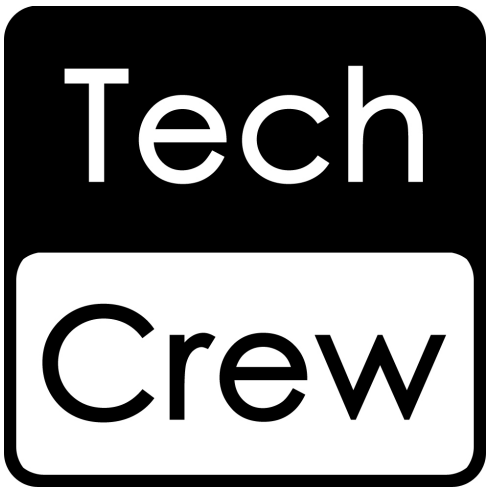
University of Warwick Tech Crew Society

Technical Guides



Basic Lighting Information

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The following Guide looks at the basics of modern lighting. It will briefly cover everything from what is a lantern up to how to address a rig with dozens of generic and moving lights on it. It is a general overview designed to introduce Tech Crew members to the sorts of lighting equipment you are likely to find on the shows and events we work on.

What is a Lantern?

A lantern is a device that emits light. Lanterns, for our purposes, come in many shapes and sizes but can be roughly grouped into the following types:

Lantern Type	Example	Information
Profile	 ETC Source Four	Capable of producing a hard edged beam that can nicely be used for the projection of shapes and logos. A standard profile has a fixed beam angle, which means that the light emitted from the lantern is at a fixed angle.
Zoom Profile	 ETC Source Four Zoom	Capable of producing a hard edged beam that can nicely be used for the projection of shapes and logos. Zoom profiles have an additional lens which gives them a variable beam angle meaning that any angle within a certain range can be achieved. For example the beam angle of an SL 23/50 ranges between 23^{o} and 50^{o}.
Pebble Convex (PC)	 Pebble Convex	A PC produces a very even light due to the type of lens it uses. The lens appears to be covered in pebbles and can produce both soft and hard edges. Beam size can be controlled and a barndoor can be attached to give control over the beam shape. A PC is widely regarded as slightly more versatile than the Fresnel as you have more control over diffusion with the PC (You can achieve the same effect as a Fresnel by adding the correct diffusion filter.)

Fresnel	 Fresnel (Shown with Barn Doors)	A fresnel lens appears to be frosted, with a series of concentric rings across it. The light produced is soft and perfect for creating washes across a stage. You have control over the beam angle and can shape the light through the use of barn doors.
Flood	 Standard Flood	This creates a general illumination of a large area. One of the simpler lanterns containing only a reflector and a lamp. Focussing a flood merely involves pointing it in the right direction. The size of the area covered by the beam is determined by the distance to the floor (or object). Main use of a flood is in the lighting of large areas of scenery, for example a sky, where selectivity is not an issue.
Cyclorama Flood	 A 4-Compartment Cyclorama Flood	This is essentially identical in design to any other flood except many floods are combined in one unit. The most common application for such floods is for washing cycloramas in multiple colours, hence the naming convention.
Molephay	 A 4-Way Molephay unit	Molephay are most commonly used as crowd blinders during band events. They are very bright and act much the same way as a flood by just throwing light everywhere. It is possible to attach barn doors to them in order to restrict their beam angle. Other than that pointing the unit in the right direction is the only focussing choice available. Molephay come in different sizes based on how many lamps they have. The 4 lamp unit is pictured.
Parcan	 Par Can (Shown in black)	Comes in a few varieties (determined by the lamp used) and is good for a large uncontrollable wash. This is probably the simplest of lanterns being merely a lamp and metal casing. There are no additional controls for focussing (With the exception of turning the lamp) you can merely point it where you want the light to go. Par Cans are standard for live band events.
Floorcan	 Floorcan (Shown in Black)	Smaller companion of the parcan that is designed to be placed on the floor. It has 2 adjustable yokes to facilitate this.

