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GUIDE TO VIRTUAL PRODUCTION

A guide to creating Mandalorian-style photorealistic worlds utilizing the latest LED wall technology.

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INTRODUCTION

It seems like everyone is talking about virtual production these days.

Many in the entertainment industry have seen what has been achieved on The Mandalorian and wondered if it is possible to shoot virtual production projects on a more modest budget. This introductory guide is based on our first two years of on-set experience doing exactly that.

You might be asking yourself if virtual production is just another passing fad, like 3D movies. In fact, a recent study suggests that virtual production will become a 5 Billion industry in 5 years. We believe that we are on the verge of a technological shift of a greater magnitude than the move from celluloid film to digital cinema. The advantages to virtual production are so numerous it is inevitable that a significant amount of film and television production will soon become virtual.

All the images in this guide are from actual Final Pixel projects.

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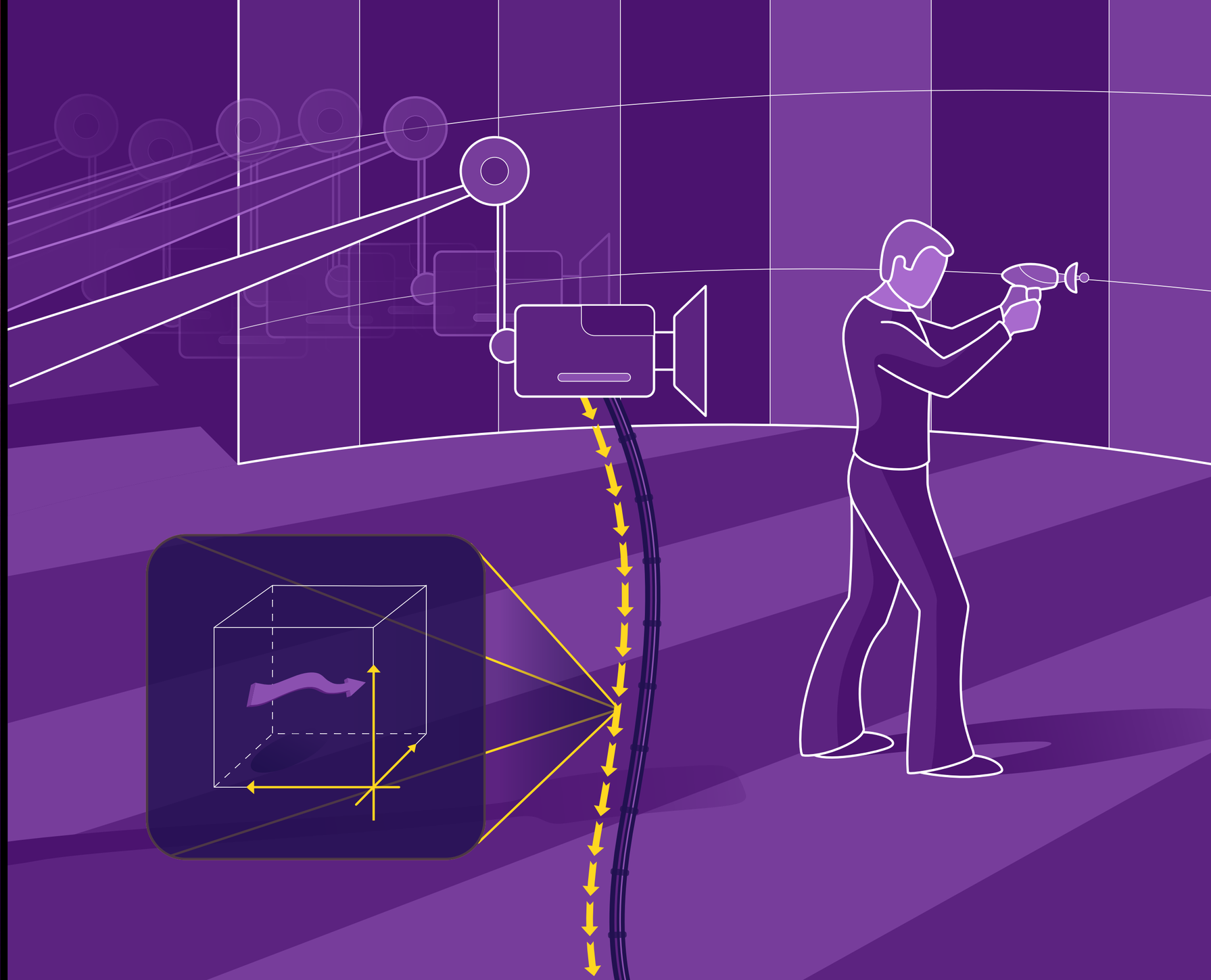
WHAT IS

VIRTUAL PRODUCTION?

Virtual production is the convergence of three existing technologies : Camera Tracking, Video Game Engines and LED Display Walls.

