B&W PRODUCTIONS · CREW TRAINING · MODULE 4

Lighting Basics for Event Crew

What each light does at an event, the fixtures you will meet, how colour and DMX work, how to cable and power a rig, and how to hang it safely. Written for beginners. Read it, work through the two tools, then pass the quiz.

B&W Productions · Proper Planning, Prevents Poor Performance



01 What lighting does at an event

Lighting is not decoration. It decides what the audience looks at, how they feel and whether the CEO's face is visible when he speaks. Before you touch a fixture, know the job each light is doing. Every light in a rig has one of four jobs.

KEY

The main light on a person's face. Bright, white, from the front and above at about 45°. If the speaker cannot be seen, nothing else matters.

WASH

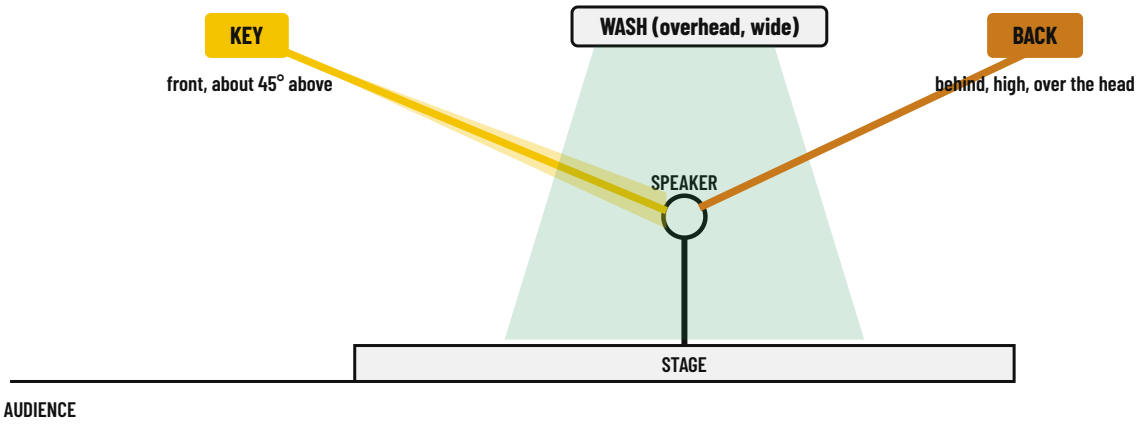
Even colour across the stage or a wall. Sets the mood and the brand colour. Soft edges, no hard shapes.

BACK

From behind and above. Puts a bright rim on the head and shoulders so the person lifts off the background. Never points at the audience.

EFFECT

Beams, gobos, strobes, moving patterns. Energy for music and entertainment. Rarely used during speeches.



Side view. The key lights the face from the front. The back light separates the person from the set. The wash fills the stage with colour.

Haze

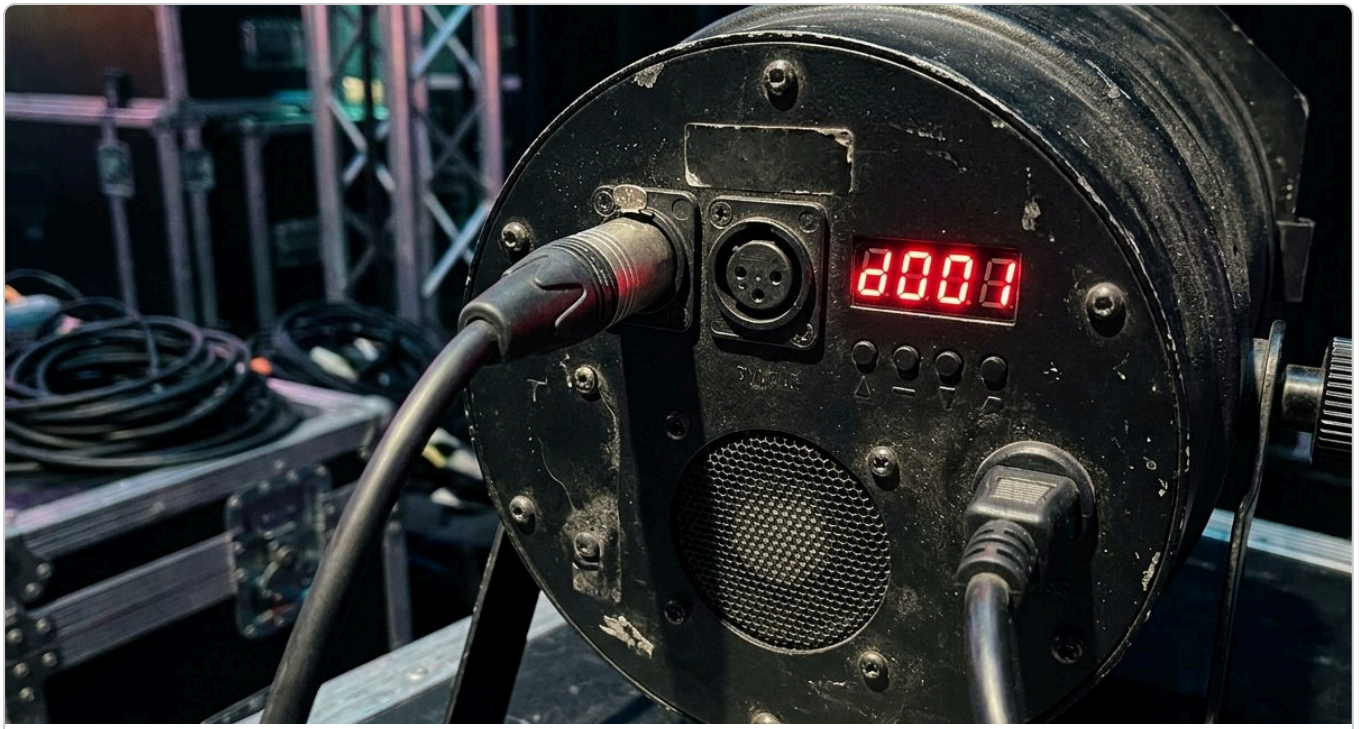
A beam of light is invisible in clean air. A haze machine puts a thin, even mist in the room so beams show up as solid shafts. A little haze makes a plain rig look twice the size. Too much hides faces and sets off smoke alarms. Ask the venue before you use it, and never run it near a smoke detector.