Birdie	 Birdie (Shown in Aluminium finish)	Miniature version of the parcan that can easily be attached to set.
Follow Spot	 Robert Juliat 'Cyrano' Followspot	This is similar in design to a profile but is mounted on a stand so that it can be moved by an operator to 'follow' what is happening on stage.
Intelligent Lights	 Martin Mac 250 Entour Moving Head (Profile)	There are a wide variety of intelligent lights available. The two most common types are differentiated as either moving heads or scanners. Moving Heads move the entire lamp and attribute housing while scanners have a mirror which moves reflecting light in different directions.
Strobes	 Martin Atomic 3000 Strobe	Worth mentioning these separately. They create a fast pulsing white light that creates a strong lighting effect used widely in clubs.

Rigging Lanterns

Rigging lanterns is better learnt as a practical exercise, but there are a few key things to remember:

- Always check that a lantern is functional while on the ground. You are better off finding out if it is faulty at this point than when it is suspended from the grid.
- Ensure that the lantern is firmly attached to the grid and that clamps are fully tightened so that the lantern can not move from its position. Though do not over-tighten the clamp.
- Safety chains must be attached to all lanterns. If for some reason a clamp comes loose this will prevent the lamp falling and landing on someone! In addition, safety chains should be attached with the minimum slack necessary (You need some slack to permit focussing) as this will reduce the shock on the safety chain if the lantern were to fall. Sudden shocks can snap a chain so

reducing this shock is important. Ensure that the safety chain loops around the bar being rigged off but does not go over any cables.

- Most lanterns have a correct way up – ensure the lantern is rigged correctly.
- If appropriate open any barn doors or shutters on the lantern.
- Once you are satisfied that the lantern is securely fixed and ready, you should connect it to the appropriate power outlet.
- If in doubt at any point ask someone as it is important that all of the above is done properly.

Cabling

The type and amount of cabling you will use in a show will vary depending on the venue in which you are working. Permanent venues will require relatively little cabling as most of the connections will have been pre-wired into the grid. For other venues it may be necessary to lay all the cabling.

15A Cable - This is similar in design to standard household 13A cable except for the fact that the plug will have rounded instead of square pins. However, the two cables are different as the 15A cable has a greater power rating than the 13A. The result of this is that more current can be drawn down the 15A cable. There is also another important difference in that 15A plugs do not contain fuses. In order to aid maintenance, fuses (or circuit breakers) will be at the power source (This will be looked at further later in this guide.)

15A Plug

15A Socket

16A Cable - This has a different type of connector from the 15A style of cable in that the connector is cylindrical. It still has 3 pins but these are contained within an outer cylinder. This type of connector is referred to as a Cee-Form. 16A Cables can be used safely outside as opposed to the 15A cables (which although can be) should not really be used outdoors as they are not waterproof.

16A Plug

16A Socket

These are the common cables you will come into contact with. However, power is distributed from higher rated supplies and you will find 32A cable and 63A cable in

common usage in venues. The connectors for these supplies are similar in style to the 16A, but larger.

16A Connectors are blue in colour. This denotes that they are single-phase connectors. With 32A and 63A Connectors you will commonly find both red and blue versions. The blue still indicates single phase but the red means that the cable carries three phases. While the difference between the two goes well beyond the scope of this guide suffice it to note that three phase cables effectively carry a mains supply three times the size of single phase.

You will not deal with these higher rated power supplies or three phase power as part of Tech Crew unless you have a good working knowledge of power supplies.

Multicore Cables

Where many cables must travel long distances it is common to use what is known as a multi-core. Lighting Multi-core – either SocaPex (often referred to as just 'Soca') or Lectriflex, will normally carry the equivalent of 6 individual cables. Using a multi-core is a far more tidy and efficient way of cabling over long distances. At the end of a multi-core you will require a 'break-out' to decompose the cable into its 6 individual pieces for connection to the lanterns. You can get both 15A and 16A break-outs (also known as a spider) for connection of different lanterns and fixtures.

	
Socapex Plug and Socket.	Socapex Breakout (or Spider)

Where intelligent lights are attached to the grid you will also need to run DMX (See explanation of DMX later in this guide) cable around the grid. This can be done as a 'daisy-chain' between each intelligent fixture.

Cable Safety

Be careful not to leave a cable coiled when it is in use, doing so can cause induction and lead to a build up of heat and result in fire. If you have an excess of cable lay it in a 'figure-of-eight' style to avoid this.

If you are required to lay cable across a public access route you must be aware of cables being a trip hazard. Where appropriate you should use a 'walk-over' strip to

conceal cables or use gaffa tape to neatly stick the cables to the ground. Use of hazard tape to highlight this is also advised.