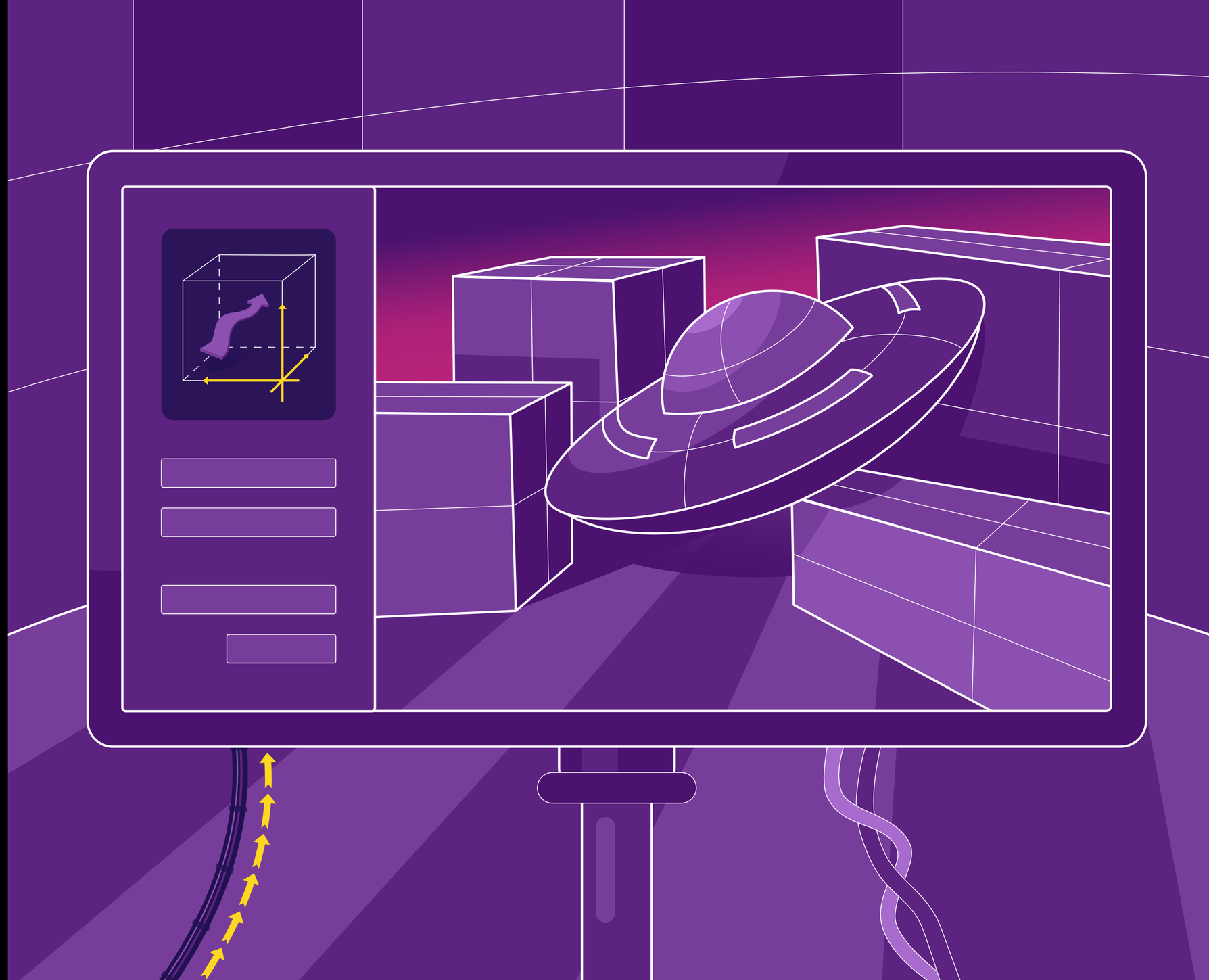
CAMERA TRACKING

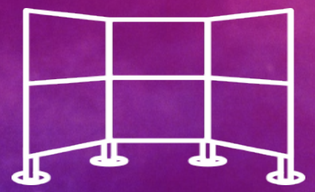
The position of a real camera in a studio is tracked in 3D space. This creates a constant stream of XYZ co-ordinate data.



VIDEOGAME ENGINE

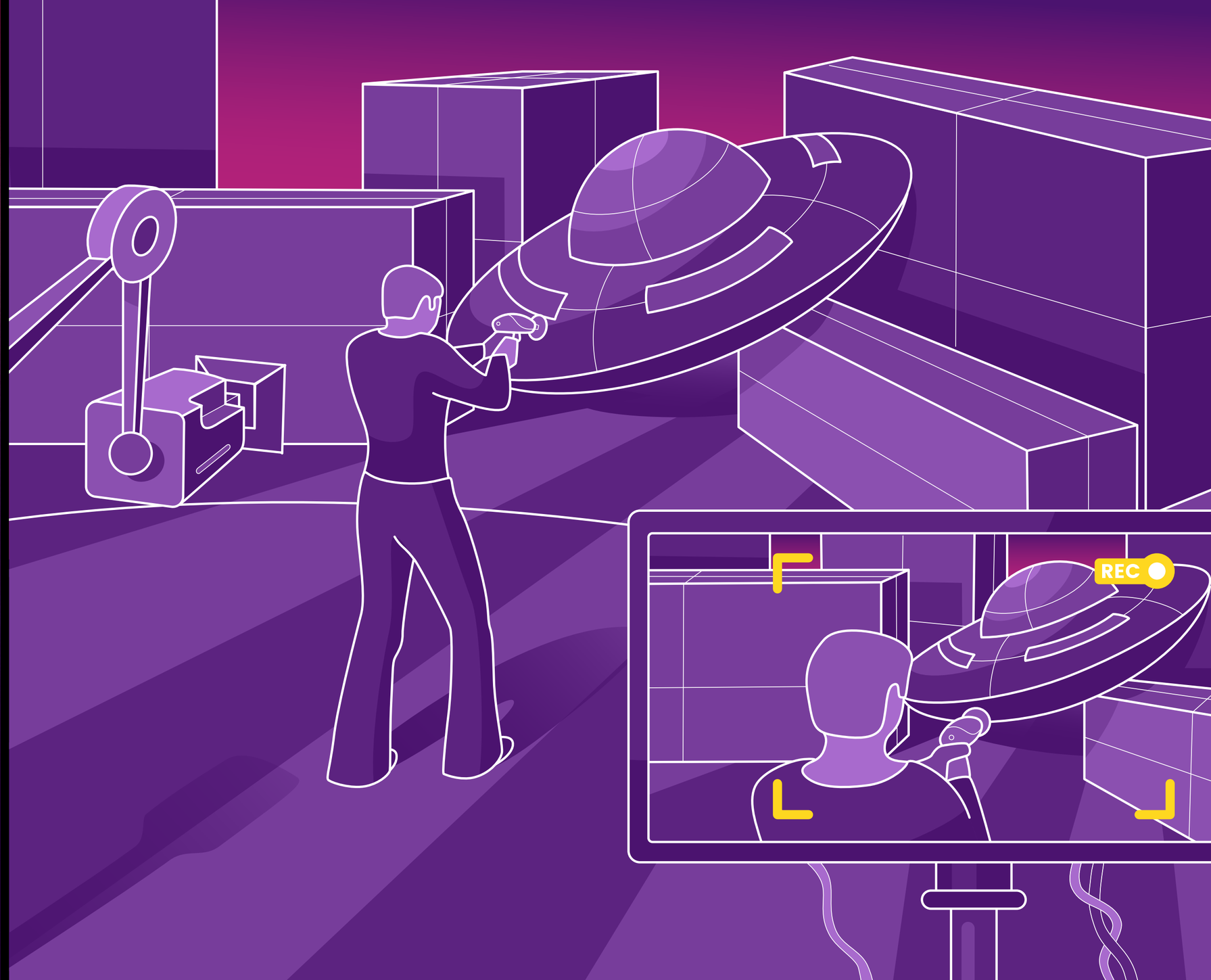
This tracking data is then fed to a video game engine running on a high-spec PC. This software renders and animates a 3D model in REAL TIME. The tracking data from the real camera is used to move a virtual camera through the 3D scene.





LED WALL

The environment is “played” from the game engine software and displayed on the LED Wall, changing perspective and updating as the real camera moves.



HOW THESE TECHNOLOGIES WORK IN CONCERT

CAMERA TRACKING

The most common camera tracking systems include Mosys, Optitrack, Stype and Vanishing Point.