The three questions

1. **Who must be seen?** Speakers, MC, award winners. Put a key on every one of them.
2. **What mood?** Warm and soft for a dinner, bold brand colour for a launch, fast and bright for a party.
3. **What moves?** Nothing during a speech. Everything on the dance floor. Movement pulls the eye, so use it on purpose.

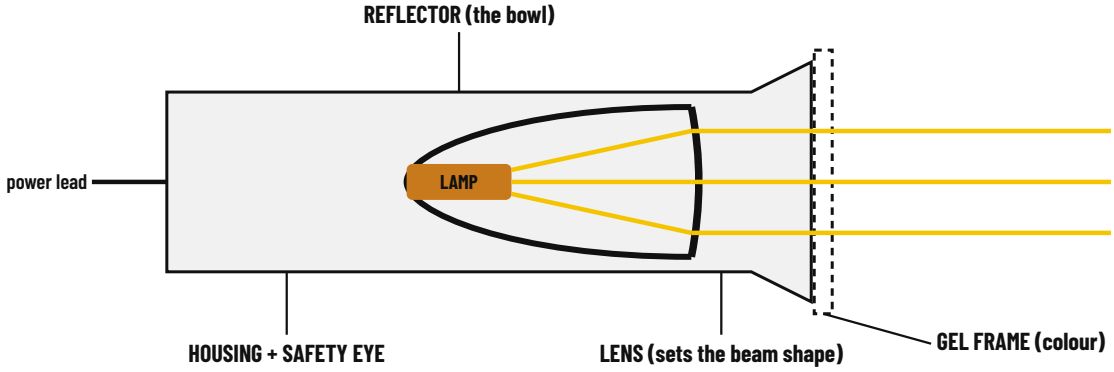
> **FIELD RULE**
> Light the people first, the set second, the effects last. If you only have power for one thing, it is the key light on the speaker.

02 PAR cans



The back of an LED PAR: DMX in, DMX out (thru), the address display and power. Set the address here before it goes up on the truss.

The PAR can is the workhorse of event lighting: a simple fixture that throws a round wash of colour. It is the first light you will rig. PAR stands for **parabolic aluminised reflector**: a bowl-shaped mirror behind the lamp that gathers the light into a beam.



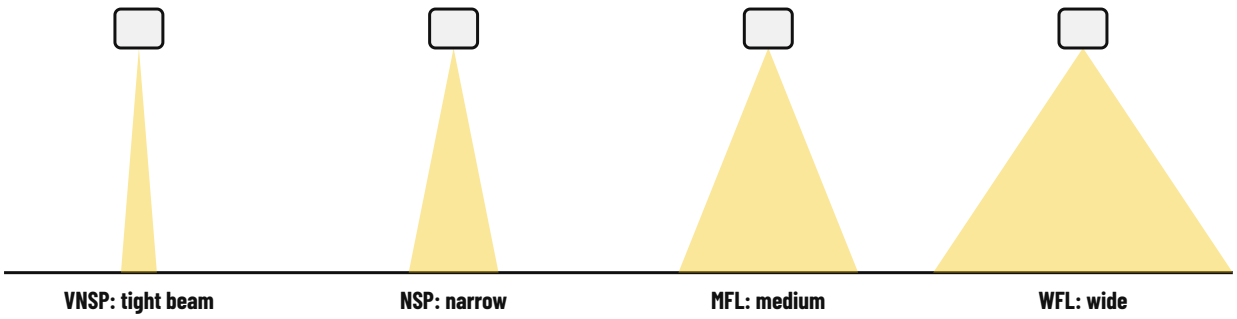
Cutaway of a tungsten PAR can. The lamp sits in the reflector. The lens and the reflector together decide how wide the beam is.

