VIRTUAL PRODUCTION
A Global Innovation Opportunity for the UK

StoryFutures Academy Immersive Skills Report 2021

By Prof. James Bennett, Dr. Claude Heath,
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National Centre for Immersive Storytelling

NFTS NATIONAL FILM AND TELEVISION SCHOOL
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EXECUTIVE SUMMARY

Virtual Production (VP) is becoming a ubiquitous methodology for the achievement of high-quality film, television and media productions. A game-changing development, VP combines virtual and augmented reality with computer generated imagery. All this is made possible by real-time game-engine technology. Exemplified by high end Hollywood productions such as The Mandalorian and in television by the BBC's Virtual Production presentation studio for the Tokyo Olympics, Virtual Production takes traditional screen media production methods to a new dimension. VP capitalises on technology developed for games development, notably Epic's Unreal Engine, and delivers stunning, photorealistic sets, environments and audience experiences in real-time.

VP offers efficiencies and enhancements for both live action (Production) and visual effects (Postproduction). VP allows for a reduction of the costs and risks associated with VFX, which typically account for 10-20% of overall budget: virtual sets not only save on production time and costs, but might also be more sustainable, reducing carbon footprint by removing travel and transportation costs of location filming. Instead of flying crews, equipment, actors and sets to locations across the world, Producers can design and build locations in the computer, which are then played back on large LED screens known as Volumes.

Such Volumes are being rolled out across the UK to service the growing need for this technology. This represents a massive investment in the technology for companies such as Netflix, Sky, ILMxLAB and Warner Bros. This is because the opportunity is also massive. Traditionally the technologies and methodologies of the games and film and TV industries have developed in parallel, with very little crossover from one field to the other. With VP the opportunity exists for a crossover of competencies allowing companies to expand from games (UK 2020 video game market worth £5.3 billion) to high-end TV (UK 2020 spend on HETV production: £1.49million) to film (UK 2020 total spend feature film production: £1.37billion) and into immersive (UK value 2021 prediction: £5.7billion). With the potential to benefit all these sectors individually and collectively, it is crucial that the UK ensures that it has not only cutting-edge VP infrastructure, but also the skills capacity to develop its own new intellectual property in the form of tools, methods and in our world-renowned ability to make the highest quality content. This is not simply a technology opportunity, it is one that brings together Science Technology Engineering and the Arts: a true STEAM opportunity for our Creative Industries.

Throughout this research we found an industry that recognised that whilst current costs were high, Virtual Production would be normalised and correspondingly cheaper within 5 years. However, 'hands-on' experience is still low. Appetite for training is therefore veracious: Epic, Screenskills, Digital Catapult, National Film and Television School StoryFutures Academy, and others, have all launched training programmes in 2020-21, with ScreenSkills seeking to establish national training standards for VP. As the then Minister for Creative Industries Caroline Dinenage commented, to ensure the UK stays ahead of the creative curve there is a need to "develop our world class screen workforce [to] help the UK's film and TV sectors build back better".[1]

This Interim StoryFutures Academy Skills Report provides a map of the VP skills needed across the film and TV industry. As with the roll out of the technology itself, the skills mapping will need to grow more widely to include games, theatre, and live production, and also look more broadly across the UK creative industries. Our Report identifies both the hard and the soft skills demands of the creative industries required to translate innovation practice into economic growth. It shows how VP changes the way key Departments operate - internally and with other Departments - during Preproduction, Production and Postproduction.

However, the report has identified many gaps and pain points in the workflows and pipelines of both Production and Postproduction talent in the UK, revealing a significant skills shortage. Demand for talent and training far outstrips supply. There is a clear need for highly creative, technical artists who can write code, problem-solve and communicate effectively with creatives while fixing complex technical issues; all within the fast-paced film and TV set environment. This shortage needs to be tackled urgently if the UK is to leverage its reputation for innovation and creative excellence across film, TV, VFX, games and computing.

[1]Quoted in **Televisual**, 10/02/21, "National Standards Plan for Virtual Production", https://www.televisual.com/news/national-standards-to-be-developed-for-virtual-production/

METHODOLOGY

This interim report is primarily qualitative and based on the experience of Virtual Production from the perspective of film and television. Semi-structured interviews with 25 leading industry professionals were conducted over two months in the summer of 2021.

Each interview lasted between 30mins and 2 hours and most were one-to-one meetings, while some were joint interviews (ILMxLAB, DNEG). At least two individuals from each film discipline were interviewed. This first set of interviews are part of a continuing series of consultations with industry planned for 2021-2 and beyond, regarding the disruptive impact of VP on the media sector.

Our primary case study, **Fireworks,** the VP short film directed by Oscar winner Paul Franklin, significantly informs our understanding of VP with six of our interviewees drawn from the crew. The detailed focus on this case study helps to frame our understanding of other VP projects, in terms of the differences that exist between productions and the skills gaps that are common to all productions.

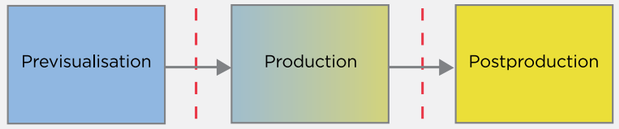
The qualitative data analysis tool MAXQDA2020 was used to analyse the interviews, developing themes presented within the data, sorted and clustered by discipline, role, Department, skills, challenge and opportunity points, pain-points, touchpoints, educational background and training. A review of current vacancies and job descriptions from large and medium sized companies, further informed and highlighted the reported gaps in workforce competencies.

© Wilder Films / Fireworks

WHAT IS VIRTUAL PRODUCTION?

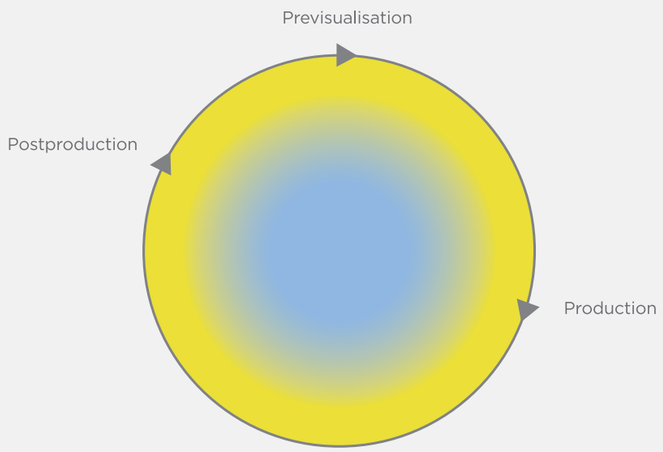
Fundamentally, VP 'rolls up' the previous linear Production process of film and television into a dynamic Production world, bringing together departments that had previously worked sequentially into simultaneous interaction (see Figure 1). There is not one node, department or role on the Mandala that only engages in the filmmaking process within a linear sequence. Most radically, traditional Postproduction roles, skills and processes have moved into Preproduction and on-set, whilst, at the same time, they retain a role in a final polish of a film before release.

Figure 1: The Virtual Production Pipeline



S In traditional filmmaking **(Above)** pipelines move through clearly identifiable and demarcated phases.

T In VP on the other hand **(Below)** these phases overlap and iterate, and an extended duration of Preproduction.



VP is a complex array of techniques and technologies, and consists of four main areas: Visualisation, Motion Capture, Hybrid Camera and LED Live-Action:

1. **Visualisation:** Using 3D VFX assets to visualise and plan a task. Various forms are available and include:

   a) **Pitchvis**: where imagery and scenes are created from a project to help raise finance or communicate a director's vision.

   b) **Previs**: allows use of 'virtual scouting' for shot and sequence planning where a digital set or location is created allowing key crew to experience and interact with a scene via a head mounted display.

   c) **Postvis**: merges temporary VFX with shot live action which can provide placeholder sequences for editorial.

   d) **Techvis**: combines filmed footage with virtual assets often used to prove physics for complex scenes, such as explosions etc, where camera data or lens choices may affect believability.

   e) **Stuntvis**: the visualisation of stunt sequences.

2. **Motion Capture** ('Mocap'): Camera and computer capture of human motion which is then incorporated into virtual or VFX people, creatures or other assets in order to animate them. Mocap first came to prominence in the 1980s, and whilst an established part of the film industry it remains challenging both technically and artistically.

3. **Hybrid Camera** ('simulcam' green-screen hybrid): This is compositing (combining) digital VFX with live-action camera footage in real-time. Simulcam was originally developed by companies such as Weta Digital (**Lord of the Rings**) and by producer/director James Cameron (**Avatar**). It offers improved results compared to shooting with a green screen background, because visualising the digital and physical simultaneously helps directors and actors to gain a better spatial understanding of the scene.

4. **LED Live-action:** This replaces shooting against green screens with shooting against LED panels or "Volumes" displaying the final-quality VFX. This is an advance on 2D video projection and requires rendered scenes to be ready to be 'played' out onto the LED wall via a game engine. This method shifts the emphasis from Postproduction to Preproduction, since key creative decisions are made before principal photography begins, allowing crews to shoot with completed VFX sequences.

LED Live-action volume: panels of LED lights display the scene, at the StoryFutures Academy/Final Pixel VP Bootcamp, 2021 at ARRI Mixed Reality Studio. Image courtesy of ARRI / CT Group.