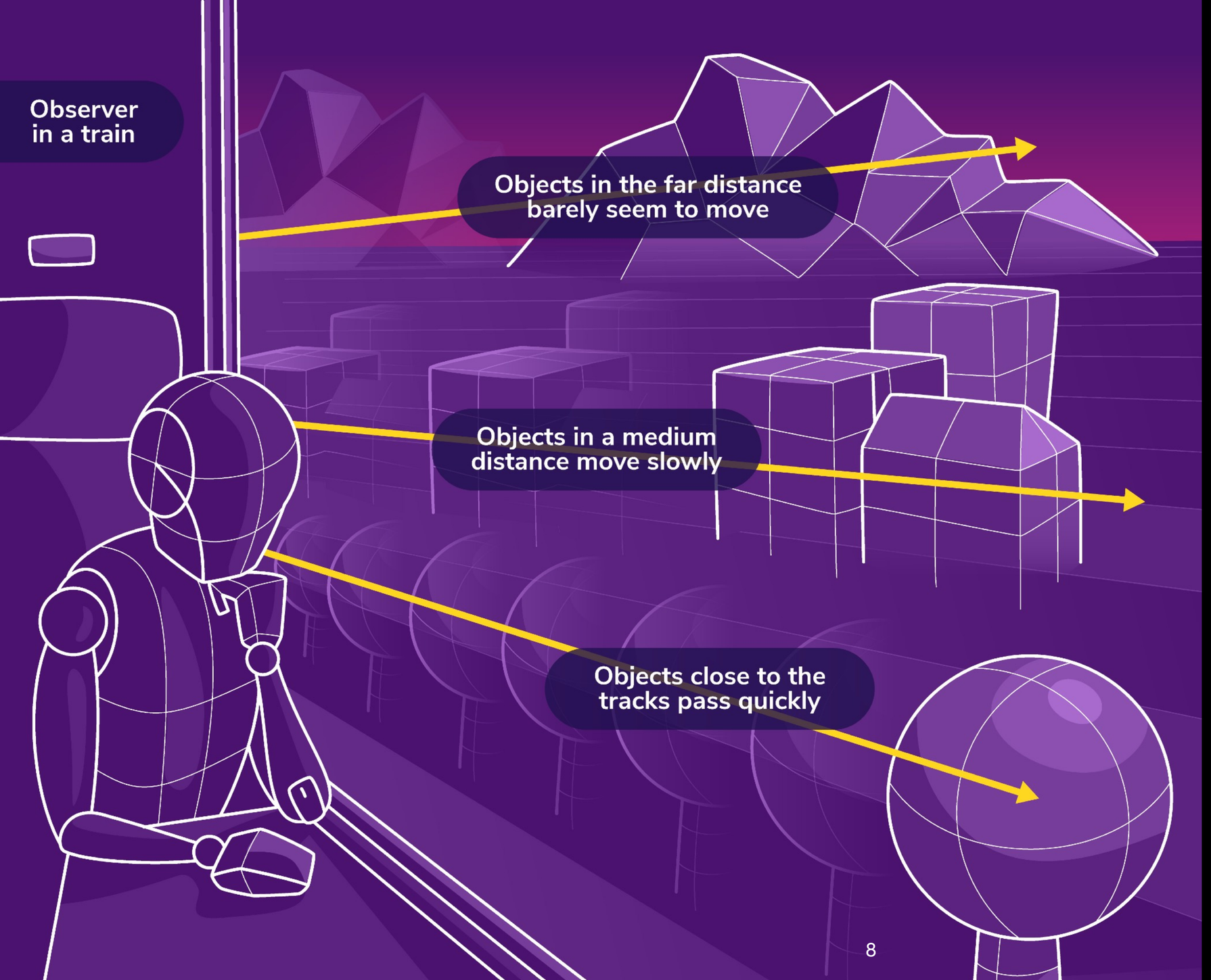
VIDEO GAME ENGINES

Unreal Engine is the most popular. Epic games have made it available for film and TV production at no cost.

LED DISPLAY WALLS

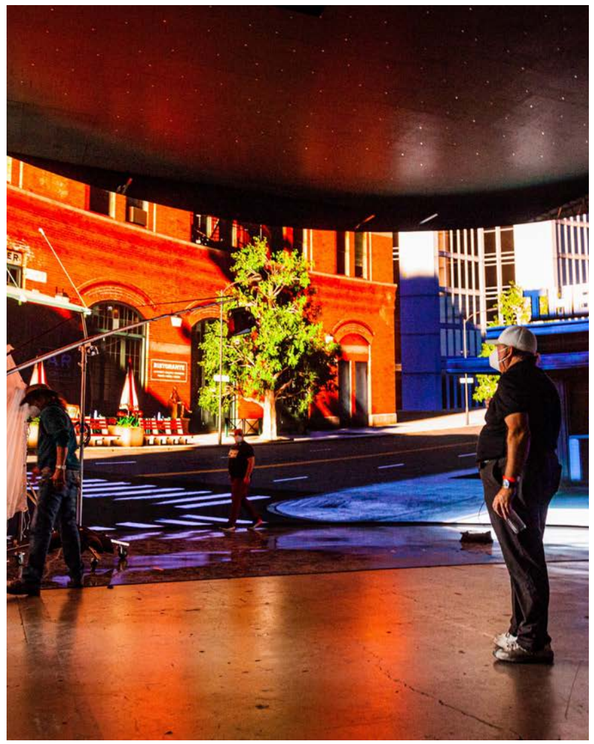
There are many LED panel vendors. Screen resolution, “pixel pitch” and the quality of the LED processors matter.

As the real camera moves, the viewer’s perspective changes, and background objects on the LED wall move in 3D space relative to each other. This creates an illusion of a larger 3D world than the physical space of the stage. This technique utilizes **the parallax effect**.



PARALLAX

Noun: A change in the apparent position of an object relative to more distant objects, caused by a change in the observer's line of sight towards the object.



HOW IT WORKS

THE ILLUSION OF 3D

Parallax is the big difference between displaying video footage on your LED wall and running a 3D environment with tracked camera(s.) For example – you could have talent in the foreground on your stage and a video clip playing of a New York street on the LED wall. However, as you move your camera, the perspective in the background would always remain the same and there would be no feeling of “3D-ness.” Historically we have approached this problem by shooting on green screen and using motion control for the camera data, or using special camera tracking software to analyze the scene and do matchmoving in post. The game changer with LED walls + videogame engine is that we can do this process live, in real-time, on a stage – and you, your crew and your clients can see the results immediately.

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IN-CAMERA VFX

In essence we are creating an *in-camera* composite. For this reason you may hear virtual production referred to as “in-camera VFX.”

The great benefit of virtual production is that you have achieved “final pixel” in camera, and the post-production process is basically edit, mix and color.

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WHAT MAKES IT MANDALORIAN-STYLE?

“Mandalorian Style” virtual production involves the addition a **practical** foreground set. This is the critical part. This completes the illusion.

The following pages are a guide to the workflow involved in creating successful Mandalorian-Style virtual production.

Image A clearly shows which parts of this particular set are practical and which are game-engine 3D - and also where the LED wall is positioned.

Image B shows the in-camera composite after time has been spent adjusting lighting, color values, creating shadows etc...

Decide Environments First.