Tungsten PAR 64

The classic. A 1 kW lamp inside a heavy aluminium can. It gives a warm, bright light and needs a **dimmer** to control it, because the lamp has no brain of its own. Colour comes from a gel, a heat-proof plastic sheet in the front frame. It draws about **4.3 A** each (1 000 W ÷ 230 V). The can is too hot to touch for 15 minutes after switch-off.

The lamp type sets the beam. The names are on the lamp or the lens:

CODE	NAME	BEAM (ROUGHLY)	USE
VNSP	Very narrow spot	about 6°	Tight, punchy beams for haze. Long throws.
NSP	Narrow spot	about 10°	Strong beam, small pool.
MFL	Medium flood	about 24°	General purpose. The one you see most.
WFL	Wide flood	about 50°	Wide wash from a short distance.



Same height, same distance, four lamps. A narrow lamp reaches far and gives a small bright pool. A wide lamp gives a big soft pool.

LED PAR

The modern replacement. A bank of LEDs behind a lens. Typical draw is **100 to 200 W**. No dimmer pack, no gels, no heat to speak of. The LEDs mix their own colour and you set it over DMX. Common types:

- **RGBW**: red, green, blue and white. Good all-round colour and a clean white.
- **RGBWA+UV**: adds amber and ultraviolet. Warmer skin tones and a blacklight effect.

In the B&W kit: LED PAR cans, moving heads and uplighters. Standard event lighting is LED PARs with moving heads on top.

WHEN IS TUNGSTEN STILL USED?

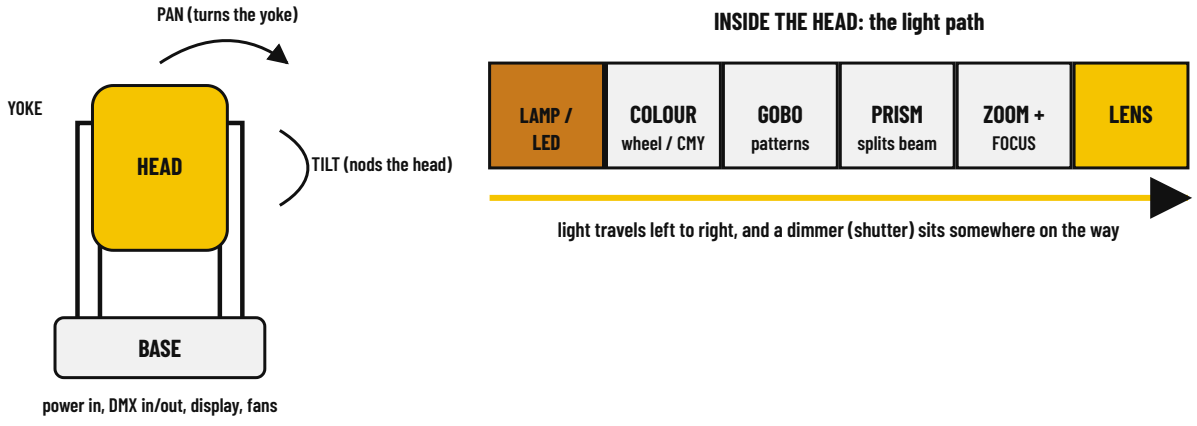
For a warm, true-white key on a budget, for old rigs, and where a client wants the classic hot-lamp look. Everything else is LED, because it is cooler, lighter and cheaper to power.

03 Moving heads



Clamp tight, safety bond on, then power. The bond is there for the day the clamp isn't.

A moving head is a fixture on a motorised base. It pans (turns), tilts (nods), changes colour, shape and focus, all on command from the desk. One does the work of ten static lights. It is also the most expensive and delicate thing on the rig.



Left: the three moving parts. Right: what the light passes through before it leaves the front.

Four types

SPOT

Tight, sharp beam with gobos and a prism. Good for logos on a wall and patterns on the floor.

WASH

Soft, wide, smooth colour. No gobos. A wash head replaces ten PARs.

BEAM

A very narrow, intense pencil beam. Made to be seen in haze. Dramatic from far away, useless for lighting a face.

HYBRID

Beam, spot and sometimes wash in one body. Flexible, but heavier and dearer.

Channels

Every function on a head needs a DMX channel: pan, tilt, dimmer, colour, gobo, zoom and so on. A typical head uses **16 to 24 channels**. Many have a reduced-channel mode. You choose the mode in the fixture menu (next lessons). A fixture set to the wrong mode behaves wrongly, even if the address is right.

Addressing and homing

Set the **DMX address** on the fixture's display or dip switches. When the head is powered, it **homes**: it runs a self-test, spinning to the end stops and back. Wait for it to finish before you send it anything. A head that never finishes homing has a fault. Note it and swap it.