Understanding the world of VP
The VP Skills Mandala

The Virtual Production Skills Mandala (see **Figure 2**) represents VP-specific roles and skills rather than traditional filmmaking. It builds upon work by EPIC visualising the cyclical nature of the VP workflow.[2] The Mandala was shown to interviewees towards the end of each meeting and developed with their input. The diagram is therefore iterative rather than exhaustive, with relationships between roles and skills not fixed. It captures different views of organisational structures, workflow cycles, and role descriptions while mapping these into the VP world as it emerged across disciplines.

Creative and directorial roles are shown as blue circles - these roles may help to shape but may not directly handle the data produced for the Virtual Production end product. Alongside these are the more technical roles - shown as yellow circles. Arrayed alongside the roles are the specific skills, aptitudes, and abilities that may, or may not be, involved in the carrying out of that role, depending on the production.

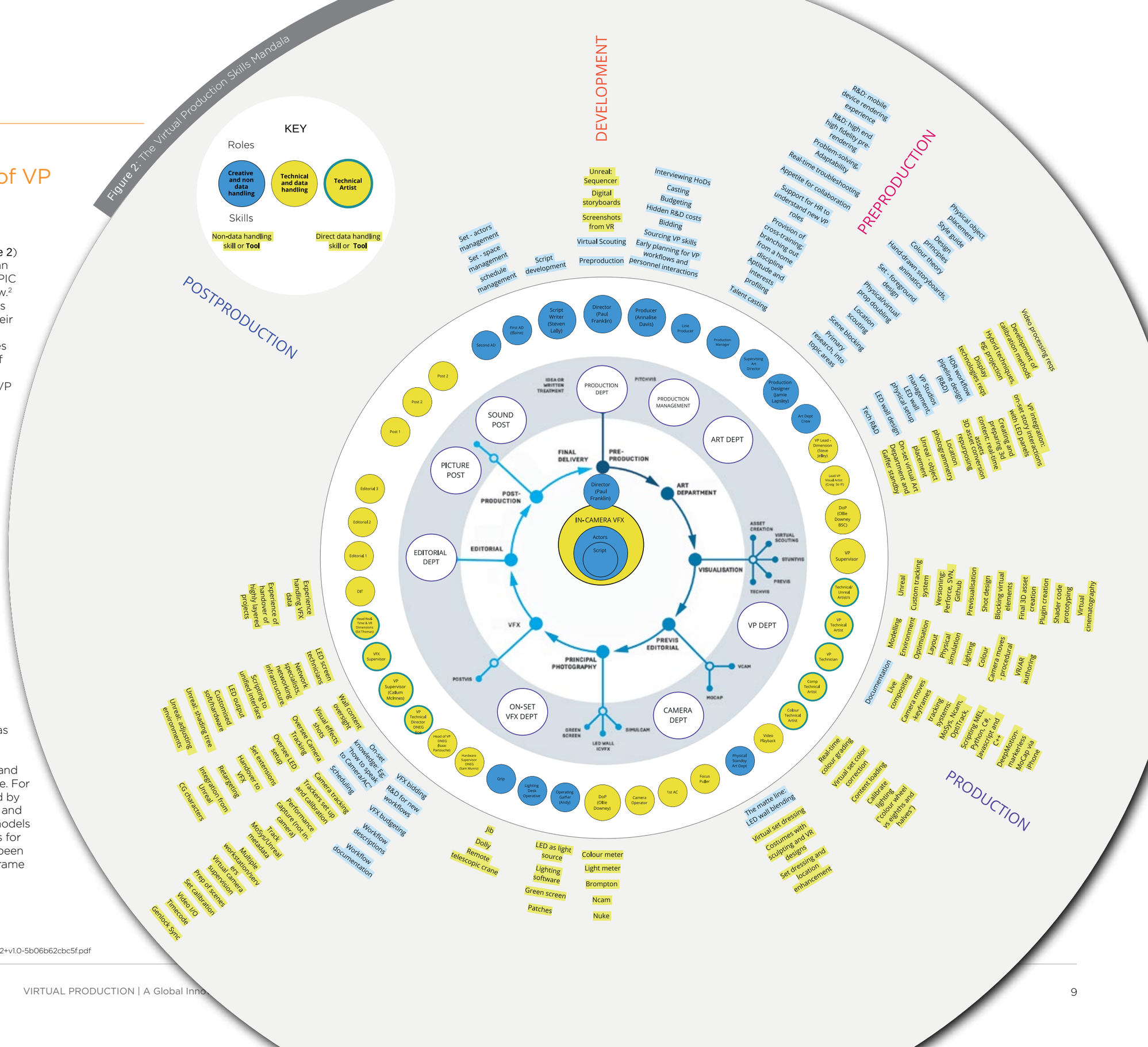
On this first mapping, the greatest concentrations of new skills associated with VP can be seen, unsurprisingly, in the emergence of a 'VP Department' and an On-Set VFX Department. But it also significantly impacts Production Design, whilst all other Departments are forced to adapt existing skills and evolve new ones, including finding new ways to communicate between Departments.

Reading the Mandala like a compass, we can observe the preponderance of creative, non-data-handling roles (blue) in the North East quadrant, whilst in the East and West, technical data-handling roles (yellow) tend to dominate - as the Virtual Production Department prepares the final assets and scene modelling and animation. Compared with linear production, 3D modelling and other technical skills appear earlier on in the cycle. For example, in **Fireworks**, Unreal Sequencer was used by the Director to generate storyboards for the film and the Production Designer created 3D SketchUp models with detailed architectural and texture references for the VP Department. These assets may not have been directly utilised in the final product, but help to frame the film during all phases of the Production.

Download a copy of the Mandala here https://www.storyfutures.com/uploads/docs/VP-Skills-Mandala_November-2021.pdfNovember-2021.pdf

[2]**The Virtual Production Field Guide**, Volume 2, Epic Games, 2021, p.148. See: https://cdn2.unrealengine.com/Virtual+Production+Field+Guide+Volume+2+v1.0-5b06b62cbc5f.pdf

Figure 2: The Virtual Production Skills Mandala

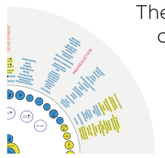


In the South East, at approximately 135 degrees, and South West (200 degrees) we find the Technical Artists roles unique to VP. These roles are shown as yellow nodes with green fringes. This denotes their distinctive blend of skills from both ends of the spectrum of filmmaking skills. Technical Artists have been described as embodying the meeting of mathematical and creative skills, in activities that merge creative and technical problem-solving through collaboration.

The metaphor of reading the map of VP skills as a compass does not, however, provide a complete understanding of VP. The compass points help identify regions of production, but the Mandala also describes a multi-layered process cycle that unfolds over time. The radial format conveys the forward movement of the project as a whole, and different Departments appear in more or less traditional order, but the analogy with linear production ends there. As one practitioner described it:

> 'The workflow... is not linear... It's all about being able to jump between tasks and having the responsiveness to manage the competing pressures. The workflow is more like a jumble or bundle of jobs in the centre, all squashed together, and we have to find a way to handle each project most efficiently; a core of tools and processes, with moving parts all around it.'

The VP methodology demands that Departments move in and out of the active centre of the production at different times and for different purposes. Rather than being linear or classically cyclical, the workflow is like a condensed and evolving bundle of tasks in the centre of the production, to be dipped into as and when needed. Around this is a core of skills, tools and processes, with moving parts all around. In this way, the Mandala is a map of the different roles and skills required of each department and the ways these interact in the world of production. Most importantly, gone are the strict dependencies of linear production – meaning that previously 'Pre' and 'Post' departments are now 'on-set', with roles, functions and tasks overlapping and merging.



The **Preproduction** phase of the project starts with the Writer, Director and Producer beginning to shape the central ideas and techniques that will be needed for the film. At approximately 45 degrees the Art Department becomes more closely involved, with the Production Designer starting work on their ideas for the look and feel of the project. At or after this stage the Director of Photography (DoP) may become involved in informing the decision-making related to how best to achieve the desired look and feel. Other early contributions will follow from the Virtual Production Department, about how best to approach the filming from a technical, modelling, animation and aesthetic perspective.

At or before 90 degrees on the VP Mandala, the **Production** phase begins. The Virtual Production Department creates the 3D digital assets that will be used to set the scene, as both backdrop to filming on-set and as a light and reflections source for this filming. It is here where many of the hybrid roles exist, artists who possess a combination of technical and creative expertise (circled in green). As work progresses, the assets mature, with feedback from the Production team and Production Designer. Meanwhile the Virtual Production Department begin to test and set the technical game engine parameters that will govern the lighting, colour and other visual effects - including the animation of some of the 3D assets. At this, and at all stages, close collaboration between the Director and the Heads of all Departments (HoD's) will drive the film project to completion.

CASE STUDY | HAZFILM

Name of Interviewee:
Haz Dulull

Job Title
Director/ Producer

Company
Hazfilm

Virtual Production Role

There isn't really a solid job description of what a Virtual Production Supervisor is, because it's fairly new ... essentially [it is] someone that understands real-time, someone that understands visual effects, but also someone that understands how to communicate to the director on how to get his or her vision using VP.

As a Virtual Production supervisor on a VP shoot, you are jumping between the actors, DoP, digital village and the Virtual Production team. The VP supervisor and the VFX Supervisor work in hand but you are also working hand-in-hand across all of those teams. That's why roles like Virtual Production Supervisor are critical and we are going to see demand for this role pop up in quite a lot of places.