Dedicate as much time in your schedule as you can to the creation of your 3D environments.
This will give you the opportunity to take maximum advantage of the 3D build process.

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VIRTUAL PRODUCTION WORKFLOW

Creative Development

Production Design

Pre Visualization

On-Stage Production

Post Production

CREATIVE DEVELOPMENT

Not every project is suitable for virtual production. And virtual production is not something that should be attempted solely for its own sake. Think of Virtual Production as a problem-solving tool. Is your dream location a place that is impossible to film in? VP may be the answer. Is there a need to have your talent in a particular location, but it's not practical to travel them (Covid, time pressures etc...) – then you can shoot them with VP. Perhaps you are a movie shooting in London, but have a couple of scenes in NYC. Instead of sending your whole crew to NY – shoot locally with Virtual Production. Virtual Production is all about removing the limits to your creativity.

If your project involves covering a lot of ground – perhaps running around in a huge parking lot, or a foot chase through the streets of Manhattan, then VP is probably not going to work well. There can be limited real estate for moving around – though some productions are now creating sets that have a long walk-and-talk practical area, with the LED wall in the background.

What advantage does this have over green screen?

It is possible to do Virtual Production with green screen. The LED wall is not essential. The technique involves shooting on green screen and everyone on set sees a live composite of the scene. However, all the issues with green spill, issues with reflections, and the all-to-real problem of visual fatigue for performers – all go away with LED wall VP. In addition the performances of the talent are elevated due to a real feeling of place provided by visual feedback from the LED wall environment.

It's wise to brainstorm in partnership with your VP vendor to make sure that ideas are achievable on time and on budget.

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CREATIVE DEVELOPMENT

Concept and Ideation

The development process is different for every project. Sometimes it's wise to design your environment before beginning the scripting/boarding process. Alternatively you may do this process first. It depends on the goal of the creative.

01

Script & Treatment

If the environment is a recreation of a real-world place – then you are usually safe to start with scripting and boarding. If the location is completely imaginary – creating the concept art first is usually wise.

02

Moodboards/Reference images

The process of creating the location – the “environment” - is complex and mistakes can be expensive. Spend time at the beginning of the project getting everyone on-board with the look and feel of the environment(s) you want to create. It is possible to model an existing environment. You have to have very talented artists to be able to do this as interiors is a real specialism.

03

Storyboarding

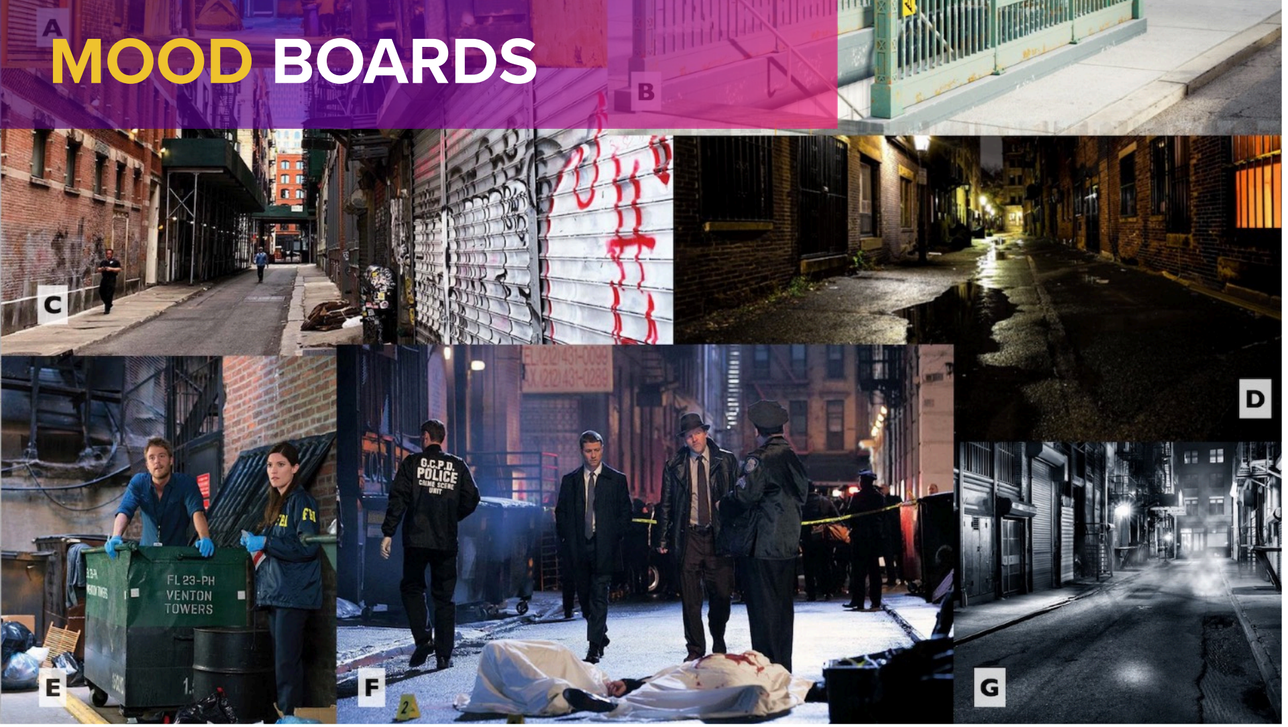
Virtual Production is much more flexible than traditional post production compositing. However it is still wis to plan out all your shots in advance.