> **NEVER MOVE A POWERED HEAD BY HAND**
> The motors and belts will strip. Switch it off, then move it. After switch-off, leave the fans to run, or wait 5 minutes before you pack it. A lamp-based head restarted while hot will blow the lamp.

In the B&W kit: moving heads are part of the standard event lighting package, run alongside the LED PAR cans.

04 Other fixtures you will meet

A PAR and a moving head cover most jobs. These are the rest. Know them by sight so you can pick the right one and rig it safely.

LED BAR / BATTEN

A long strip of LEDs. Washes a wall, a backdrop or the front edge of a stage from the floor.
Use for: cyc wash, stage edge, under tables.

BLINDER

A bank of bright warm lamps. Hits the audience with a wall of light. Very bright.
Use for: big moments in a party. Never aimed at faces for long.

STROBE

A very fast flash. See the epilepsy warning in lesson 10.
Use for: short, announced effects only.

FRESNEL

A soft-edged theatre light with a lens you can focus wider or narrower. Soft, flattering and quiet.
Use for: stage washes, speaker key light.

PROFILE (LEKO)

A hard-edged spot with shutters. You can shape the beam to a doorway or a lectern and project a gobo.
Use for: a clean key light on a lectern, logos.

FOLLOWSPOT

A big manual spot with an operator. The operator keeps the beam on a performer or speaker as they move.
Use for: awards, concerts, big presenters.

UPLIGHTER

A small LED fixture on the floor, pointed up a wall or column. Often battery powered with wireless DMX.
Use for: room colour in brand colours.

FESTOON

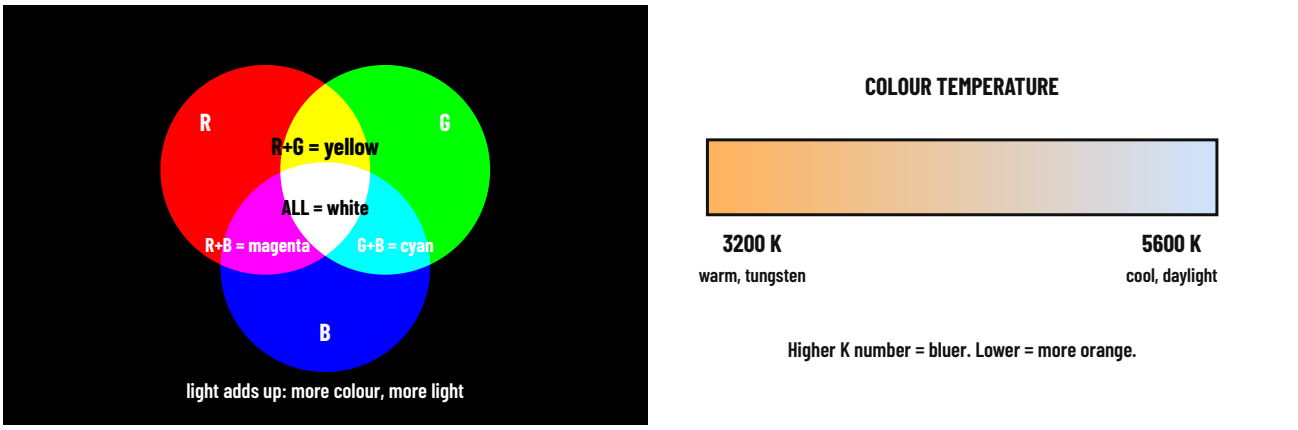
A string of lamp holders, like party lights. Warm and informal.
Use for: marquees, gardens, weddings.

In the B&W kit: LED PAR cans, moving heads and uplighters. Other fixtures are hired in when a job needs them.

> **FIELD RULE**
> For a corporate stage, a profile or fresnel with a white lamp, or an LED engine with a good white, beats a coloured PAR for lighting a speaker's face. Colour is for the set.

05 Colour

You will be asked for "our brand blue" and "a warmer white". Know why LEDs mix as they do and why one white is not the same as another.



Left: how LEDs make colour. Right: why two "whites" can look different side by side.

Additive mixing

An LED fixture has red, green and blue emitters. Red and green make yellow. Red and blue make magenta. Green and blue make cyan. All three make white. It is the opposite of paint: more colour means more light, not less.

A fixture made from only RGB gives a slightly cold, greenish white. **RGBW** adds a real white LED, so whites and pastels look clean and skin looks natural. That is why the white channel matters on a key light.

Colour temperature

White light comes in warm and cool versions, measured in kelvin. Tungsten lamps are about **3 200 K** (warm, orange-white). Daylight is about **5 600 K** (cool, blue-white). Mix them in one scene and one looks dirty. Pick one and stay with it.

Gels, CTO and CTB

Tungsten lights get colour from gels. Two correction gels matter. **CTO** (colour temperature orange) warms a daylight source down to tungsten. **CTB** (colour temperature blue) cools a tungsten source up to daylight. Use them to match a light to another.