The Changing Role and Relationship to other Departments

Relationships between the Departments are slightly different and we have a new Department as well in VP, the Virtual Art Department, or VP Department. I would hover between the DoP, the first AD, the actors, and the Production Designer if there's something specific for set dressing.

Those cross-departmental conversations should be happening on the Virtual Production shoot. All Departments should get an element of training during the tech recce, and get the Gaffers involved in the conversation with the Virtual Production supervisors so they're aware and know how to help and supplement the Virtual Production streams.

The Opportunity

I find VP is a good place for people that are trying to break into the industry. Back in the day, you had to be an intern or a runner, make the Director's or Producer's coffee. Now I think there's a place where interns can be hands-on with a Virtual Production such as moving lights or doing a lot of data transferring, managing the Unreal engine scenes, or doing backups on the day.

The Skills Challenge of VP

It is all in the prep, we Previs the hell out of a shoot. But not only do we do pre-vis, we tech-vis as well. Which meant that we go onto the Virtual Production stage, we measure it, we get floor plans, we rebuild that stage in Maya. We even had footage playing in Maya on a make-believe LED screen to really plan it. The thing about Virtual Production, amazing as it is creatively and technically, it's very expensive. You can't really have the luxury to experiment, spend a couple of hours to see what you can do and then do a tech recce day. There's a lot you learn the minute you come on the set and the minute you start putting on the graphics.

There's a lot of decisions you can make instantly... the thing I love about VP is that when you're relating to production and executives, sign-offs are much quicker. With Virtual Production, because you know your shoot date is in two months' time, and you have two months to make a decision creatively, what the environments are, what the look is, what the film is, it forces executives and decision makers to work with directors, to sign off the director's vision.

The Skills Demand

I'm finding my artists have changed. I'm hiring a lot of people from the video game industry. Because here's the thing: I'm making an animated film. It's a 90-minute movie. We've got a deadline to hit. You've got to be smart. And I find people that work in the video game industry, in terms of CG artists, they have one word on their mind that artists in film and television don't usually have. And that word is 'optimisation'. They have to optimise it to work on a game engine and it has to work really, really well.

CASE STUDY | WILDER FILMS

Name of Interviewee:
Annalise Davis

Job Title
Producer

Company
Wilder Films

Virtual Production Role

With VP, as a producer, you can have more control over the production, and it allows for more flexibility on set. Similarly, for a designer and a DoP, it's brilliant, because they have more input into what goes on screen, compared to working with green-screen.

The Changing Role and Relationship to other Departments

My number-one goal with any film is around story. Not just telling a good story, but ensuring everybody's telling the same story. When you have a Virtual Production, you're working with a Director, obviously, and you're also working closely with a Production Designer and a cinematographer. All those people are part of that storytelling conversation. On a VFX-heavy film with larger mixed technical and creative teams, there is a risk that the key creative input from the cinematographer and designer may get lost.

As a producer, I worked very hard with the AD department, because I wanted the technical element not to overshadow the team, the cast and their performances. On **Fireworks**, we made sure the actors didn't feel that they came second to the technology, even though we waited for the technology a lot more than we waited for the actors! If you allow the technology to take over, then you're not respecting the actors and their process, and you need to do that to get good performances.

The Opportunity

I felt that Virtual Production took a familiar setting and gave us a new perspective on that world, on how we see those people, and elevating the story in really interesting ways. So, for me, it was very much a story-driven and character-driven decision; it didn't ever change the story of **Fireworks**, it only enhanced it. When we realised we could retool **Fireworks** using Virtual Production, Steve Jelley from Dimension Studio said, "Come and visit our set, and you'll see what I mean," and I understood it properly for the first time when I walked on the set; up until that point it was a very technical process with words I didn't fully understand. After visiting the set, I could see how the technology could serve the story, and we realised that it could work; what Virtual Production allowed us to do was open up the scope of the story and the ways we could engage with the characters in that world.

The Skills Challenge of VP

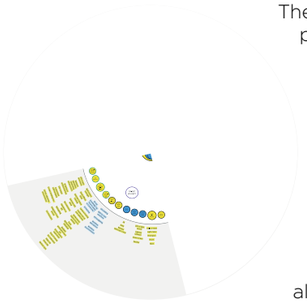
Gaffers on set talk about light using different language from VP gaffers' lights. Also, on a film set, if the AD who's running the day says to a cinematographer, "How long?" and the cinematographer says, "Five minutes," it's going to be five minutes. But if the AD says to an VP person on a Virtual Production, "How long?" and they say, "Five minutes," it could be five minutes, but sometimes it can be 20 minutes, sometimes four hours. Where every minute costs money, this is a very real challenge.

The Skills Demand

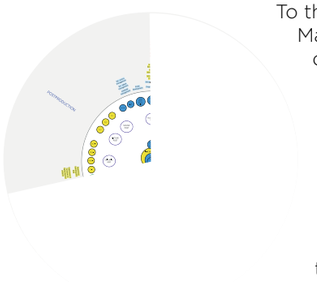
Because the film industry and film sets work in a very specific way, and there are cultural differences between games and film, and communication can be a challenge.

A film aesthetic is very different from a games aesthetic; narrative design is a different way of looking at the world. There will be real demand for Unreal technicians who can work on film sets, and are trained in that 'setiquette'. As well as film and VFX technicians who can learn to work in the Unreal world.

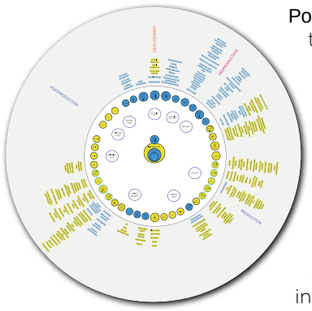
The VP Skills Mandala



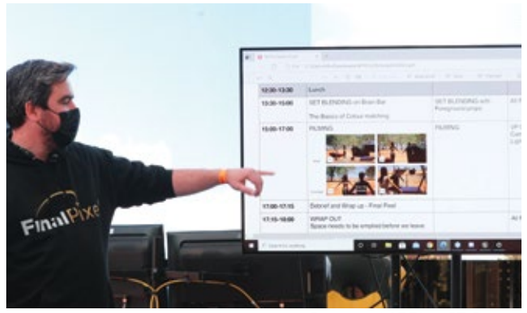
The Camera Department prepare the set from around 180 degrees. The Director of Photography will be coordinating between Director and the technical camera team, as well as the Lighting and Grip teams. The DoP will also liaise closely with Visual Effects and Virtual Production supervisors to ensure that the real-time visual effects created by technical artists in the Virtual Production Department will merge seamlessly with the filmed action on-set. The team under the Virtual Production supervisor calibrates and maintains the camera tracking system - without which there would be none of the spatial and temporal synchronisation between the camera and the virtual set displayed on the LED volume, which together make up the 'storyworld' for cast and crew alike to work within. It is this close integration of technology and story that produces the effect of visual parallax between virtual background and real foreground as the camera moves around in this 'world', and it is this that makes Virtual Production filmmaking so convincing for viewers.



To the West of the Mandala, at 225 degrees, the Editorial Department has received the data from which the final product will be formed, after which the film enters the final **Postproduction** phase ('Post'). Here the Sound Post and Picture Post crew will add any additional effects needed to complete the production design and round off the look and feel so that the story can be delivered according to the original vision of the Director and their Production team. This portion of the cycle looks different to a traditional shoot: visual effects (VFX) for example, are no longer a 'Post' task, having been completed 'in-camera' in real-time during the filming on-set. Any further VFX required will add time and cost to a Virtual Production and may result in the same visual effect having to be carried out twice. This underlines the fact that careful planning of shots and effects during Preproduction is always needed, with much effort shifting to significantly earlier in the project cycle.



Postproduction comes to a conclusion with final colour grading and other finishing, bringing the VP cycle full circle, 360 degrees. An important piece of work that is adjacent to the VP Mandala is work carried out prior to all of the above in the recruitment of crew to a project. The VP Skills Mandala shows an initial mapping of the roles and skills for Talent Strategist and Director of Production, who will lead recruitment. The skills in these roles include talent casting for Technical Artist and other roles such as R&D Engineers to assist in the development of new forms of VP. Significantly, the Director of Production is never simply looking for technical skills, they profile new employees for their aptitudes, interests and approach to working collaboratively in time-pressured situations.



Courtesy of ARRI / CT Group

THE OPPORTUNITY

As Screen Daily reported in March 2021, the pandemic has accelerated the growth and popularity of Virtual Production for its ability to help conquer travel and social distancing measures. But the scale of the opportunities makes VP skills ones the "industry workforce must get to grips with." [3]

Creative Opportunities: Opening Pandora's Box

VP has great "untapped potential in terms of aesthetics, in terms of understanding of storytelling" according to creatives working in VP, potential that goes beyond the current usages of VP "essentially as a green-screen proxy, or a back-projection proxy" (Jamie Lapsley, Production Designer). Realising this potential depends on seeing the creative opportunities of the real-time physics engine, the ability of the game engine to create "a reality" with its own logic. The engine can provide "instantaneous feedback, and intuitive control" and can liberate the creativity of Directors and others in this way (Paul Franklin, Director, DNEG). This can be a two-way exchange between technicians and creatives, as noted by a Director of Photography, "I said to an Unreal Artist, 'Can we do this, can we do that?' They're like, 'No one's ever said that to me before.' So these are the good things that would help drive new stuff" (Andreas Neo, DoP). Crucial to unlocking the potential of VP is providing the space for departments to communicate and understand the skills and technical parameters involved in any task or creative process. As one interviewee explains:

> "those on set need to know if [something is] definitely impossible... or is a slightly more involved process that will take more time?"
> Russell Shaw, VP Supervisor, Quite Brilliant at the Garden.

