *can* buy an exciting car – the market is large enough that it can support niche products aimed at a tiny fraction of the total market. For example even a tiny portion as small as 0.1% of the annual $500 Billion automobile market is still $500 Million and that's worth having! However that same 0.1% of the annual moving light market is less than $1 Million a year and not a very attractive business proposition. It's difficult to justify a sports car, high performance, moving light product on those figures.

In the same way as with cars it is certainly true that you could produce a high performance unit with enhanced functionality where the fixture mechanics are pushed to the limit - but I'm not convinced we are willing to pay the price – in cash or maintenance to justify this.

Are the manufacturers of automated lights holding back on performance in favor of reliability and a low price? Yes, of course they are. But they are only doing it because that's what the market wants and is willing to pay for. The real selling price of moving lights today once you take account of inflation is something like 50% of what it was in the early 1990's – again this is a typical result in a maturing industry moving towards commoditization.

Maybe a prestigious touring production would like a customized high performance product. And maybe they'd accept a higher rate of breakdowns in the same way that sports car drivers do. But frankly, I'm skeptical, I suspect that the LDs would scream like mad if the fixtures broke down – and with good reason. This is where the analogy with cars really breaks down. People love cars for their own sake; they become an object of desire disconnected from any job or task they perform. However a lighting fixture is always a means to an end – it's a way for the lighting designer to express his creativity and paint his vision on the stage. A light is a tool – pure and simple; and you want your tools to work, and work always, no exceptions.