> **CORPORATE RULE**
> Brand colour goes on the uplighters and the set. White goes on the faces. A speaker lit in brand blue looks ill, and a client's CEO will notice.

06 DMX explained properly



5-pin DMX XLR



3-pin XLR (many LED fixtures)



powerCON (mains in / link)

DMX uses 5-pin or 3-pin XLR; the cable should be 120 Ω data cable, not mic cable. powerCON carries 230 V between fixtures, within the limit printed on the fixture.

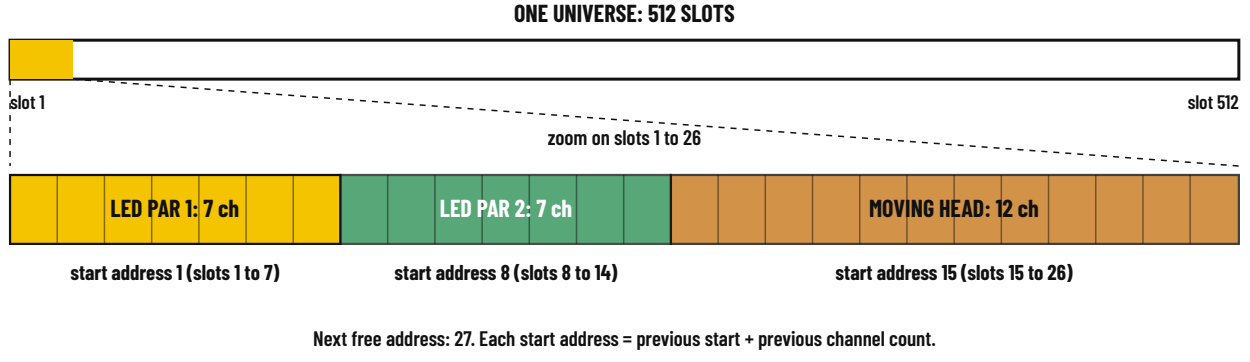
DMX is the language that lighting desks speak to fixtures. Every light you control from a desk uses it. If you understand addresses, you can fix most lighting problems in two minutes.

DMX512 carries up to **512 channels** on one cable. That set of 512 is called a **universe**. Each channel holds a number from **0 to 255**: 0 is off or minimum, 255 is full. The desk sends the whole universe about **44 times a second**. A fixture listens only to its own slots and ignores the rest.

Modes and addresses

A fixture's **mode** is how many channels it uses. A simple LED PAR might have a 4-channel mode (R, G, B, W) and a 7-channel mode (dimmer, R, G, B, W, strobe, macro). A moving head might have 16 or 24. Read the channel list in the manual, then set the same mode on the fixture and in the desk.

The **start address** is the first slot the fixture listens to. It uses that slot plus the next ones, up to its channel count. The next fixture must start where the first one stops, or its slots overlap.



Each fixture owns its own run of slots. Overlap two fixtures and they move together.

THE SUM

Start address of fixture n = 1 + (n − 1) × channel count, when all fixtures are the same type. Seven channels each: 1, 8, 15, 22, 29…

When you need a second universe

A universe holds 512 slots and a fixture is never split across two. Twenty-four 24-channel heads need 576 channels, so they need two universes. Each universe needs its own output from the desk or node and its own cable run. Fixtures on different universes can share the same start address, because they are on different lines.

TRY IT: DMX ADDRESS CALCULATOR

Start addresses: 1, 8, 15, 22, 29, 36, 43, 50

CHANNELS PER FIXTURE	MAX FIXTURES IN ONE UNIVERSE	START ADDRESSES
4	128	1, 5, 9, 13, 17, 21, 25, 29
7	73	1, 8, 15, 22, 29, 36, 43, 50
12	42	1, 13, 25, 37, 49, 61, 73, 85
16	32	1, 17, 33, 49, 65, 81, 97, 113
24	21	1, 25, 49, 73, 97, 121, 145, 169

A DMX line also stops at 32 devices, whatever the channel count. Use a splitter after that.

07 DMX cabling and data

DMX is a fast, low-voltage data signal, and it hates bad cable. Most "the lights are doing odd things" calls are cable calls.

Connectors and cable

The standard is the **5-pin XLR**. Many fixtures use **3-pin XLR**, which looks like a mic connector. Pin 1 is the screen, pin 2 is data –, pin 3 is data +. Pins 4 and 5 are unused. Use proper **DMX cable**, which has a 120 Ω impedance. Use a 3-pin to 5-pin adaptor when you must mix.