VP creates an opportunity for creatives to have a stronger say at the beginning of projects, putting their stamp on the look and feel of the production, and ensuring that early creative conversations and decisions are perpetuated throughout the cycle. Producers working in VP gain an improved level of control over certain aspects of production and planning. Creative opportunities are linked to innovative VP techniques, enabling practitioners to push the envelope with "insane hybrid virtual camera moves" and to "blend Virtual Production cameras with my real cameras," test out lighting, plan and carry out re-shoots and pickups via the game engine Unreal, and use virtual sets as a source of lighting and colour (Haz Dullul, Director/Producer, Hazfilm). Fireworks director Paul Franklin adds that key production design opportunities emerge through the deliberate merging of the virtual and physical:

> "in fact, we needed to consider them as a whole, even though they're two very different worlds, they're these different imaginary spaces that exist within the same visual world"
> Paul Franklin, Director, and Creative Director, DNEG.

Business Opportunities

VP is reaching quickly into all areas of production, although, so far, there has not been a full feature film made using VP. Nevertheless, as a measure of the range of VP, "there is now not a single [key] show on Sky that does not use immersive tech in some way" (Richard Nockles, VR Creative Director, SkyVR). Real-world factors play a part here, since "the reason why people are doing it is... because it's going to make things quicker and therefore cheaper" (Mark Flanagan, EMEA Education, EPIC). This speed makes VP a very different proposition up and down the production hierarchy, with Executives able to make immediate decisions:

> "They're like, 'Wait, what? This never happens. We expect a week later to get some notes, and we sit around and do a whole bunch of notes on email.' I'm like, 'No, you can just address the notes now.' So that's a game changer for them"
> Haz Dullul, Director / Producer, Hazfilm.

Efficiency is therefore a key driver for the uptake of VP. This comes at a time when efficiency gains that have been made in recent years may have reached their limit. VP offers new opportunities, such as previsualisation, which can reduce re-shoot requirements that often run to 20% of total budget. LED shooting techniques reduce the cost of Postproduction, including compositing and rotoscoping, and can often lead to faster production of screen-test versions of projects, thereby reducing the overall time needed to reach a final product. Virtual sets can also save on production time and costs: travel for the crew is minimised, as is transportation and the cost of filming on location. Quite Brilliant VP studio at The Garden undertook a carbon analysis on a recent VP shoot with Ad Green and We Are Albert, the industry consortium created to drive sustainability, which indicated that VP might have been "130 times more effective" compared to going on location (Russell Shaw, VP Supervisor, Quite Brilliant).

Beyond efficiencies, second-order business opportunities also expand around VP: for example, creating scans or models of well-known locations or unique props to be licensed as digital assets to other productions. The ability to reuse digital 3D assets and virtual scenes is also likely to have an impact on driving productions towards a more efficient approach to budgeting and scheduling of resources between and across productions. Following the increasing appreciation of the business potential of VP, one client-facing VFX Supervisor reported that he could see that "commercials people were just literally thinking, 'We just don't need a set'," and are becoming aware of the time and money that can be saved in this way (Gary Brown, VFX Supervisor, Ghost VFX). For studio owners, LED equipment and virtual sets can be used for production of commercials, and can be re-used for further seasons on Series-based productions, or on sequels and other content for film projects.

Entry Opportunities

Many of our interviewees related the fact that VP "is a good place for people that are trying to break into the industry" (Dullul, Director/Producer, Hazfilm). With the number of VP stages expanding rapidly, and the unprecedented demand for content across many platforms, there is a moment of opportunity for entry-level runners, interns and graduate trainees to gain valuable experience on-set in VP. Rather than standing aside deferentially, these entrants would be well advised to "ask for something to do... because VP is so big, and there are so many tiny little things that need to happen, I think interns can play a big part in that" (Dullul, Director/Producer, Hazfilm) and shorten what is traditionally a long multi-decade journey to rise to the level of Director or VFX Supervisor, for instance. Recent graduates can also take advantage of this freedom to operate. A graduate from 2019 found his university training in Contemporary Media Practice to be extremely useful - for example, he was able to transfer the skills from the marked documentation modules of the course to current VP projects, which is an area in need of development to support evolving workflows. This earlier involvement, at the ideation stages of a project, is an opportunity:

> "because I'm doing a lot more than just a technical role at the moment, I'm being brought on a lot sooner, which is also beneficial for me, getting more experience in more aspects of the pipeline"
> James Codling, VP Stage Technician, Final Pixel.

After all, says Production Designer Jamie Lapsley, "there's a zero cost way into this - Blender and Unreal" (Lapsley, Production Designer), and it is partly this that promises to deliver a diversity of backgrounds into VP. Practitioners acknowledge that, to-date, when recruiting for roles in immersive "it has tended to be white men" (Peng and Dobbs-Beck, ILMxLAB) and that with VP there is an opportune moment to change this. The current skills shortages in Unreal for VP mean that the employment net is being cast wide by companies, however, this has not helped to remedy the prevalent gender imbalance:

> "It is at the level of your, unfortunately, boy in the bedroom. I wish it was a girl in the bedroom, but it's not"
> Simon Frame, VFX Supervisor, Netflix.

© Wilder Films / Fireworks

[3] Baughan, N. (2021) 'Training: How Virtual Production will become essential beyond the pandemic', Screen Daily, 17/03/21. See: https://www.screendaily.com/features/training-how-virtual-production-will-become-essential-beyond-the-pandemic/5158106.article

CASE STUDY | SPACE FILM & VFX

Name of Interviewee:
Matthew Nelson

Job Title
Producer

Company
Space Film & VFX

Virtual Production Role

I work in the production side, and that's all about communication, it's all about information, sharing it, and getting it. Whereas in the visual effects world, and a lot of the characters are... not all of them, but some of them can be quite introverted themselves. They like what they like, and that's what they do. Whereas directors or actors, they're the opposite, aren't they?

The Changing Role and Relationship to other Departments

VP will definitely affect roles in that they will need to evolve to adapt to VP. It may not, for example, affect the Wardrobe Department ... but certainly the roles and relationship between the set designer and the Director will change.

I think Postproduction will become more of a priority... VFX is going to really be helping in the look of a film, working closer with the DoP and the director and the whole creative and technical process. They will be involved at the beginning and have a stronger say in how the overall vision is delivered.

The Opportunity

VP is going to become the norm over the next three to four years because it reads instantly. You've got lights interacting with physical objects that are actually there and real so it's definitely 100% believable.

It's currently a very expensive way of shooting. But I think over the next two or three years, the price will come down. There'll be more and more skilled people available to do it and there'll be more and more assets available.

The Skills Challenge of VP

At the moment, it's still expensive to shoot in VP. To build a studio with a volume is probably going to cost more than flying out to shoot in a location and doing it. So, at the moment, if you're going to do it, I think you've got to get a lot more added value and residual use out of using VP.

As a company we've put VP options forward for a production but perhaps the Director's not used VP before and Directors will probably still go out and shoot it on a location rather than do it with a VP set.

I've also had that as a problem with people working in games; they're brilliant at that and it's good for games, but for film it's a completely different discipline.

The Skills Demand

We need people who are passionate about visual effects ... because there's so much to learn. 3D skills are going to be even more important. That's where we'll be focusing our hiring, over the next two or three years. But the challenge is that globally there's a shortage of VFX artists.

Courtesy of ARRI / CT Group

THE CHALLENGE

Courtesy of ARRI / CT Group

Broadly, we might think of the challenge in terms of the colour-coding of roles and skills in our Mandala: technical and creative. As per the Mandala, in roles like the Technical Artists, these challenges often overlap, whilst the need to build new and e ective work ows is a challenge that unites all of the roles, processes and skills detailed on the Mandala. But here we outline them separately to help identify the challenges and then, in the next section, speci c skills gaps and touchpoints for these. In so doing, we hope to also point out where these two challenges need to be tackled together to increase the opportunity of VP.

Creative and Communicative: Making "the Magic Happen"

The changing place of roles within the film production pipeline as well as the introduction of roles from the games sector creates new kinds of creative and communication challenges. As Producer Annalise Davies explains, "film sets work in a very specific way, and to have games people within that world is a big cultural issue," which has an impact on how people communicate up and down a long established on-set "chain of command." This is a two-way problem, of film adapting to games and vice versa: for those coming from games, a VP shoot is "just a different aesthetic, a different set of guidelines that you wouldn't get if you're doing a game compared to doing something that's for a VP stage" (Jon Wadelton, VP Consultant). However, true innovation and new forms of screen entertainment only emerge from the convergence of these worlds: "we're looking for the aesthetic that the film folks bring to the table, and we're looking to the interactive [real-time domain experts] for the interaction design. The magic happens when they both bring the best of their past but are willing to learn from one another" (Vicki Dobbs-Beck, Vice Executive in Charge, President Immersive Content Innovation, ILMxLAB). A way forward is:

> "to actually acknowledge the difference in approach that these two industries have... the goal then is to figure out a way to take the best of both" Julie Peng, Director of Production, ILMxLAB.

