Camera roles – Virtual production competencies

This document lists the additional competencies (or skills and knowledge) required to incorporate virtual production techniques into different parts of the workflow within camera departments. The competencies for the various camera related functions and departments are divided into three main areas of work, based on the existing structure of the National Occupational Standards:

1.   Supplying and maintaining camera and related equipment
2.   Setting up camera and related equipment
3.   Using equipment to capture quality images

This document lists the skills and knowledge required to include virtual production in each of the above areas of work.

The grids below list the new or modified competencies needed in order to adopt virtual production within a project. These complement the wider competencies required within each of these functions to undertake more traditional projects, which are detailed in the full National Occupational Standards.

1. SUPPLYING AND MAINTAINING CAMERA AND RELATED EQUIPMENT FOR VIRTUAL PRODUCTION

Main function	Skills related to virtual production *You must be able to:*	Knowledge related to virtual production *You need to know and understand:*
Identify camera equipment and tracking technology (DP role)	1. identify camera equipment which suits the type of location, power supply, LED screen and the expected use considering the likelihood of mixed reality 2. ensure compatibility between camera and screen 3. ensure that any camera used for VP is gen lock enabled 4. ensure third party suppliers are aware of the camera systems being used 5. ensure artistic requirements of the director and DOP are prioritised when choosing a volume and camera equipment 6. Check which Realtime Player is being used and which version of the software to ensure correct integration (e.g.: UE5 or UE4.27 etc)	1. currently used models of camera, their compatibility with LED volume - accessories and grip equipment and major obsolescent models and its features, uses, benefits, limitations and costs including weight and manoeuvrability. 2. Synchronisation between camera and screen in terms of frame rate, and shutter angle 3. FIZ Data and locational data required for tracking 4. Lens calibration, and camera calibration for real-time engines 5. Ensure colour pipeline is agreed between VP supervisor, DoP & DIT 6. the advantages and disadvantages of the various shooting format options in relation to the requirements of VP 7. how to check equipment is compliant with channel deliverables 8. the relevant health and safety implications when determining resources for VP

		9. the importance of reaching an acceptable compromise between technical and artistic requirements (for now technology leads, but in the long run narrative will) 10. equipment suppliers and facilities houses for VP 11. how to draw up an inventory of selected VP equipment
Maintain and provide supplies of camera equipment and materials	1. confirm availability of required camera equipment with appropriate suppliers and hirers 2. liaise with production manager / producer about gear costs and delivery costs and timeframe 3. confirm timings with appropriate people to ensure an adequate supply of camera equipment and materials to meet production requirements allowing for redundancy where possible 4. ensure camera records include shutter angle, frame rates, lenses height and note any moire or artifacts observed during shooting 5. Differentiate between what gear is required on Test Days, vs Gear Required on Shoot days, and the cost implications of this.	1. camera handling techniques and the implications of damage to cameras through mishandling 2. supplies of equipment and materials including cameras, lenses and accessories, digital camera memory cards, film stock, film camera magazines and digi-slates 3. actions to take to ensure equipment is ready for use including checking that it is clean, has been maintained and that digital memory cards are correctly formatted and of suitable size. 4. cleaning and maintenance procedures and products for the camera equipment in use including cleanliness of all glass surfaces 5. how to set up and equip a clean and completely dark dark-room and loading area 6. why it is important to maintain good working relationships with camera rental houses and studios 7. the role of others involved and when to liaise with them including camera operators, and 1st camera assistants or focus pullers – be aware of new roles emerging directly as a result of the needs of VP 8. how to store cameras and lenses safely and securely 9. any special requirements to ensure the safety and security of equipment when left unattended 10. relevant manufacturers' instructions for the equipment in use 11. the requirements of the relevant Health and Safety legislation and procedures

Further considerations:

- **Rigging track, mounts, dollies, lights and monitors –** Ensure to synchronise cameras with LED Wall, and real-time engines. – e.g. Unreal Engine, Unity
- **Packing camera equipment for transport** – Ensure any replacement or additional equipment is notified to the VP supervisor, the producer and the LED tech to ensure compatibility
- **Maintaining film cameras** – Be aware that shooting on film in a volume is an option: film has successfully been used