04

Environment Sketch

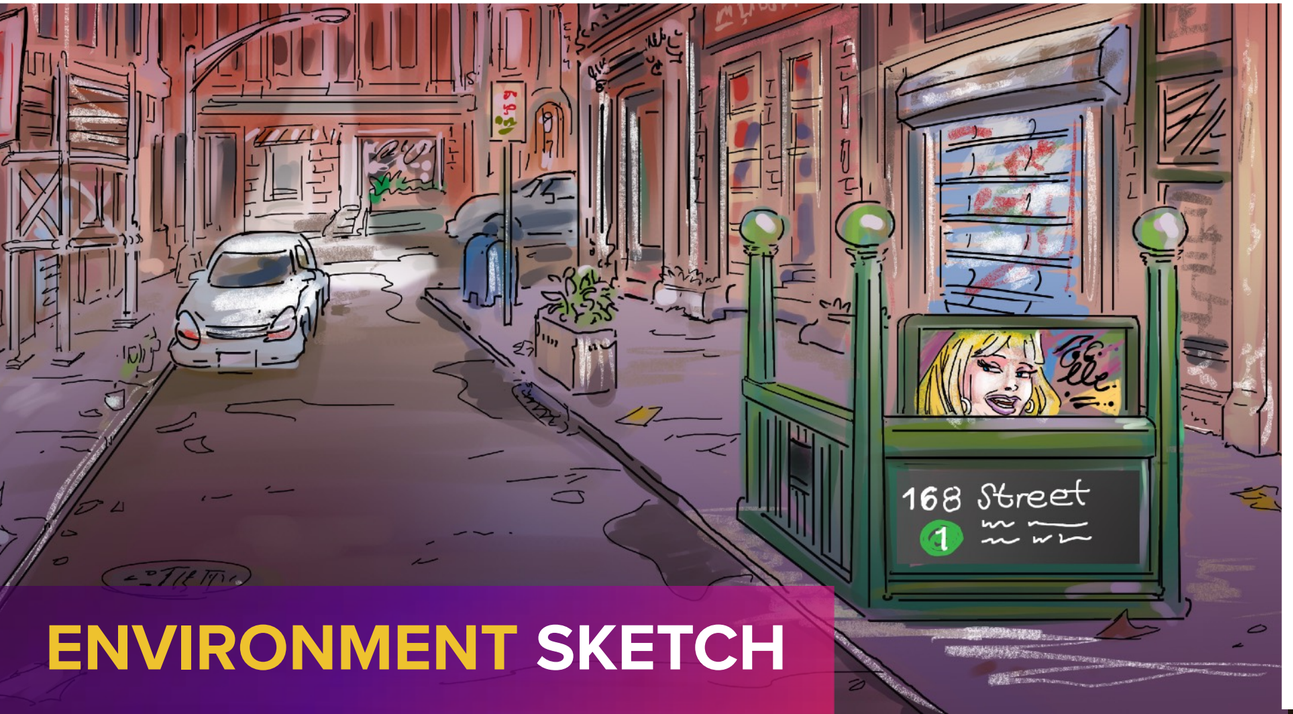
Concept art is a critical step in the workflow. It’s important to get everyone on the same page with the environment(s) plan. At this point it is a simple matter to rearrange parts of the scene and much cheaper than once the 3D design process gets underway.

MOOD BOARDS



STORY BOARDS

ENVIRONMENT SKETCH



3D ENVIRONMENT

REAL LOCATION

3D RECREATION

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PRODUCTION DESIGN

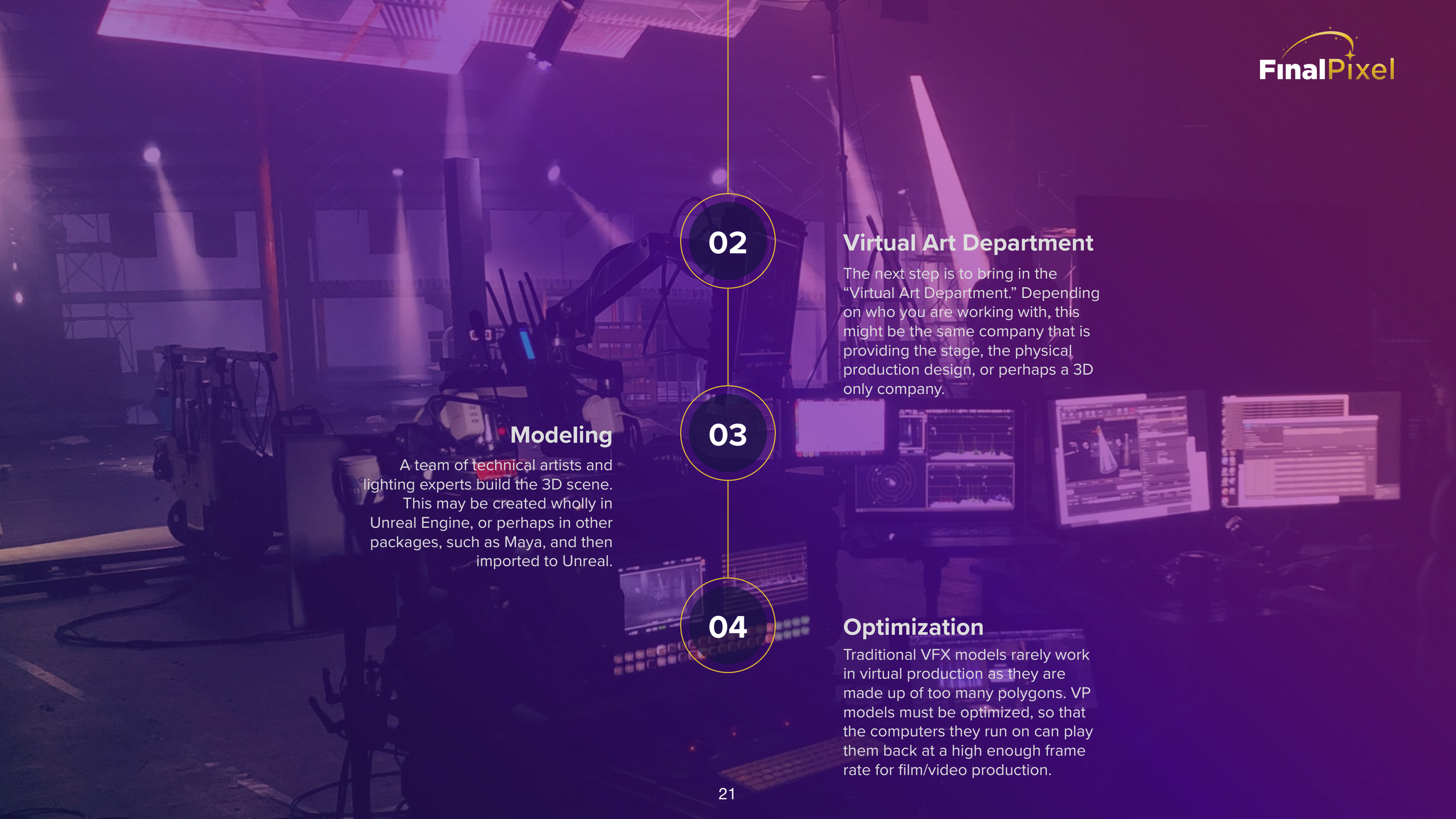
Production Design

At this point it is important to involve a production designer in the process. If your shoot is going to involve a practical set that is blended with the virtual set, then you need to make sure your physical production designer understands the brief and what will be required

01

Physical/Digital Production Designer

The understanding of virtual production is currently limited to a small number of production designers. We recommend working with someone who has a good grasp of the issues.



02

Virtual Art Department

The next step is to bring in the “Virtual Art Department.” Depending on who you are working with, this might be the same company that is providing the stage, the physical production design, or perhaps a 3D only company.