Fuses and Circuit Breakers

A fuse is designed to be the weakest component in a circuit. If too high a current is drawn by the device connected to a power outlet then the fuse will melt breaking the circuit. Unlike domestic 13A plugs, cabling used in theatres does not contain fuses. In order to facilitate maintenance all fuses are located centrally at the power source e.g. the Dimmer.

A circuit breaker does a similar job to a fuse in that if the current being drawn is too high then it will 'trip' and break the circuit preventing any damage. However this is where the similarity to the fuse ends. There are two types of circuit breaker worth noting here;

- The RCD (Residual Current Detector) – This monitors the difference in current between the live and neutral cables. If the difference exceeds a certain limit then the breaker will 'trip' and break the circuit. This device is there to reduce the risk of electrocution. If for example you were to cut through a cable then an RCD would detect the difference in current now flowing down the neutral and break the circuit, hopefully saving your life.
- The MCB (Miniature Circuit Breaker) – This monitors the total current being drawn down a cable and if a certain limit is exceeded then it will 'trip' and break the circuit. This device does the same job as a fuse but if it 'trips' it can be easily reset unlike with a fuse that must be replaced.

Dimmers

This is where the difference between generic and intelligent lighting becomes important. All of the lanterns mentioned above are generic except for the strobe and intelligent lighting categories. Generic lights are controlled by dimmers, intelligent lights are not. A dimmer controls the amount of power sent to a lantern and as a result controls the brightness of the lantern's lamp. Dimmers are supplied directly with power from the mains. This power is then distributed by the dimmer to the lanterns as it is instructed.

Dimmers can be 'patched' which means that you can connect a lantern to a specific channel to simplify control. Dimmers vary a lot therefore it is more of a practical task to learn how to patch a dimmer.

Depending on the dimmer it will be controlled in one of two ways. Newer dimmers are digital and controlled via a control cable called DMX. Older dimmers still operate on an analogue system and are controlled using analogue cabling. Analogue and digital are explained later, but suffice it to say that there are two possible control methods.

Each channel on a dimmer will have a maximum 'load' which means that only a certain amount of power can be drawn through it. Every lantern will have a power rating based on how much it draws when fully on. You can attach lanterns to a dimmer up to this maximum load level. The physics/maths bit:

In a simple sense you have current (Amps) and voltage (Volts) in an electrical circuit. The current is the number of electrons in the circuit, while the voltage is the speed at which the current flows. Power is measured in Watts and is calculated using the following formula:

Power (Watts) = Current (Amps) x Voltage (Volts)

All lanterns have a power rating, in the case of a Par 64 with a CP62 lamp in it this is 1000 Watts (1000W) or 1 Kilowatt (1kW). Mains voltage in the UK is around 230/240 Volts so this lantern will draw a current of around 4 Amps (4A). Now most commonly dimmer channels are rated at 10A which means that you can safely attach two par cans to this dimmer channel however 3 would overload the channel and cause its circuit breaker to trip or fuse to blow.

Lighting Desks

This is how you control all of your generic and intelligent lights. The desks you will come into contact with working for Tech Crew should all be DMX desks which means that they send out signals to control the lights via a cable which has 512 channels on it (DMX is explained below). The desk will control the output from the dimmers, and thus controls the lights.

Desks vary considerably and you will find that some desks are better suited to different tasks. Operation and programming of desks will be explained as you come into contact with a particular desk. For details of desks used in the various venues you should consult our venues guide. The two main types you are likely to come in contact with as part of Tech Crew are the Avolites Pearl series desks and the Strand 500 series desks.

Analogue Versus Digital

Digital control of lighting equipment is the newer way of thinking and is gradually becoming the normal thing to find. However you will still find analogue control systems, particularly when it comes to Dimmers. Some older lighting desks also still incorporate analogue control output, though this is becoming increasingly rare.

Analogue

Analogue control systems work by varying the voltage being carried down a cable. This variance can then be detected by receiving objects and the appropriate

action taken. For example a dimmer would interpret the voltage changes and translate that into lantern intensities (or at least output level). The usual way of setting this up is to have a 'fully off' setting of 0V and a 'fully on' setting of +10V, with other intensities lying in between (One notable exception to this is Strand).