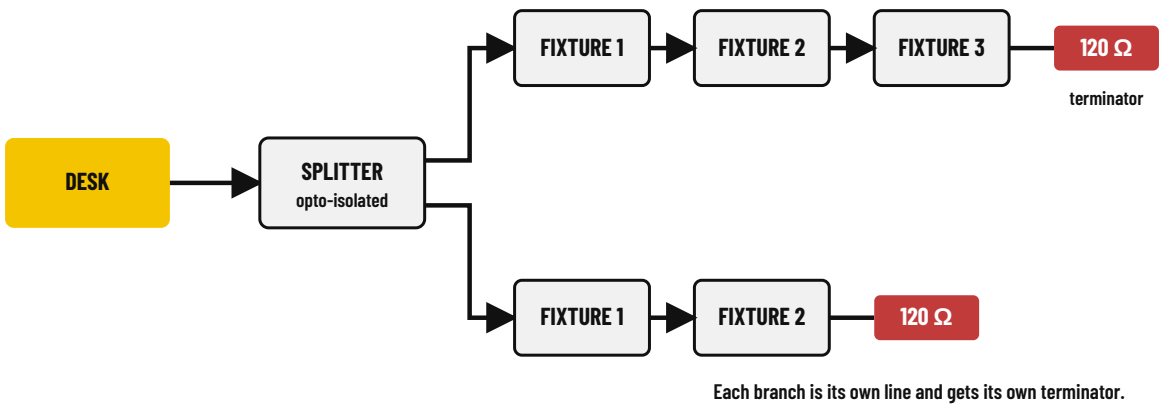
> **DO NOT USE MIC CABLE**
> Mic cable is the wrong impedance. On a short run with a few fixtures it appears to work. Add length, more fixtures, or a stage full of radio noise, and the signal reflects, the lights flicker and you will not find the fault. Use DMX cable.

Daisy chain, in order

DMX goes from the desk **in one line**: out of the desk into fixture 1, out of fixture 1 into fixture 2, and so on. No T-pieces or Y-splits. The order on the cable does not have to match the address order, but each fixture must be in the chain. The last fixture needs a **terminator**.

Terminators

A terminator is an XLR plug with a 120 Ω resistor built in across pins 2 and 3. Plug it into the DMX **out** socket of the last fixture. It stops the signal bouncing back up the line. Many rigs run without one and work fine. Add it when you get glitches. It is the first thing to try.



One line out of the desk, split into two branches. Each branch ends in a terminator.

Limits

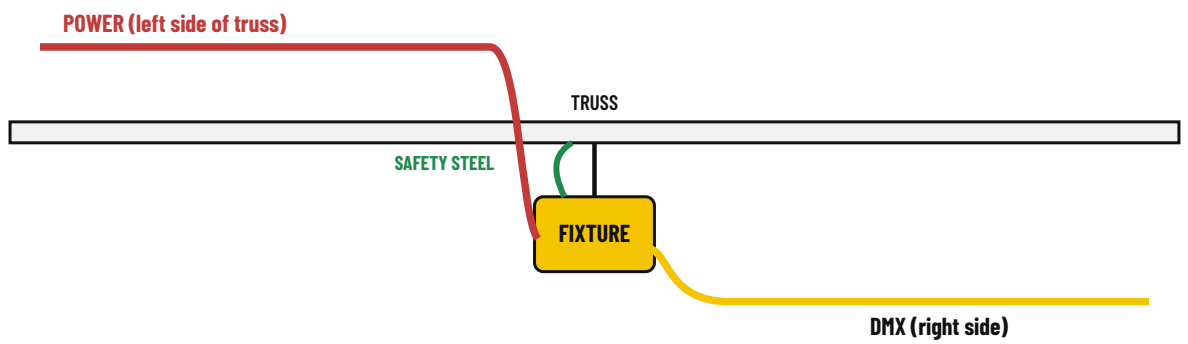
- **32 fixtures** on one line. Past that, use a splitter.
- **About 300 m** of cable on a line. Past that the signal fades.
- A **splitter** (opto-isolated) copies one DMX line into several clean ones and stops a fault on one branch killing the rest.

Wireless and network

Wireless DMX sends the signal over radio to receivers on the fixtures. It is perfect for uplighters on the far side of a room, but it is only as good as the radio environment. Keep the transmitter in line of sight. **Art-Net** and **sACN** carry many universes over a network cable (Ethernet). This is the next step for big rigs: one cable, dozens of universes. For now, learn the cable and the address.

08 Power for lighting

A lighting rig has three kinds of cable running over the same truss. Mixing them up is the commonest way to get hurt or to ruin a show.



The three cables on a rig: power, DMX and the safety steel. Power and DMX run apart. If they must cross, cross at 90°.

Power cables put noise onto DMX cables that lie alongside them. Keep them on opposite sides of the truss, taped or clipped every metre, and cross at right angles when you must cross.

Power-link limits

Many LED fixtures have a power-in and a power-out so you can chain them from one plug. The chain has a limit. **Read the number printed on the fixture or in its manual**, usually 4 to 8 LED PARs on a 16 A line. Tungsten is much heavier: about one PAR 64 per 10 A dimmer channel. Never chain past the stated number.