03

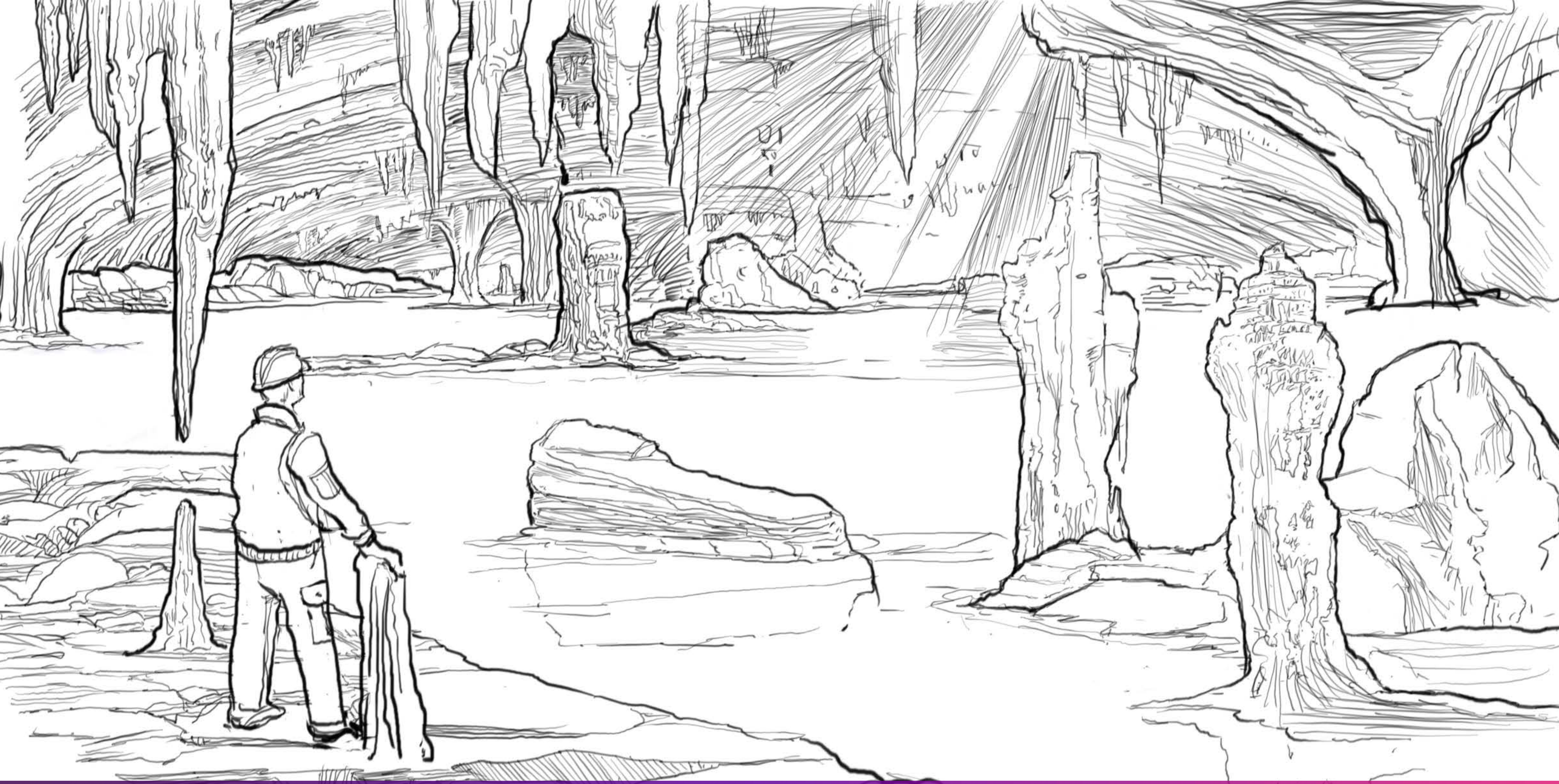
Modeling

A team of technical artists and lighting experts build the 3D scene. This may be created wholly in Unreal Engine, or perhaps in other packages, such as Maya, and then imported to Unreal.

04

Optimization

Traditional VFX models rarely work in virtual production as they are made up of too many polygons. VP models must be optimized, so that the computers they run on can play them back at a high enough frame rate for film/video production.



ENVIRONMENT SKETCH

3D WORK IN PROGRESS

3D FINISHED MODEL

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PRE-VISUALIZATION

Pre - Visualization

A great advantage of virtual production is that during preproduction you can get very close to seeing what the final product will look like.

01

Scanning/Modeling of Key Props

One technique is to research what physical props are available – then create 3D models of the props (see salon chair on following pages.)

02

Model lighting

Director and DP can dial in the lighting look they want prior to the shoot day.

03

Client walkthroughs

Clients can be given a “virtual tour” of the set over videoconferencing software, or using Virtual Reality headsets.

04

Director plans staging and blocking

With a fully-built 3D set, the director can try out various camera framings and actor blocking - all adding to the efficiency of the shoot day.

PRACTICAL TECHNIQUES

FOREGROUND MODELING

One technique is to research what physical props are available – then create 3D models of the props. These can be inserted into your 3D environment, allowing you to re-create your practical foreground set within the 3D model. This allows for sophisticated previsualization. The director can plan out all her shots in the fully-realized scene prior to the shoot. It is also possible to fly-through the 3D model and share it over videoconferencing software with clients, bosses etc. In fact, it is even possible for many remote people to come together in Virtual Reality and do a Virtual Scout, while wearing VR headsets. Features like these unlock the true collaborative potential of Virtual Production.

MODELED FOREGROUND SET PIECES BEAUTY SALON

SHOOT DAY

IN-CAMERA COMPOSITE

IN-ENGINE LIGHTING

It is even possible for the director and the cinematographer to work on lighting the scene – before you even go to set. Everyone can see the effects of various lighting choices within the Unreal Engine scene. It is possible to connect Unreal Engine to zoom and fly a camera around within the set so that clients can take a closer look at the elements, lighting etc... This helps immensely with expectation management.

VIRTUAL SCOUTING

You can take the pre-visualization process one step further by arranging fully-virtual, immersive scouting. Collaborators can don VR headsets and meet virtually *inside* the set. Lights can be placed, set pieces can be moved around and lighting ideas can be tested. It's not essential to use this VR approach to workflow, but for large, complex sets it's very useful.

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ON-SET WORKFLOW

Stage Selection

There are already a multitude of LED wall stages popping up, however they are all getting booked and it's important to start looking early.

01

LED wall build

If you are building a custom wall, you should allow at least three days for the process of bringing in, installing and testing your wall.

02

Camera Tracking and Lens calibration

This usually takes a 1-2 days.

03

Model Testing

It’s critical to have at least a day to test your models on screen and make final tweaks and adjustments to maximize performance

04

Set Build and Prelight

Once the tech is dialed in you can build your set and prelight. At the moment it is wise to make sure everything is working well - prior to the shoot day.