This is not simply about the world of games entering films: the overriding challenge is to find ways of minimising any potential "disconnect" when companies expand into VP and come into closer contact with the real-time computing mindset as a result, says Julie Peng. Communication, as ever, is key – with our interviewees stressing the importance of soft skills as well as technical competencies to make the most of the VP opportunity. This new emphasis on the importance of communication will help asset-producers working in new Virtual Production Departments to manage a different kind of relationship with clients, one that is now more strongly mediated by Production Designers – playing a role earlier, or higher up, the production pipeline. There is a need to counteract old habits where:

> "people doing real-time assets [are seen] as being separate to people doing the backend, a little bit of that [divide is still] being created"
> Jon Wadelton, VP Consultant.

This balancing act is reflected in the integration of physical and virtual sets:

> "You try and merge the worlds together. It's tough, it's tough" Andreas Neo, DoP.

The primary aim, therefore, is to create an appropriate environment for the specific constraints, challenges and opportunities of VP. Professionals consider this by asking:

> "How can we fit that creative vision within these practical constraints? And if that's a balanced kind of relationship, you tend to end up with the best work" Vic Wade, Head of Training, DNEG.

Technical and Logistical: "faster, cheaper, and better"

As Virtual Production workflows develop, there is a constant process of adaptation to the fact that at present "the technology that they're introducing is essentially always in beta mode" (Andreas Neo, DoP). This is an R&D moment in cutting-edge technology that promises to transform the way we make film, television, games and immersive experiences. Alongside this, there are nevertheless strict limitations on how to plan camera moves so that camera tracking systems are not compromised, and on-set time must be planned for recalibrating the system for each lens and scene change.

Key logistical and technical challenges include the fact that the cost of VP is prohibitive for most independent or low-budget television productions or low-budget films, especially when compared to green screen techniques which are relatively cheap. Where opportunities for VP exist in long-form high-end television and film, the costing and planning of VP shoots is an area much in need of understanding. VP is a new type of production, where there may be savings on the one hand, due to the economies of filming on-set compared to filming on location, while on the other, there may be potential hidden R&D technical costs. As Paul Franklin reflects, "I think people just come on to it with unrealistic expectations." Scheduling and budgeting for VP requires a heavy up-front investment of time and money into the Preproduction phase, before a single piece of data is captured on-set, a fact that clients may not appreciate fully until their first VP project has been undertaken.

Small scale commercial projects may find this particularly challenging at present:

> "By the time we find out [about a potential VP project], the client's signed off on the job. They want to get it done and shot and delivered in six weeks, and it's on air"
> Matthew Nelson, Managing Director, Space Film and VFX.

VP has a different timescale to traditional filmmaking, one where "fixing it in post" is effectively eliminated: "it forces decisions to be made much quicker, which I think is a big plus. And it's because of the way Virtual Production is. It's all in-camera. And they know that fixing it in Post is very expensive" (Haz Dullul, Director/Producer, Hazfilm).

Amongst the many technical challenges of VP is the real-time "integration" of set, actors, the virtual scene and visual effects. This process challenges all aspects of production, both hardware and software, as well as the skills needed to operate VP technology: from developing new DMX lighting rigs to creating innovative solutions to improve sound performance against the LED volumes. In this fast-paced landscape of innovation developing repeatable and documented workflows becomes crucial: "If you wanted to do it all properly, you would look to have everything in the engine from the beginning." and use the real-time engine for previsualisation and shot planning before coming to the VP stage (Jon Wadelton, VP Consultant). Similarly, Production Designers Caroline Greville-Morris and Jamie Lapsley argue that attaining the optimal form of handover from Production Designer to the VP Department is essential:

> "Any assets we [the Art Department] generate need to be able to be taken in either direction [digital and physical] without any more input from us, because of the way that the technology is moving. Now we are going to [need to] make models, Unreal Engine models, of every single environment that we are creating for the film"
> Jamie Lapsley, Production Designer.

Ultimately, this new technology, processes and workflows all comes down to developing a rapid skills pipeline. In the current market, where such skills are scarce, companies discuss a fierce talent retention battle and a fear of 'brain drain' as tech companies poach the brightest screen industries' professionals. Even for large film studios, like Lucasfilm, it is "hard to compete [with] big companies like Microsoft [who] are very invested in Virtual Production and Immersive development" (Julie Peng, Director of Production, ILMxLAB).

CASE STUDY | ILMXLAB

Name of Interviewees:

Vicki Dobbs-Beck
and Julie Peng

Job Titles

Executive in Charge,, Immersive Content Innovation with overall responsibility for ILMxLAB (Dobbs-Beck); Director of Production with responsibility for talent strategy, ILMxLAB (Peng).

Company

ILMxLAB, Lucasfilm

Virtual Production Role

The Virtual Production group at ILMxLAB is seen as two teams. One is the on-set team, and the other is everyone preparing the content to be used on-set. I think those two 'mind-sets' are quite different. The latter is a little bit more of a traditional workflow, CG asset creation essentially, everything has to be really efficient rendering-wise. The on-set mind-set, however, is about being adept at real-time troubleshooting. It's like working on a live action shoot essentially. One of the training opportunities is to actually acknowledge the difference in approach that these two have and figure out a way to merge the best of both.

The Changing Role and Relationship to other Departments

We want to have adaptability for each producer to be able to adapt their style while also allowing things to work well for that project and still be able to have a project manager easily jump from one project to another.

Our wider immersive development workflow is highly creative and collaborative and we do always have a lead creative who is the final decision maker. We had a couple of Animation Supervisors who said it was a new experience for them to be included and consulted on so many different creative levels. Everyone has the ability to contribute ideas and it really is a taskforce to figure out what is the best narrative here? How are we going to tell this story in the best way? What's working? What's not working?

I think Postproduction will become more of a priority... VFX is going to really be helping in the look of a film, working closer with the DoP and the director and the whole creative and technical process. They will be involved at the beginning and have a stronger say in how the overall vision is delivered.

The Opportunity

For apprentices, I think there are very few barriers to working in VP, it's open for everyone ... In some of these emerging areas, the growth can be much quicker than the traditional journey up the ladder.

The people in the ILM Virtual Production teams, be that on the LED stage or running the real-time teams that are operating all of the visuals that go on the displays, have come from almost every single discipline within the VFX side. They're modellers, texture artists, layout artists, compositors. There's not really one discipline to transition into VP from.

In our roles, almost every single role requires some level of programming. So whether it's in Unreal Blueprints, which is more of a visual based programming language, node based, or, you're writing C++ plus code, whether you're an experienced designer, level designer, technical designer, gameplay engineer, Technical Artist, even an animator or asset artist, environment and character artist, all require some level of scripting at some point in your day.

The Skills Challenge of VP

One of the challenges of VP is to help these two groups eventually get closer and closer to the same mind-set so that we weren't speaking two different languages.

We need to write job descriptions and have job titles that appeal to people out in the world so they understand what it is that we're recruiting for. But sometimes we bump up against the fact that what that title means in the interactive space, it's different to what it means in the visual effects space. Plus, all the Virtual Production studios are developing their own proprietary workflows, so each studio will have its own special sauce, if you will, of how their solution is a little bit different or better.

The Skills Demand

Unreal is definitely an area where there's a talent shortage, and Technical Artists for us is the most challenging position to fill. The talent base is growing exponentially which is fantastic.

There have been open positions with us at ILMxLAB, and these are R&D roles for VP, that have been open for literally months and months. These positions require specialist high-end scientists and engineers who are interested in melding different mindsets, and it is an interesting skills gap that will be there for a while.

The demand for people with real-time capability is absolutely escalating at an incredible pace and it crosses many industries. It's not just competition within the immersive storytelling or within the games space, it is competition for people with real-time capability across industries.

Courtesy of ARRI / CT Group.

THE SKILLS GAPS

In this section we analyse the responses of our interviewees to the question: "What roles and associated skills are in most demand for Virtual Production?" Within the current internal business structures there are signi cant challenges around recruitment of skilled people. This is becoming a barrier to growth. Those who can make the crossover from games or VFX into VP are in short supply and all respondents who had responsibility for recruitment reported that there are severe skills shortages. These skills gaps are represented in the detailed images of areas of the VP Mandala that are shown in this section, and which highlight the mix, and overlap, of creative and technical skills currently in short supply.

Skills in VP may be used across different roles and Departments, however, here we present the insights gained about skills most in-demand in VP, organised across two broad domains:

- **Creative and Communicative Skills:** which includes soft skills needed for collaboration and to manage on-set technical skills in VP VFX for example **(Figures 3, 4)**.
- **Technical Skills:** including those used by VP Artists, and VP R&D for innovation of new workflows, as well as VP Colour specialisms **(Figures 5, 6)**.

By presenting these in this order we follow the general sequencing of the Mandala. Within each domain we present an ordered list of the key skills gaps, as described by our interviewees. Many of the most in-demand skills are in the Technical domain, while other critical skills gaps are in Production Design, for example, within the creative sphere. Talent Strategy is dealt with in more detail in the ILMxLAB Case Study (see p.20 and **Figure 4**, for Production manager role).