Analogue control cables have 6 channels which means that you can control 6 items with one cable. For example you can control the 6-ways of a dimmer with one analogue cable. A standard analogue signal cable is shown below.

A Bleecon Analogue Signal Connector

Digital

Digital control is by a system known as DMX, which is explained later in this guide. While DMX is not the only protocol that can be used for digital control it is by far the most common and you are unlikely to come into contact with others that easily.

A digital signal cable being used in conjunction with the DMX protocol can have 512 channels running down it due to the time divisions used as part of DMX. 3 pin and 5 pin DMX cables are shown below:

	
3 pin DMX Cable	5 pin DMX cable

Conversion

A number of devices, mostly dimmers, still require analogue control input. Lighting desks outputting digital signals still often need the ability to control these analogue devices and thus converting from digital to analogue signals becomes necessary. Converting from digital to analogue is achievable by way of a device known as a De-Multiplexer, or Dmux. A Dmux takes the digital signal provided down a DMX line and converts it to an analogue signal which can then be sent out down a series of Analogue cables.

Lighting Effects

A number of the effects that will be mentioned below are not going to be explained in great detail as they are better explained to individuals as they are encountered.

Gels

Gels are used to change the colour of a generic lighting fixture. Gels are a form of thin plastic that allow certain parts of the light spectrum to pass through. This results in coloured light as opposed to white light. Gels usually slot into a frame which in turn slots into a pre-defined space on the lantern. There is usually some sort of mechanism in the light to ensure the gel frame can not just fall out.

Gels come in many, many colours. The most common supplier that Tech Crew uses is Lee Filters and you'll probably see one of their swatches of gels appear at a production you work on.

	
Gels	Lee Swatch Book

Gobos

Gobos are used to project an object, using a light. They are similar in idea to a stencil, in that when you shine a light at it, some of the light is blocked thus creating a shape. For example you could project the tech crew logo using a profile and an appropriate gobo. Gobos can be custom made – and a popular company for this service is DHA.

Commonly you will find gobo's made of thin metal, however more complicated designs can be found on glass, and can even be done in colour.

An Example Metal Gobo

Animation wheels

An animation wheel can be attached in front of a profile (or some other lanterns) and depending on the type of wheel will create an effect out of the light. You can for example create fire or water effects using such an animation wheel.

Barn Doors

Barn Doors are used to restrict the amount of light coming out of the lantern. They sit at the front of the lantern and can be adjusted to allow as little or as much light through as is necessary.

It is important to ensure that barn doors are closed when a light is in transit.

Colour Scrollers

A colour scroller can be attached to some lanterns and contains a number of colours that can be scrolled round to change the colour being emitted by a lantern. Using a colour scroller means that you can use a number of different colours without having to use a different lantern for each. A few lanterns with colour scrollers could replace the job of a dozen lanterns.

Intelligent Lights

Intelligent Lights are based on the same principles as generic lights but are far more versatile. There are two main types of intelligent light; Moving Heads and Scanners.

Moving Heads

A moving head light is named because the lighting fixture can be panned and tilted (i.e. the beam direction can be changed without having to move the light manually). However, moving head lights will normally have many other attributes to it; colour changing (in some cases full colour mixing), gobo changing and spinning, prism effects, focussing, and even animation effects on some more advanced models. A moving head could easily replace the job of a few lanterns but at a high price. The Martin MAC range starts from about £2000-£3000 per fixture going up to about £12000 for their best moving heads. Compare all this to the £30-£40 you would pay for a Par Can and you begin to see the cost comparison.

Its also worth noting that for theatrical purposes moving heads can be quite noisy because of the large fans they need for cooling.

Martin MAC 250 Entour is an example of a moving head fixture.

Scanners

Capable of producing some similar effects to a moving head, a scanner uses a movable mirror to point light where it is desired. Scanners will normally incorporate colour changers and sometimes gobo changers like a moving head. A scanner is capable of producing a much faster pan/tilt than a moving head because it has far less to move.