Calculating load

Watts ÷ 230 = amps. A 150 W LED PAR draws 0.65 A. Add every fixture on the circuit. Then stay under **80% of the breaker**, because breakers trip on a steady load near their limit and lamps and motors draw extra when they switch on.

TRY IT: LIGHTING LOAD CALCULATOR

FIXTURE	WATTS	AMPS	MAX ON 16 A (80%)	MAX ON 32 A (80%)
LED PAR	150	0.65	19	39
Moving head	350	1.5	8	16
Tungsten PAR 64	1000	4.3	2	5
LED bar	100	0.43	29	58

80% of 16 A is 12.8 A (2 944 W). 80% of 32 A is 25.6 A (5 888 W).

Lights and sound on separate circuits

Dimmers and switching power supplies put electrical noise into the mains. That noise comes out of the PA as a buzz. Run lighting and sound from **separate circuits**, and where you can, from **different phases** of the distro. This is basic good practice and it costs nothing.

In the B&W kit: the 32 kVA three-phase generator feeds 63 A distros with four 32 A outputs each. Put lighting on its own 32 A output and sound on another, ideally on a different phase.

> **CREW PLUG IN. ELECTRICIANS WIRE.**
> Never open a plug, change a fuse in a distro or connect cable ends. If a plug is damaged, tag it and take it out of use.

09 Desks and programming

Every lighting desk is different on the surface and the same underneath. Learn the ideas and any desk will make sense inside an hour.



The same workflow on every desk, from a small controller to a big console.

PATCHING

Telling the desk which fixture is at which address, in which mode. If it does not match the fixture, nothing works.

FIXTURE LIBRARY

A list of fixture profiles in the desk, one per make, model and mode. Pick the exact mode.

GROUPS AND PALETTES

A group is a set of fixtures you select together. A palette is a stored colour, position or beam you can recall onto any group.

CUE, CHASE, BUSK

Cue: a stored look, played on command. **Chase:** a loop of looks. **Busk:** playing it live, by hand, to the music.

MASTERS

The **master** scales a whole playback. The **grand master** scales every output on the desk. **Blackout** kills all light.

FLASH

A button that turns a light on while you hold it and off when you let go. Good for hits, and for testing one fixture.

You can practise with no gear. Free desk software runs on a laptop and has a 3D visualiser: **grandMA3 onPC**, **ETCnomad** and **ChamSys MagicQ PC**. Download one, patch some fixtures, build a few looks.

Your first show, in six steps

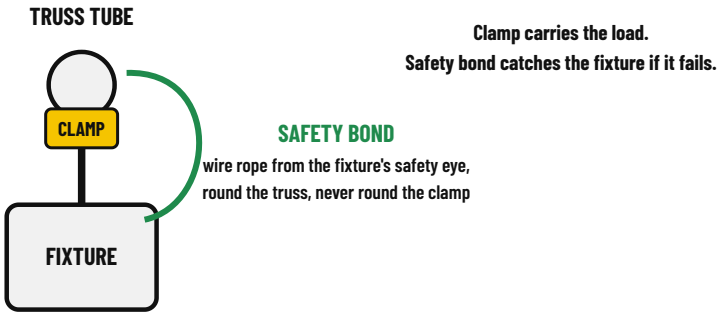
1. **Patch.** Add each fixture type, set its mode, give it the address you set on the fixture.
2. **Check.** Select each fixture and bring it up. Each one should react. If not, check address and mode.
3. **Group.** Make groups: key lights, uplighters, back lights, effects.
4. **Set looks.** Store a white state for speeches and a brand-colour state for the room.
5. **Record cues.** Number them in the running order: walk-in, speeches, awards, party.
6. **Run it.** Fire the cues in order, and keep a blackout and a safe white state one press away.

FIELD RULE

Always keep a plain white "house" look ready. When something goes wrong, you want light on the room in one button.

10 Rigging and safety

A fixture weighs from 2 kg to 30 kg. If it falls, it kills. Rigging is not a place for improvising. Follow the rules every time.



Every fixture hangs from a clamp and is also tied to the truss with its own safety bond.

Truss and clamps

- **Truss** is a rigid frame of aluminium tube. It comes in square (box) and triangular shapes, in lengths from 0.5 m to 3 m, joined with pins or bolts.
- **Hook clamp** or **half-coupler**: the usual clamp for hanging a fixture on a tube.
- **G-clamp**: the common clamp on small rigs. Use only the type rated for lighting.
- **Safety bond:** a steel wire or rope that ties the fixture to the truss separately from the clamp. **Every fixture gets one.**

SWL and who rigs what

Every piece of truss, clamp, shackle and stand has a **safe working load (SWL)** printed or stamped on it. Add up the weight of everything on it and never exceed the SWL. If it has no SWL, it does not go up.

Truss on stands (ground-supported, low) is a crew job when you have been shown how. **Flown truss** (hung from motors or the roof) is for **certified riggers only**. If you are not one, you do not touch it.