5.1 Creative and Communicative Skills

Communications

Communications are central to the creative process of VP, says Monica Hinden, Producer at Final Pixel, "giving heads-up when things happen, asking honest questions, having open lines of communications, being comfortable to say what you need from people, and to tell them when and what was a problem for you." The Preproduction process involves an intensive cycle of collective 'review and rework', which must be planned for.

The necessity for early and resolved conversation is apparent when the pressures of disciplinary work and scheduling are considered: "10 scenes in two days... It's almost choreographing the whole thing. It's got to be so regimented" (Shaw, VP Supervisor, Quite Brilliant). "My not having the vocabulary to describe things made it difficult, especially to talk to the people who control the software" says Grapes Wasserman, Production Designer. To take one example of where communication is paramount, in the Camera Department, says Andreas Neo, Director of Photography:

> "[Usually] we have quite strict dialogue on sets on how to communicate with one another... there's a learning curve attached to a completely new Department being on the set ... [but] what's interesting with a virtual environment is the communication will be completely different ... it's not [with] a Gaffer. I have to understand that it's not as easy as turning a switch on a physical lamp versus a virtual one."

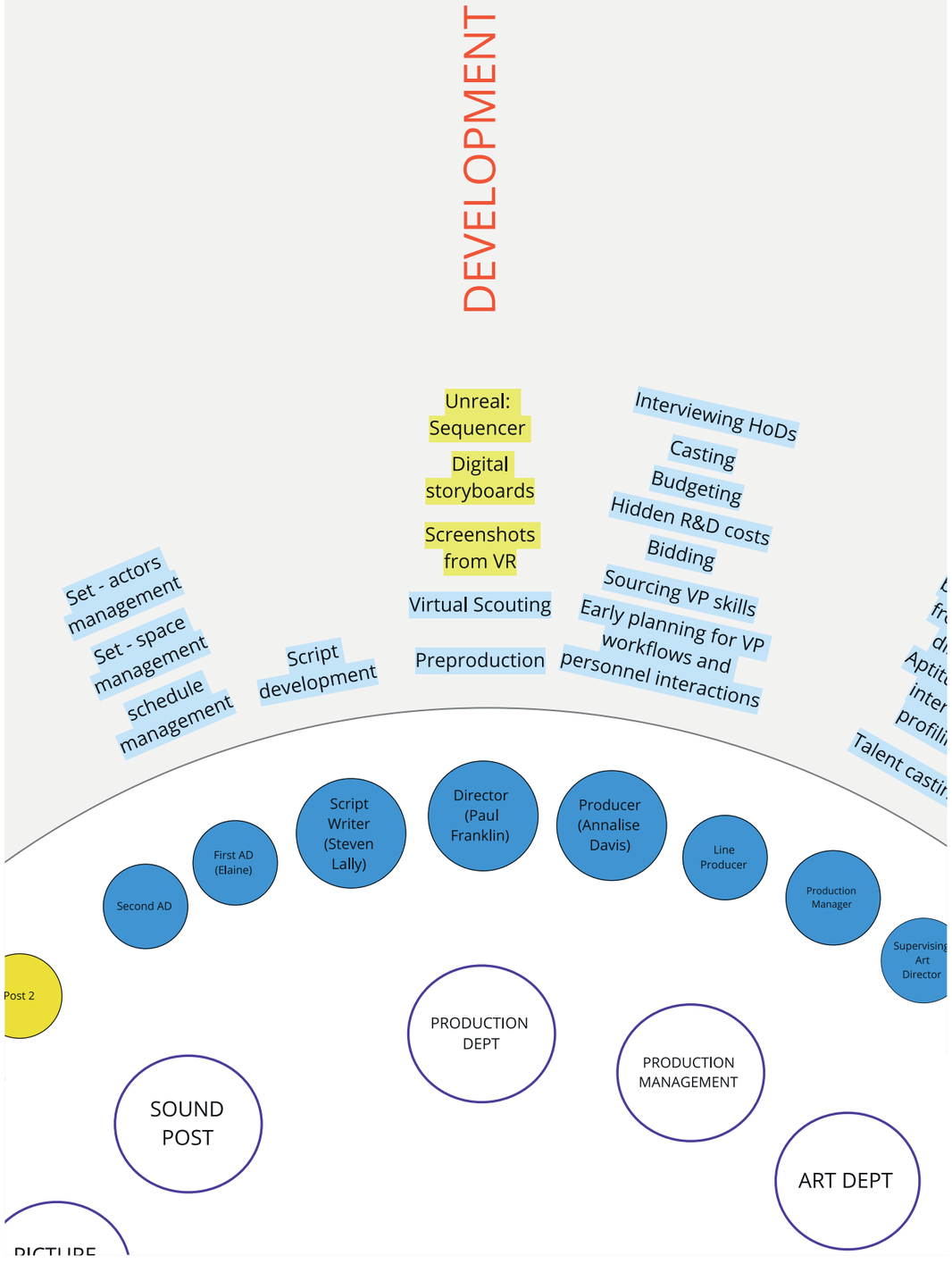
Acquiring the new communication skills for this is important for making the adjustment to a new way of working: "this was slightly different to what the DOP was used to, [who was] saying, 'Can you just take the magenta out?', and the LED chap didn't have that control, he only had RGB control over things" (Ellie Clement, VP Supervisor).

With good communications in place an Unreal Technical Artist can collaborate effectively with Art Department Physical Standby on crafting the "matte line" (the join between LED screen and real set), to say, "Well, actually, it'd be easier for me to quickly just put a fake bit of grass, or something, where that joint is and just try and blend it a bit better rather than you starting to physically move things around" (Russell Shaw, VP Supervisor, Quite Brilliant).

Integration of Film-Games Cultures and Tools

Interviewees noted problems with combining skills and methods associated with games into a film context. Some crew lacked an understanding of how games tools can be integrated into the general flow of the VP shoot day. In the context of a busy working crew on a VP stage where time management is key to 'shooting the schedule', general problems were noted with incompatible working practices and lines of communication. Teams were also confused by differing nomenclatures and reporting structures. This often came down to lack of understanding of

Figure 3: The VP Skills Mandala, detail: Creative and Communicative, Development phase



the culture and tools that each department worked within and with. Thus, interviewees from the film world would complain of visual effects and games people "finding themselves on-set" without an appropriate "understanding of stagecraft" which, in turn, might lead to asking technical artists on set for unrealistic timelines to implement environmental scene changes. Directors who are used to be able to make instantaneous decisions now need to work with people who understand the trade-offs in VP stagecraft "so that when somebody says 'I want the sun over there', they can swing the sun round in the digital environment, rather than saying 'Ooh, it's gonna take me 15 hours to do this'." (Paul Franklin, Creative Director, DNEG).

Work ow Integration

> "I would say that integration and knowledge of how it all fits together is what would be missing. Even if you had the technical knowledge and on-set experience or educational training, it's the knowledge of how Virtual Production differs and how it integrates."
>
> James Codling, VP Stage Technician, Final Pixel.

A key difference between traditional film methodology and that of VP is the front loading of what was traditionally postproduction. The lack of understanding of the integration of VP pipelines and workflow models (which originate in the Games Industry) with those of traditional filmmaking is cited by many interviewees as being vital to the success of VP projects. It is important for producers and relevant crew to understand how the workflows of traditional film production are hybridised for VP: the various workflows needed to deliver high quality work from concept to completion are being rewritten for VP so as to emphasise the 'front loading' of the process. Significantly, this workflow largely removes the possibility of "the fix-it-in-post method", thus altering workflow, budget and production culture established norms and hierarchies.

VP Supervision

> "Virtual Production Supervisors and the Tech Artists ... are becoming a lot more important for projects."
>
> Vicki Dobbs-Beck, Executive in Charge, VP Immersive Content Innovation, ILMxLAB.

In some companies this role is referred to as 'Real-Time Supervisor.' During Preproduction, Directors, HoD's and, importantly, executive decision makers are able to sign off the in-engine environments, locations and scenes before principal photography begins. This front loads the delivery process, crews no longer shoot against green screen and months later the post vendor delivers the VFX package. What you shoot is final pixel in-camera. The work of pulling this effort together on set falls to the VP Supervisor. The role of the VP supervisor is based loosely on that of the VFX supervisor in that they provide a bridge between the Directors ultimate vision and the on-set teams' ability to realise those ambitions. Many of our interviewees with the job title VP Supervisor have come from a background in Motion Capture or Previsualisation. The VP Supervisor designs and manages the workflow for each show, and plays a vital role on-set in managing all aspects of the VP package. Ultimately the VP Supervisor is a bridge between different work cultures, tools, methods and workflows that must bring these together on-set to help realise a shared creative vision. Crucial to such a role are soft skills in communication, people management, scheduling and assessing risks and opportunities for the production as a whole.