2. SETTING UP CAMERA AND RELATED EQUIPMENT FOR VIRTUAL PRODUCTION

Main functions	Skills related to virtual production *You must be able to:*	Knowledge related to virtual production *You need to know and understand:*
Prepare camera equipment for shoots	1. identify camera equipment needed to meet production requirements 2. check the availability of camera equipment and associated materials with appropriate people 3. check whether the LED volume offers its own dedicated camera and lens package 4. make sure camera equipment is tested and calibrated for the specific LED wall and working prior to commencement of shoot 5. explore tracking options and chose most appropriate to the scene 6. discuss maximum frame rate that the LED wall can accommodate 7. if shooting multi camera, discuss the availability of multiple frustrum 8. pre calibrate lenses for real-time engines and / or tracking 9. consider advantages and disadvantages of shooting anamorphic on the LED wall 10. Be aware of additional prep time required for VP shoots, and make production aware of increased prep time.	1. key characteristics of current cameras, lenses and attachments and compatibility with VR stage 2. camera handling techniques and the implications of damage to cameras 3. cleaning and maintenance procedures and products for the camera equipment in use including cleanliness of all glass surfaces 4. how to check the availability of camera equipment and associated materials 5. how to interpret camera equipment needs from a call sheet 6. how to load and organise the working layout of a camera truck 7. the purpose of equipment bags, what they should contain and how to organise them 8. the role of others involved and when to liaise with them including camera operators, and 1st camera assistants or focus pullers 9. how to store cameras and lenses safely and securely 10. any special requirements to ensure the safety and security of camera equipment when left unattended 11. relevant manufacturers' instructions for the camera equipment in use 12. the requirements of the relevant Health and Safety legislation and procedures including requirements for lifting and carrying

Assemble cameras, lenses, lens encoders including tracking systems and other attachments	1. check that all required lenses, filters and accessories are available and in the required condition 2. consider impact of LED wall on traditional filters 3. in conjunction with tracking suppliers consider best tracking crown for style of shooting - will it be handheld, will camera be fairly static? 4. liaise with LED technicians on frame rate of the wall and the source material – select appropriate shutter angle and frame frate 5. consider moire and off axis colour shift when planning camera positions 6. ensure all changes made to camera settings are communicated with both the Brain Bar and LED technicians	1. the importance of mounting lens encoders and tracking systems and understand how this is done and why 2. how to check the required condition of lenses and filters including that they are clean and scratch free and that irises function 3. the function of pan and tilt locks, fluid head controls and platform and centre locks and how to maintain and store fluid heads 4. mechanical and electrical attachments including focus and zoom motors 5. how to attach matte boxes without causing vignetting 6. how to attach filters in the correct alignment 7. recording media required for camera type and how to attach it or load it including how to format digital recording media 8. the role of others involved and when to liaise with them including directors of photography, camera operators, directors and 2nd camera assistants
Test the functions of cameras before shoots	1. confirm all required accessories are fitted and secure specific for VP 2. carry out sync and gen lock tests, calibrate tracking and ensure 3D tracking is functioning 3. daily check of colour drift and colour balance 4. check FIZ data and camera 5. establish daily check list in conjunction with VP supervisor 6. Whenever possible conduct these tests on the actual wall you will be using.	1. the importance of doing both a conventional test independent from VP and a VP specific test 2. the importance of testing before you get to the shoot 3. the importance of daily test to make sure everything still functions 4. why you need to involve the entire crew in testing 5. common problems encountered with test results and how to resolve them 6. the purpose of frame leaders and how to shoot them in different aspect ratios 7. what is involved in checking power sources including the suitability and condition of cables and connectors and battery charge levels 8. how to tactfully suggest solutions to any problems or restrictions 9. the role of others involved and when to liaise with them including directors of photography, camera operators, directors and 2nd camera assistants

Further considerations:

- **Loading film in camera and set up accessories** – Liaise with the DIT and the VFX department on the deliverables and file format and workflows. Discuss use of show LUTs, playblack LUTs. Ensure that the show LUT is multiplied to the LED wall, so the DIT can then work to prevent double lutting.
- **Setting up exposure monitoring** – Ensure camera output meets monitor requirements (rec709, rec 2020, show LUT)

3. USING EQUIPMENT TO CAPTURE QUALITY IMAGES FOR VIRTUAL PRODUCTION

On-camera considerations when shooting on a volume

Below is a list of camera parameters that need to be considered when working with an LED volume starting from the lens, sensor, aperture, noise, shutter speed etc.