Martin MX-10 Scanner

Rigging Intelligent Fixtures

Rigging of intelligent lights is not always a one person job. Intelligent lights are heavy, most weigh upwards of about 15Kg per fixture. A MAC 2000 Profile weighs approximately 45Kg! Take care to ensure that you are working in a safe manner when dealing with the rigging of intelligent lights at ground level and especially when at heights. **The most important thing to remember at all times is the safety of yourself and the others working around you.**

In addition, as with generic lanterns, ensure that the clamps are tightened sufficiently and that the safety bond is attached. Once done you can connect the fixture to a power supply. Connections on Intelligent Fixtures are quite often 16A. Then you should connect the DMX input. In most cases you will also have a DMX output to connect as it is usual to daisy chain the DMX between intelligent fixtures. Also, as strange as it sounds, check that you switch the fixture on at this stage.

Control

Control of an Intelligent light is different to a generic lantern. Separate dimmers are not required for intelligent lights because they will have their own built-in alternatives and so a control desk can not control an intelligent light through the normal way. DMX is used to directly control the attributes of a moving head. Power is

supplied to each individual fixture along with the DMX input. A suitable desk can then be used to control your intelligent lights.

DMX

DMX (Digital Multiplex) has 512 channels per line, which means that one DMX cable is capable of sending data to 512 individual lighting fixtures. However, this is not quite the whole story. Intelligent lights require more than 1 channel to run properly. For example a MAC500 requires between 12 and 16 channels to control all of the various attributes of the fixture.

Generic Lights and DMX

Obviously, the lights can not be directly controlled by the DMX line. The dimmer output must therefore be controlled in order for the desk to control the lights. The Dimmers will be attached to the DMX line coming out of the Lighting desk, and will be set to accept input from this, or as discussed earlier the DMX line may send signals to a dimmer via a DMux.

Intelligent Lights and DMX

Unlike a generic light an intelligent light has its own power supply and built in controls for dimming. Intelligent Lights take their instructions directly from a DMX line and will be set up to take input from the DMX channels you tell it to use. The common way to do this is to give the light a starting address (The address of the first DMX channel you wish it to use) and then the fixture will automatically take input from the next channels up to the total number it needed. So if you gave a MAC500 a starting address of 1 then it would accept input from channels 1 – 16. You would then set up the next fixture to start at address 17 so that there is no overlap.

Different types of intelligent fixture require certain numbers of DMX channels. While the MAC500 requires 12-16 channels a MAC600 requires only 10-14. On most lighting fixtures the number of channels used can vary. For example with the MAC500 you can use 12 or 16 channels. This is a mode dependent setting which is set on the fixture and means that the light can be controlled in two slightly different ways. In this case the difference accounts for how fine the control of pan and tilt is for the fixture.

DMX Cable

You connect up all of your various fixtures and dimmers using DMX cable. It comes in two varieties 3-pin and 5-pin, distinguishing the number of connection pins that can be found on the connector. Though 5-pin is the true DMX standard, two of the pins (pins 4 and 5) are rarely used and thus quite often ignored. Both types of

connector are cylindrical and have the pins (or slots for them) located inside an outer guard. DMX cables can be daisy-chained together as the connectors will connect up to each other. The 3-pin variety looks the same as what you may know as XLR cable (or microphone cable) and although XLR can be used for control of lights this is not ideal (and soundies tend to get annoyed when you start stealing all their cable!)

The End of a DMX line

A DMX line, like any other data transmission line has a maximum theoretical length before the signal will begin to degrade. With DMX this length is 1500 metres, however because you get a decrease in signal strength when you encounter a lighting fixture, you should not use a single DMX line for more than 32 fixtures.

A DMX line does not form a circuit, in that it does not return to the lighting desk at the end of the chain. Therefore at the end of a DMX line you also need a terminator. A terminator stops the DMX data from bouncing back on itself and travelling the opposite way back down the cable. Such an 'echo' effect can cause problems for the lights and they may exhibit strange behaviour due to receiving conflicting DMX information.

The DMX Universe

Although initially it may seem that one DMX line and its 512 channels seems inexhaustible, this is quite quickly not the case when you introduce intelligent fixtures which use many channels. There is also the limitation to consider of only being able to handle 32 fixtures before the DMX signal has degraded too much. Large lighting rigs need more than one line can offer and this is achieved by using multiple DMX lines which are referred to as different DMX universes. Many lighting desks are already designed to handle multiple universes, for example the Avolites Pearl series can handle 4 DMX universes i.e. 2048 channels. Newer, more complicated desks can control even more channels.