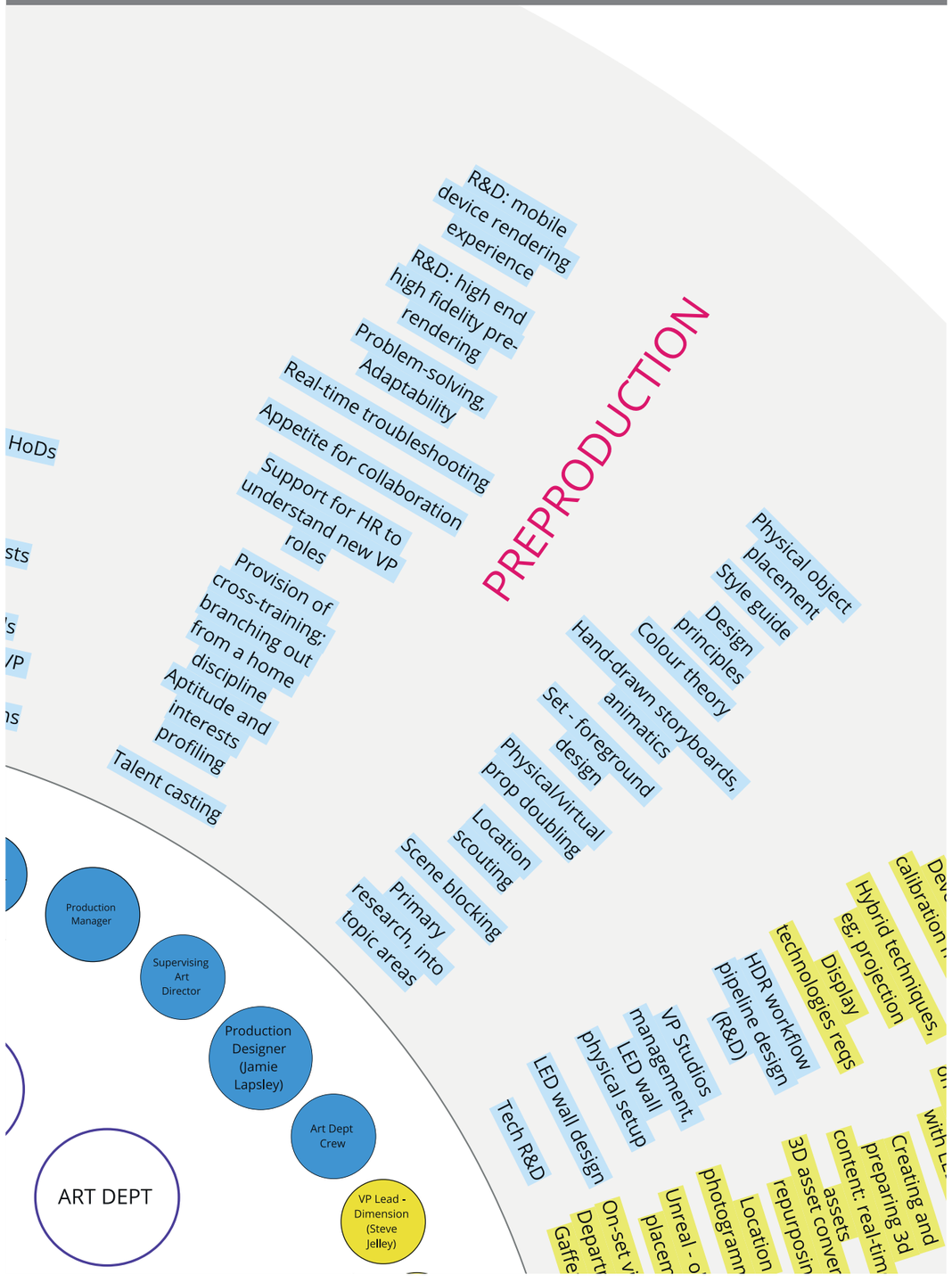
VP Production Planning and Budgeting

Producers need to understand how to budget for VP and how to schedule crews for VP. These VP skills areas demand a refresh in terms of how Producers schedule a project, and how they are budgeted from the outset:

> "Producers [who] understand VP, that's lacking too, understanding, not just from an operating perspective, but also from a costing perspective. What would make sense to do it on the LED screen? What doesn't? What kind of people you have to pull in to get a thing done, and [an appreciation of] the stages of VP production there are, that's definitely missing."
>
> Jon Wadelton, VP Consultant.

Ensuring the finance plan and the budget match is a primary goal for Producers, especially important because of the often higher budgets needed for Virtual Production. Working as a producer in VP also requires a willingness to spend a great deal of preparation time working with leads from the VP Department to refine and plan the workflow and scheduling, in tandem with Production Designers from the Art Department.

Figure 4: The VP Skills Mandala, detail: Creative and Communicative roles and skills, at Preproduction



> "As long as we're stuck with the old 'everything happens in post' spending model, it's really, really bloody hard to actually get the amount of prep and work happening up front that you need to do it well... the project management planning side of it also needs to come along."
>
> Joe Statham, VP Technical Director, DNEG.

In addition, says Statham, other Departments are struggling to keep up with new VP practices. The variability and lack of stability of VP workflows requires up-front R&D costs, which may not be anticipated by Producers initially.

Like Virtual Production itself, Statham argued, with VP "everything has to happen now, everybody's schedules change, those budgets have to be accounted for." In such a world, everything changes and there is not a skillset, methodology, culture, workflow or tool that remains untouched. The challenge is, therefore, manifest.

5.2 Technical Skills

Universal 3D Skills for VP

> "We need people who understand creating assets and maintaining them for real-time engines; using real-time tools, so, understanding how the real-time tools work, understanding the differences between real-time tools and the visual effects tools."
>
> Paul Franklin, Creative Director DNEG,and Director, Fireworks.

3D skills for VP are noted by many interviewees when describing a general skills gap. Highly skilled 3D artists working for Postproduction vendors are traditionally used to working with shot plates, photorealistic assets and scenes generated from traditional filming methods. The switch to VP places more emphasis on designing and building assets and scenes prior to filming which are signed off and 'played back via the LED screens' as final pixel: the scene is captured 'live' in camera. The impact on the demand for 3D skills is significant: it not only requires 3D artists to work earlier and across different parts of the production pipeline, but also requires that their work is undertaken using a games engine rather than traditional Postproduction software packages such as Houdini, Maya, Nuke and Blender.

Common Art Department Games Engine Skills

> "There is definitely a gap in the market at the moment for technical artists and production designers and stage technicians especially. People who have got the experience of working on a film set but also understand the game engine."
>
> Annalise Davies, Producer, Wilder Films, Fireworks.

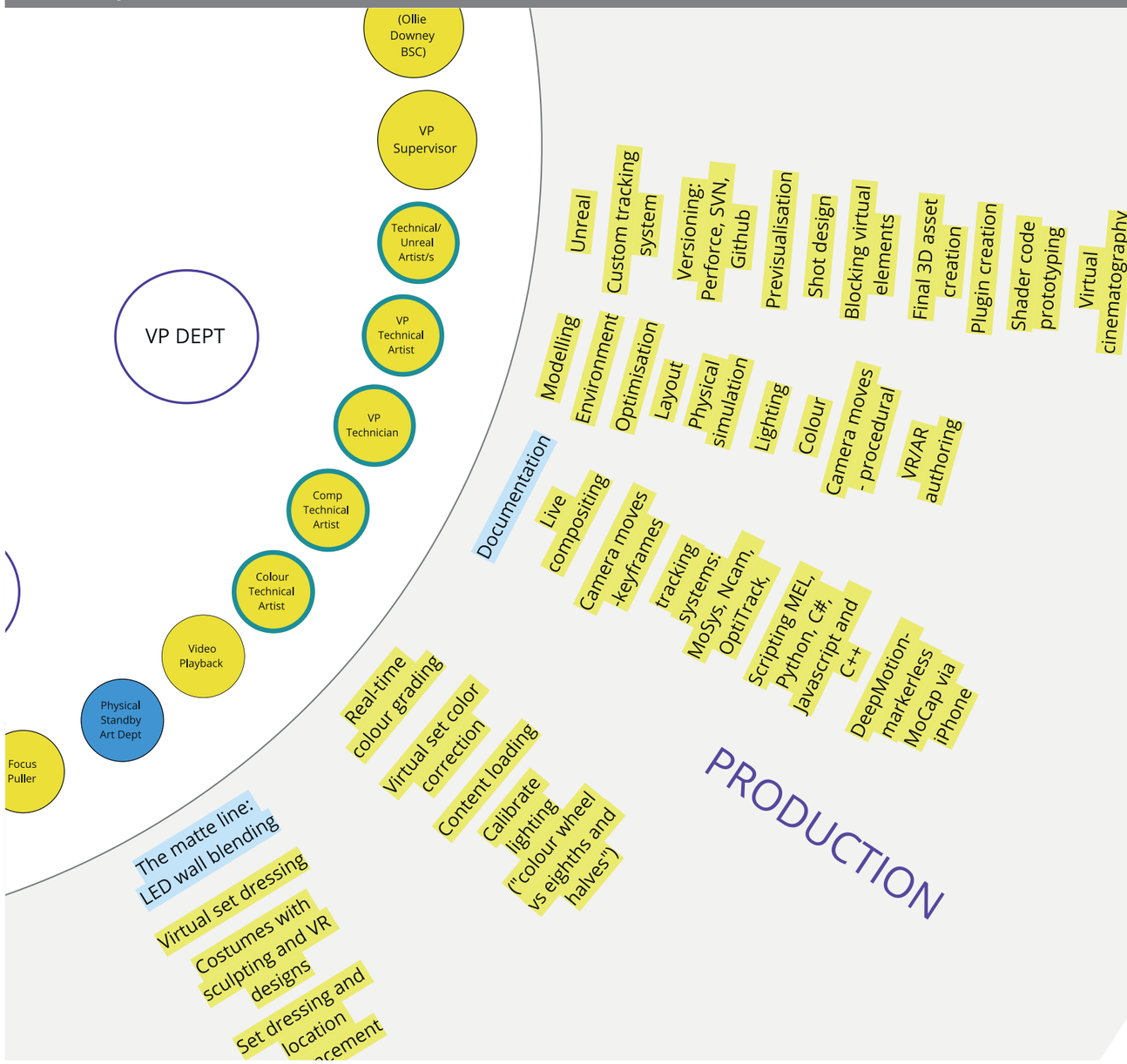
Here lies one of the fundamental skills problems: the unique mix of high technical capabilities in game engines, mixed with creative skills, plus experience required of working on-set in the Art Department for VP is a problematic one. Production Designers and their teams – including Art Directors, Set Dressers, Props Departments, Painters and Set Construction teams – often have skills in computer design tools (such as Sketchup), but very few have any training in handling and designing assets in a game engine. Where once an Art Director would work with the Set Dresser to populate a set with real props, now they will need to design / buy assets for both the engine and the reduced elements of the physical set. Many interviewees noted the lack of symbiosis between real props / assets and those designed in-engine. Discrepancies between the Production Designer's vision and the Technical Artists' ability to work to this vision are regularly noted, resulting in assets being rejected by Production Designer or Director as unrealistic or oppositional to the overall design concept for the project.