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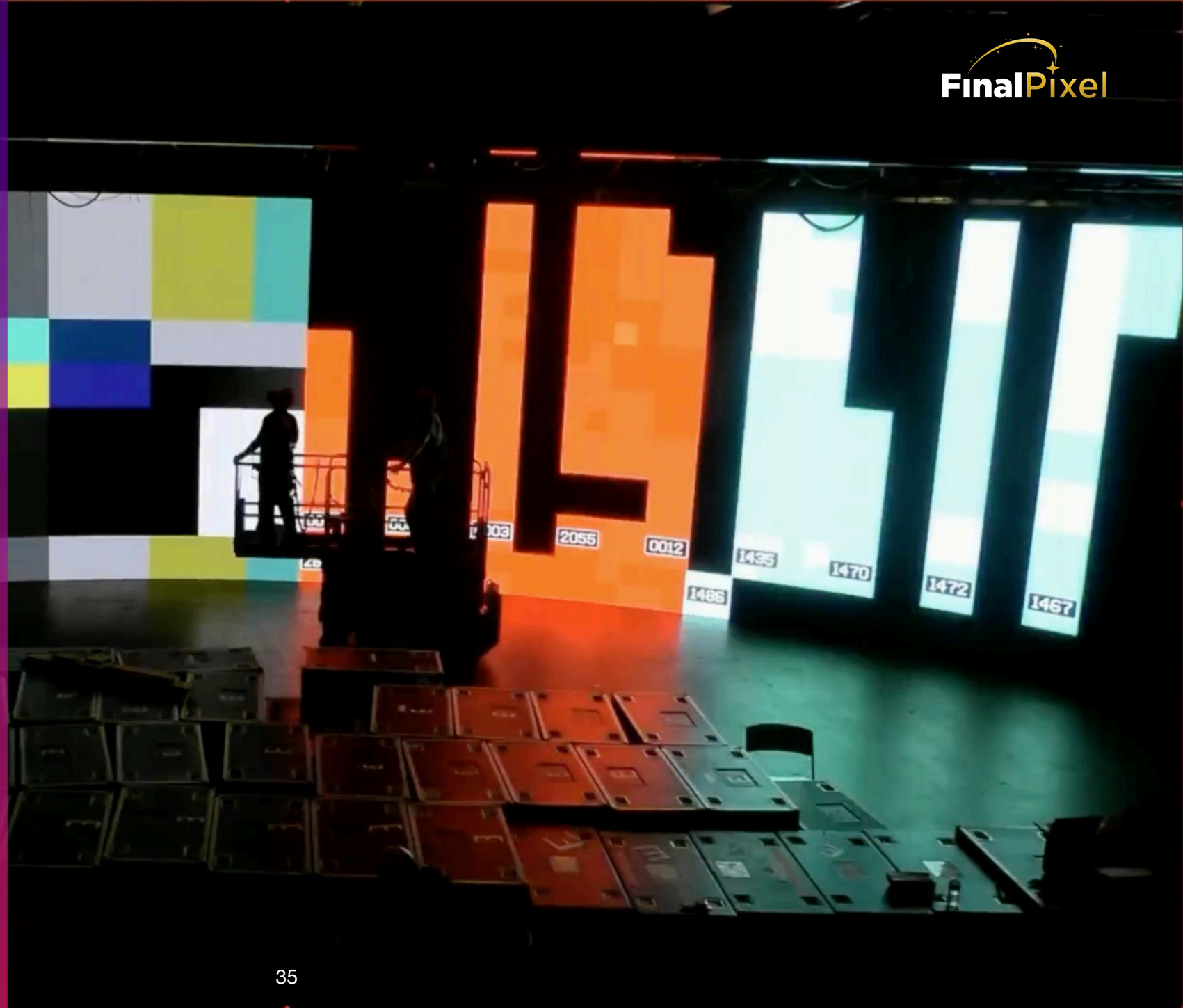
STAGE SELECTION

Your project may sit neatly in one of the pre-existing stages – or it may benefit from a more bespoke shape/size of screen.Remember you will need space for crews, lights, production equipment and art department - especially if you are doing a large foreground set. If your are planning a lot of set changes during your shoot day, this can lead to requirements for a much larger stage than otherwise might be the case. It is also important to make sure power needs for the LED wall are discussed.

LED WALL BUILD

In this fast-moving tech sector, new products are being announced weekly. The market is mature due to the use of these video walls for pop concerts, conventions and other big corporate events. One of the key metrics to pay attention to is pixel pitch. Generally, the smaller the LED pixels on the wall, the more convincing the image. The current high water mark is 1.5mm. When the screen is built, it is then divided into several 4K sections – each being fed a 4K image from a single video server. These images are tiled on the screens to cover the entire surface area.



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CAMERA TRACKING

One of the most important parts of the stage setup is installing the camera tracking system. There are many tracking systems – as these have been used for years in TV “Virtual Studios” – such as sports commentary or virtual TV news studios. These include Mosys, Optitrack, Stype, Vanishing Point and others. These tracking systems may use reflective dots, special cameras or other technological components.

LENS CALIBRATION

Another key part of setup is calibrating your lenses to the LED wall screen. This can be time-consuming and can only take place on an empty stage where the camera can see the entire, unobstructed LED wall. Usually this takes place as soon as the wall is built. It’s important to choose your lenses early and don’t make any changes to the camera body after calibration.
Lens calibration should take place with whatever camera mounting you will be using on the shoot day - crane, steadicam, dolly etc... Ideally the camera should stay in place until the shoot day.

If you are planning to use a teleprompter, you may need to have this mounted on the camera rig prior to lens calibration.

MODEL TESTING

As virtual production is still a new technology, it is important to have model test day(s) on stage, and ideally a pre-light day also. This allows you to see how the models look on the big screen, and to dial out any gremlins and glitches that might have cropped up.