> **HEAT, LADDERS AND STROBES**
> Hot lamps burn: let tungsten cool for 15 minutes before you handle it. Ladders: three points of contact, someone footing it, tools on a belt and never over a person. Strobes can trigger seizures in people with photosensitive epilepsy: warn the client and the venue before any strobe, never aim one at faces, and keep runs short. If a guest says it affects them, stop.

Cables and weather

Tape or clip all cable runs. Never leave cable across a walkway without a cover. Outdoors, fixtures must be rated for it (look for an IP65 or IP rating on the label). Keep power connections off the ground and under cover. If it starts raining and the fixtures are not rated, switch off at the distro and cover them.

Pre-show checklist

- Every fixture has a clamp and a safety bond.
- Truss pins and bolts all in, locked.
- Total load under the SWL of the stand or point.
- Power and DMX apart, runs taped, nothing across the walkway.
- Loads under 80% of each breaker.
- Lights and sound on separate circuits.
- Every fixture reacts, at the right colour.

Fault table

SYMPTOM	CHECK	FIX
Fixture dead	Power lead, power link limit, breaker	Swap the lead. Plug straight into a known good point.
Flickering	Power supply, loose plug, overloaded link	Reseat plugs. Split the chain into two feeds.
Wrong colour	Mode, address, white balance on the desk	Match the mode to the patch. Re-check the address.
DMX "spazzing"	Cable type, damaged cable, no terminator, too many fixtures	Swap the last cable. Add a terminator. Use a splitter.
Moving head not responding	Homing, address, mode, DMX in/out the right way round	Power-cycle. Wait for homing. Check the DMX in socket.

11 Check what you learnt

Ten questions. Circle one answer for each. The answer key is on the last page. Pass mark: 8 out of 10.

1. Which light is the main light on a speaker's face?

- ○ **A** Wash
- ○ **B** Back
- ○ **C** Key
- ○ **D** Effect

2. What does PAR stand for?

- ○ **A** Parabolic aluminised reflector
- ○ **B** Power adjustable reflector
- ○ **C** Programmable array rig
- ○ **D** Primary angle reflector

3. Roughly how much current does one 1 kW tungsten PAR 64 draw at 230 V?

- ○ **A** 0.65 A
- ○ **B** 1.5 A
- ○ **C** 10 A
- ○ **D** 4.3 A

4. A moving head is powered and the yoke is in the wrong place. What do you do?

- ○ **A** Push it by hand to where you want it
- ○ **B** Switch it off, then move it
- ○ **C** Pull the tilt lock and force it
- ○ **D** Leave it, the motors will fix it

5. **Which fixture is best for lighting a lectern with a clean, shaped beam?**

- ○ **A** Profile (leko)
- ○ **B** Blinder
- ○ **C** Strobe
- ○ **D** Festoon

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6. **Why does RGBW give better whites than RGB?**

- ○ **A** It runs cooler
- ○ **B** It uses less power
- ○ **C** It can strobe faster
- ○ **D** It has a real white LED

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7. **Fixture 1 has 7 channels at address 1. Fixture 2 is also 7 channels. What is its start address?**

- ○ **A** 2
- ○ **B** 8
- ○ **C** 7
- ○ **D** 14

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8. **A DMX line runs 20 fixtures and glitches. What is the first thing to try?**

- ○ **A** Use mic cable instead
- ○ **B** Add a T-piece in the middle
- ○ **C** Add a terminator on the last fixture
- ○ **D** Raise the master

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9. **A circuit is a 16 A breaker. What is the most load you should put on it?**

- ○ **A** 12.8 A
- ○ **B** 16 A
- ○ **C** 14 A
- ○ **D** 8 A

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10. **Who may work on flown truss?**

- ○ **A** Any crew member with a ladder
- ○ **B** The lighting operator
- ○ **C** Whoever got there first
- ○ **D** Certified riggers only

Answer key

1. **C**. The key light is bright, white and from the front at about 45° above. Light the people first.
2. **A**. A bowl-shaped reflector behind the lamp gathers the light into a beam.
3. **D**. 1 000 W ÷ 230 V is about 4.3 A. That is why tungsten fills a circuit quickly.
4. **B**. Moving a powered head by hand strips the motors and belts. Switch off first.
5. **A**. A profile has shutters and gives a hard-edged, shapeable beam. Blinders and strobes are effects.
6. **D**. RGB alone gives a slightly cold, greenish white. The white LED cleans it up and helps skin tones.
7. **B**. Fixture 1 uses slots 1 to 7, so the next free address is 8.
8. **C**. A 120 Ω terminator across pins 2 and 3 on the last fixture stops reflections. Mic cable is the wrong impedance.
9. **A**. Stay under 80% of the breaker: 12.8 A, or about 2 944 W.
10. **D**. Flown truss hangs over people. Only certified riggers touch it. Crew on stand-mounted truss still use an SWL and a safety bond on every fixture.

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