The problem is exemplified by Production Designer Jamie Lapsley speaking of the steep learning curve, communication and workflow issues encountered when integrating skills and methods from the games industry into on-set VP production:

> "This is less about what it looks like, which is one of those counterintuitive things, but production design as a story-telling tool is essentially an intellectual exercise where you're solving story and script problems, with a visual medium. And your own internal aesthetic will dictate what it looks like. We really have to get vendors to understand how we work, and how we would be taking the process forward. So trying to move them into a film pipeline, [in contrast with] their normal client based pipeline in the commercial sector or sports. The placement of objects needs to be organic and real."

As Lapsley continues, the problem is that games artists may be used to having free reign to build game environments, whereas on a film project "you sit with a script and you work it's a design there's steps you go through in thinking about things and the investigation of the material... [and] we need to know why everything is there when we do this environment."

Figure 5: The VP Skills Mandala, detail: Technical roles and skills, the VP Department



Plugin Design Skills

> "The real growth in all this is who's going to write the plug-ins for user-friendly film and TV tools. Where are the plug-ins?"
> Simon Frame, VFX Supervisor, Netflix.

Only a small number of film-friendly tools are currently available for Virtual Production. During our research, respondents mentioned the release of EPIC's Unreal version 4.27, which includes new tools specifically designed for filmmakers. There is a need, however, for a skilled workforce able to add new functions and features when needed which are specific to the filmmaking process and that operate within the existing game engine software. As ILMxLAB specified in a recent job advertisement: 'We're looking for engineers with experience in-camera VFX, performance capture, real-time visualisation, retargeting and/or complex systems integration. We need people with a keen interest in making production-worthy tools for artists, and with the drive to put them into action on our upcoming slate of exciting shows.'

Technical Direction (TD) Skills

A Technical Director is the programming / engineering lead for a games studio or VFX vendor. Typically from a software engineering background, they are a leader responsible for developing tools to deliver the project. The Virtual Production TD is responsible for running virtual camera sessions and is part of a larger Virtual Production final pixel stage. They will look after assembling scenes from the virtual scouting sessions and virtual camera shoots, as well as being a key stakeholder in the continuous development of the VP pipeline. The role requires many years of experience, as the lead (real-time) technical director works on-set as part of a Virtual Production Department team, working closely with other on-set specialists such as the Virtual Production Supervisor, supporting the filmmaking process and ensuring, in the words of a recent DNEG job advertisement, that: 'the team remain dynamic, versatile and efficient. Your work will improve the overall creative experience and ensure educated decisions can be made. … As well as being technically proficient, you will also need to be a solid communicator.'

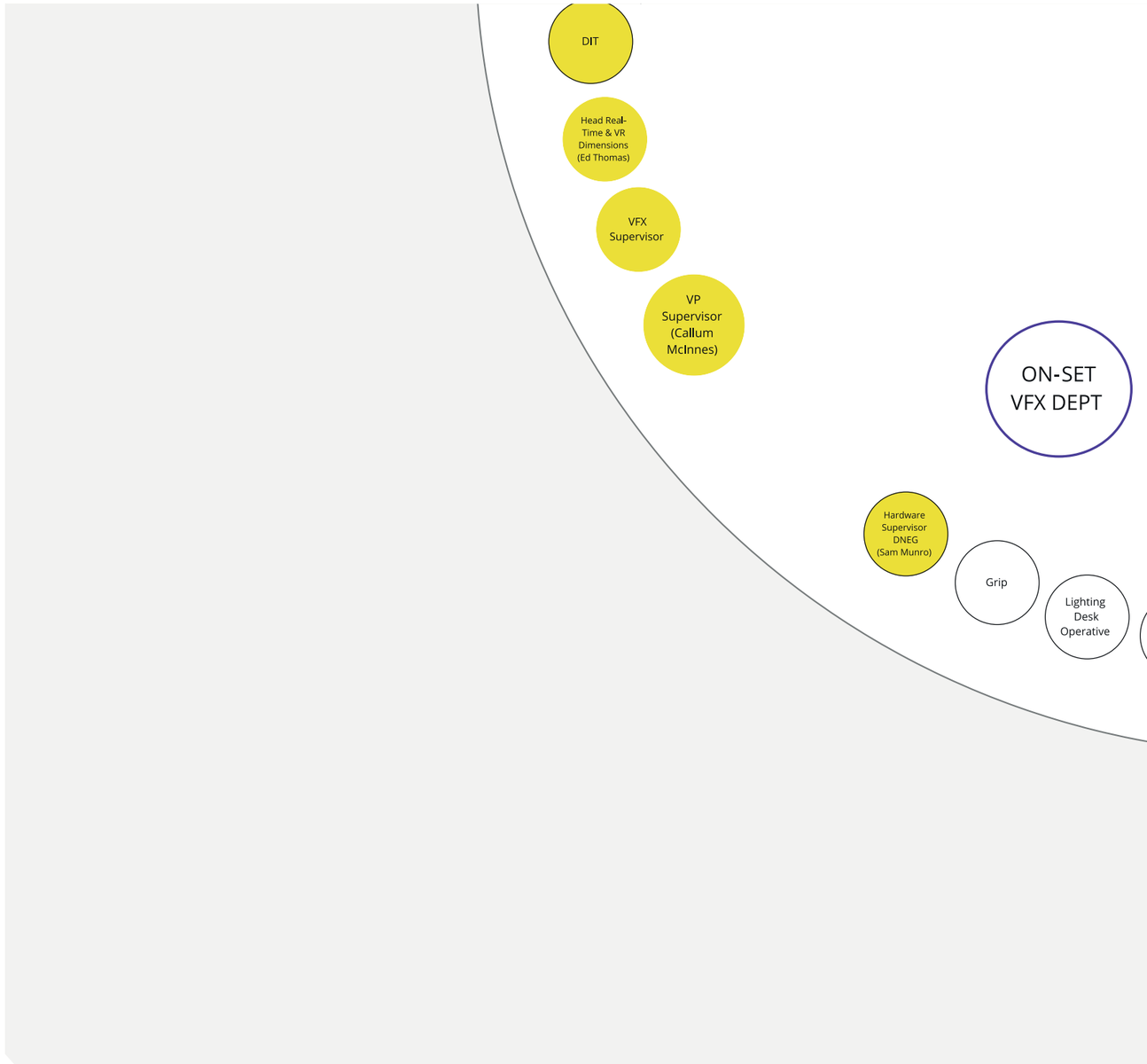
Asset Building Skills

> "One challenge is just [VFX] houses that are capable of making real-time assets, there is a short supply of those."
> Jon Wadelton, VP Consultant.

The various props, buildings, vehicles and set dressing that form part of the virtual set are referred to as assets. In traditional filmmaking, each set is populated with dressing required to help tell the story. The work is specified and led by the Production Designer and Art Director and is approved by the Director. In VP these assets are created by an artist or asset builder who works across the complete process of conceptualising, modelling, texturing, and integrating the real-time VP assets. Multiple vendors are often sought for asset creation. The Asset Builder plays a core role in the Pre-Production team, working towards the delivery of the engine-based sets. The role combines the skills of a 3D artist with competencies in modelling, texturing and shading for 3D characters, objects, props and environments, which are then optimised for real-time workflows.

General Coding / Engineering Skills

> "You need coders, you need people who can get into the Unreal Engine. There's just not enough of them, and most of them are in Games and they don't want to leave."
> Simon Frame, VFX Supervisor, Netflix.

This reported 'lack of interest' in moving from games into film has its roots in the separate business models of film production and games. Games companies tend to hire their workforce on longer term or full-time contracts. Film production companies traditionally use shorter fixed period contracts. VFX vendors are hired by the lead production company on a 'by project' basis, with VFX supervisors often employed 'in house', and therefore on loan to the production company for the duration of the shoot. As we found in our first Skills Report, the safety, familiarity and relative job security of the games studio far outweighs the appeal of the on-set and sporadic work world and methods of film production.

Moreover, as Vicki Dobbs Beck and Julie Peng at ILMxLAB argue, the skills required are 'unique … [because we are] looking for some folks who