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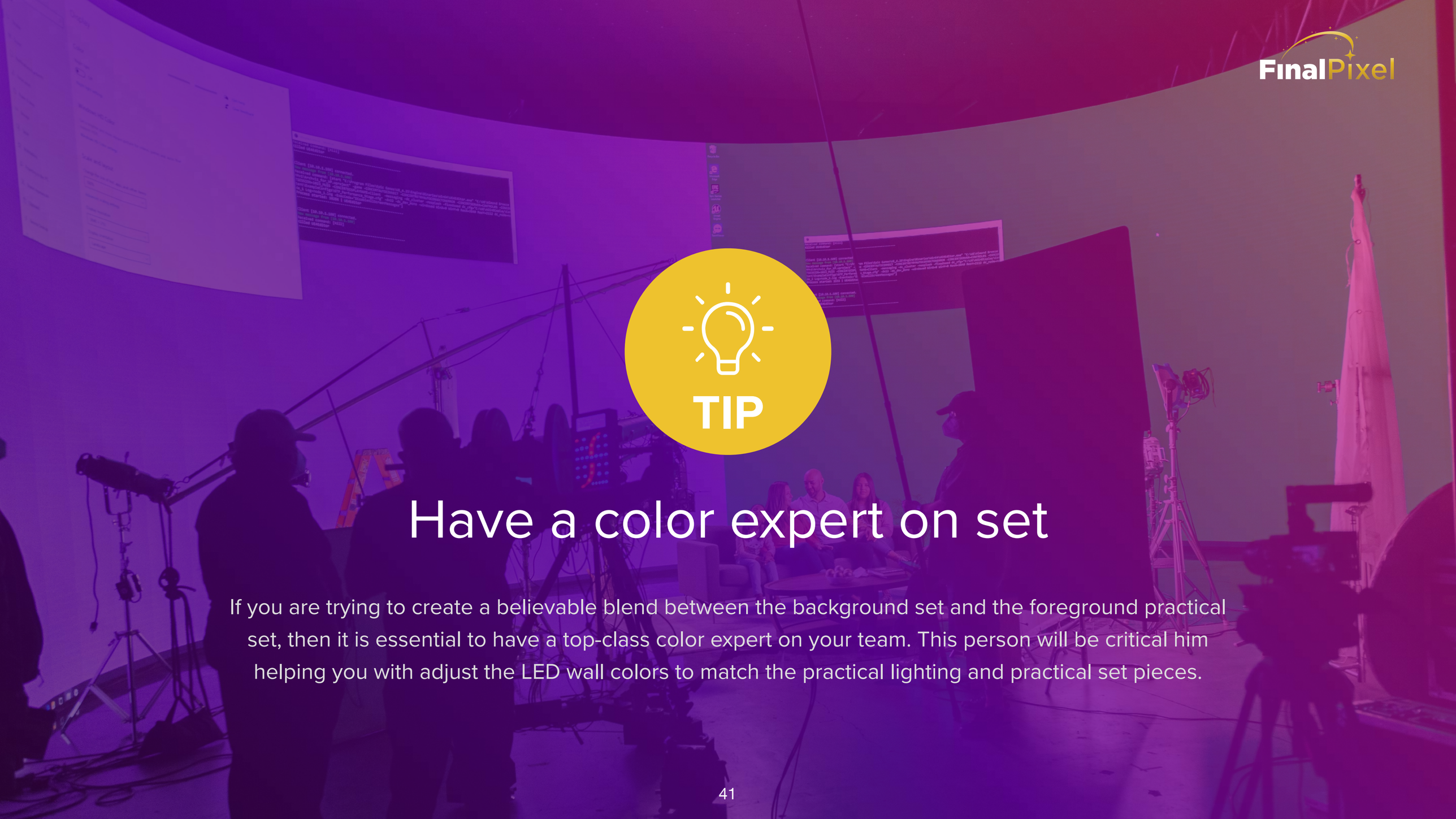
SET BUILD AND PRELIGHT

Once the stage is ready you can build your foreground set. Usually, the floor is the most difficult thing to install, and to get properly-blended with the 3D environment. Some LED walls will have a gap at the bottom, between the LED and the floor. You can try to disguse this by placing foreground elements. For example – a raised deck in the foreground hides the gap. IF your scene is the top of a hill, or a rocky environment – then you can build up your foreground to hide the gap. Finding a color match between the practical floor and the 3D floor can take some time. Your 3D team may ask to take photographs, or scan, part of the physical floor – so they can recreate it in the 3D world. A big part of the set build and prelight day is fine-tuning the color match between real floor and digital floor. Even if there is no gap at the bottom of the wall, you will still have to be skillful about disguising the border line.

IN-CAMERA COMPOSITE



TIP

Have a color expert on set

If you are trying to create a believable blend between the background set and the foreground practical set, then it is essential to have a top-class color expert on your team. This person will be critical him helping you with adjust the LED wall colors to match the practical lighting and practical set pieces.

THE FRUSTUM

Feeding the 3D model to the LED wall is very processor-intensive and requires high-end PCs and graphics cards. One way to reduce the load on the computers is to only show on the wall exactly what the camera can see. Sometimes the screen is black, except for what the camera sees (what the camera sees is called the frustum – a moving rectangle on the screen.) Sometimes we feed a low-res image, with the frustum being a roving section of hi-res video. This gives the actors the full picture on the screen, so they can feel “in the scene.”

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CONTROL SOFTWARE

In addition to using Unreal Engine to provide your 3D world, it is common to use a separate piece of software to display that 3D world on the LED walls. You may come across software and hardware from companies such as Disguise, Aximmetry and Pixotope. Each of these provides a more “production-ready” interface to Unreal Engine. They have advantages in color-correction, frame rate, set extension and many other aspects of virtual production.

MULTIPLE CAMERAS

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It is entirely possible to shoot with two tracked cameras at the same time. With two cameras come two frustums. The challenge is not to let them overlap, otherwise you will ruin one of the shots. In the future technology will solve this problem by using frame remapping.

You can add an untracked camera which can conceivably share a frustum with one of the other cameras. This really only works for long-lens shots with the background somewhat out of focus.

SET EXTENSION

It is possible that you might desire a wider shot than the LED wall allows. To do this you can create a laser 3D scan of your actual LED wall, import that into your wall-controlling software, such as Disguise, and then when you pan off the wall, you see the only the 3D model, instead of the studio wall or ceiling. This is a little tricky to get your head around – but incredibly powerful when you see it.

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POST PRODUCTION

Cut, Mix, Color and Deliver

Unlike conventional VFX workflows, the post process in VP is a call back to earlier days of film production.

POST PRODUCTION

The great benefit of virtual production is that you have achieved “final pixel” in camera, and the post process is basically edit, mix and color. There is no further vfx work to do. This brings a real sense of traditional filmmaking to the process. No more long debates in post over green screen composites that don’t quite look like you imagined they would be. Everyone sees the final result on the stage on the shoot day. As a result, post is dramatically shorter than on a traditional VFX shoot. Overall, we find that a VP schedule is roughly similar to a normal schedule – just with more time taken from the post process and moved into the pre pro part of the schedule.

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WE HOPE...

...that you found this guide to virtual production useful. Join us in pushing back the boundaries to creativity and making the impossible, possible.

> “The Previz became The Viz!”

A global creative studio
specializing in end-to-end virtual production.
From concept to final pixel.

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CONSULTING | CREATIVE | PRODUCTION

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WE ARE

FILMMAKERS FIRST

OUR TEAM

MICHAEL MCKENNA
CEO and Dir. of VP

Senior team - BBC and EndemolShine.

Integral to establishing BBC Studios, a £400m production powerhouse. Has successfully grown companies producing content for Netflix, Discovery, BBC...

MONICA HINDEN
Executive Producer

20 years of experience as an Executive Producer.

Has planned impossible shoots for Discovery Channel in Alaska, Land Rover in Bolivia, and countless other nationally-recognized commercial and entertainment brands.

CHRIS MCKENNA
Creative Director

Award-winning commercial director and creative director.

Clients include ABC/Disney, Marvel, Discovery/Scripps, Dish Network, Land Rover, Nissan, Target, Lucasfilm...

STEVE HUBBARD
VFX Supervisor

Ex Rhythm and Hues.

Extensive feature credits include: Missing Link, Alien Covenant, Lego Batman, Captain America, Warcraft and countless others. CG Sup on Black Sails for Starz.

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