	PARAMETERS	VIRTUAL PRODUCTION CONSIDERATIONS
LENS	FOCUS	Consider moire when selecting focus point
	FOCAL LENGTH	Focal length will be dictated by creative interpretation, this will vary depending on sensor size and aspect ratio. • the lens choice might be affected depending on whether lens mapping is required. Ensure focal length and aperture are matched in real time player
	APERTURE	Aperture setting is dictated by traditional exposure requirements – however foreground lighting may need to be balanced to specific output of LED Wall
SENSOR	DYNAMIC RANGE [ISO]	ISO requirements are dictated by traditional exposure requirements
	WHITE BALANCE	Under most circumstances white balance should be set to the foreground element ie not the virtual environment. There is a lot of flexibility within the LED processing to change colour temperature on the wall. Th preferred method however would be to make changes to colour temperature within real-time engines and to keep both the wall output and the wall colour temperature fixed.
	SHUTTER SPEED AND FRAME RATE	Frame rate is constrained by the refresh rate of the screen and sync issues. Currently limited to +- 50FPS.
	FRAME RATE	On occasion it may be necessary to phase shift the shutter timing to prevent artifacts and sync lines. This is less of an issue when the camera has a global shutter

	RESOLUTION	To be determined by broadcast deliverables and post production resources
	FORMAT	To be decided based on creative interpretation, but needs to be communicated to all interested parties. – Brain Bar, LED Tech, DIT, and production
	FRAME RATIO	As peer broadcasters requirements.
RECORDING	FILE FORMAT	No known constraints
	COLOUR SPACE	Dictated by specific volume, and camera selection – Check if the studio has an established colour pipeline
	CODEC	No known constraints / no additional considerations
	COMPRESSION	No known constraints / no additional considerations
	L.U.T.	Do not apply show LUT to screen, only to camera output.

Additional technical considerations for film crew transitioning from traditional location/studio work into a virtual production (mixed reality) environment on LED volume

Specific to working with the LED Wall, the camera crew also needs to be aware of the following technical considerations:

The pixel pitch of the LED	This will dictate how close they can shoot to the screen whilst maintaining photorealism.
The colour temperature of the LED	To ensure correct colour balance
Colour bias	Elect whether to make adjustments through lighting filtration, camera filters, in post-production, or by manipulating the LED output. Most LED screens currently in use were not designed for filming, and consequently the colour bias can cause significant problems
The content being screened on the wall	Does the content have a LUT applied, Is the content HDR, 8Bit, 10 Bit
The frame rate and refresh rate of the wall	This will influence choice of frame rate and shutter angle, banding and synchronisation between the camera and the wall

The frame rate of the original footage	It is always good to know the original frame rate of the footage, to determine if creatively the footage is supposed to look slowed down or speeded up
Whether there is a need for tracking	Depending on what the source material is, and what the director's intentions are, it may be necessary to use a tracking system on the camera. This tracking allows for parallax correction as the camera moves around the set. It enables the real-time engine to know exactly where the camera is within the environment and adjust the output to the LED screens accordingly.
Lens calibration and mapping	Again this is may be required to ensure that the screen output represents the image as seen by a specific focal length or style of lens. It can match all lens aberrations and individual lens traits to ensure the LED output is an accurate representation of what the camera and lens combination would see on a conventional set.
The use of the LED for volumetric lighting	Is the LED wall being used simply as an alternative to green screen or rear projection, or is the intention to use the wall as a lighting source too? This will have practical considerations
Integrating conventional and Smart lighting fixtures within the LED environment	Consideration should be given to pixel mapping fixtures to screen content within the real-time engine environment, and if not, a decision should be made as to how to best approach colour balance, and matching foreground with LED output.
Rethinking prep time	Generally when working in an LED volume you are aiming to achieve as close to final pixel as possible – consequently you are taking some time (and budget) from traditional post work flow and using it in what would traditionally be called pre-production. This method of working normally requires the engagement and involvement of the Camera team, and in particular the DoP earlier in the production process. Allow enough time for testing and checking your source material before the shoot.
Artefacts / Moire / Banding / Frame lag	These are all issues that can occur if proper consideration is not given to frame rate, shutter angle, lens selection and distance from screen. Crew need to be aware of these issues and the reason they occur, to ensure a seamless shoot day

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