The Virtual Opera House: hybrid realities in lighting design processes for large scale opera

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Abstract

Digital visualisation tools – virtual models – are increasingly used as part of the creative and production processes of large-scale theatre and opera. These technologies not only enable the modelling of the performance space with its scenic and lighting scenographies, but also facilitate the modelling of production processes and human relationships. Focusing on lighting at the Royal Opera House, London, I examine the role of digital visualisation in the production process of large-scale opera. Digital models allow designers and production teams to manipulate not only virtual space, but also virtual time, and I show how the 'Virtual Opera House' allows multiple possible futures to be modelled, reviewed and selected. Further, the limited time available on the opera stage for lighting and technical rehearsals can be supplemented with additional, virtual stage rehearsals inserted between the physical ones: interstitial time. Effective working relationships between members of the lighting team are critical to the successful realisation of design intentions – relationships that take considerable labour to develop and maintain. The Virtual Opera House creates a space and time where professional relationships can be modelled; away from the pressures of stage rehearsals, the lighting designer, lighting programmer and others spend time to develop and nurture the working relationships they rely on later. Using primary evidence from practitioners, I demonstrate how the Virtual Opera House is not only a virtual model of the stage and physical production, but is also an environment where processes and relationships can be modelled and remodelled: a hybrid-reality collaborative environment.

Introduction

Theatre has always proposed itself as a kind of virtual reality: the creation of fictional worlds, to a greater or lesser extent like the one inhabited by its audience, and more or less immersive. Cinema, and later radio, television and related technologies prompted the drawing of a distinction between the live and the mediated, a distinction that was and is complex, ambiguous and contested, as Philip Auslander has notably pointed out (2008). Our sense of theatre's apparent liveness, of its physical and concrete presence, its 'quiddity' (to borrow Christopher Baugh's term [2013, 10]), is a back-formation from the invention of technologies of mediation. By theorising media and mediation, we have come to a richer understanding of the live and liveness in performance, in a way that goes beyond thinking of the live and the mediated as mutually defining opposites. In a similar way, the development of various forms of virtual reality – typically through digital technologies – has created a contra-distinction between the physical and the virtual. Again, the difference is not a binary one; rather, there is what Paul Milgram et al have called a 'reality-virtuality continuum' (1995, 283) in which reality and virtuality mix to varying degrees. Meanwhile, Gilles Deleuze (1966), Brian Massumi (2002) and others have developed complex, differing and very specific philosophical uses of the terms 'virtual' and 'virtuality' that go beyond a simple distinction between the physical and the digital. However, for my purposes here I want to use the term 'virtual' broadly, to refer to a wide range of ways in which one thing can model, simulate or stand in for another – a kind of visual, spatial or temporal metaphor in which the virtual shares certain characteristics with the actual. Thus, a performance may be a virtual representation of 'real life,' and a physical designer's model is a virtual representation of an imagined future scenic environment. (I use the term 'digital model' to describe

three-dimensional models generated by computer software, viewed on a screen or in a 360-degree immersive way via a VR headset.)

It is within this complex hybrid of the live and the mediated, the actual and the virtual, that I want to examine the role of the digital computer model during the development of a performance scenography – a usage often referred to professionally as *visualisation*.[1] Specifically, I focus on visualisation as part of the processes of lighting design and realisation, as it is practiced at the Royal Opera House, London in a facility known by various names, but which I refer to here as the Virtual Opera House. My enquiry is located at the intersection of three themes: the design model (both physical and digital) as a strategy for shared creative and technical development; the working practices of theatre lighting professionals; and virtuality as a means to manipulate time and space. As Thea Brejzek and Lawrence Wallen have pointed out, the set designer's or scenographic model has received little critical attention in the discourses of theatre and performance studies – a matter they have corrected in book form (2018a) and by editing a themed issue of Theatre and Performance Design journal (2018b). Similarly, the practices of lighting designers, programmers and the other professional roles involved in the creation and realisation of performance lighting has not been the subject of scholarly research until comparatively recently. Again, this has been changing, with important contributions by Palmer (2013), Abulafia (2015), Moran (2017), Graham (2018) and Zezulka (2019a and 2019b), as well as some of my own work (Hunt and Melrose 2005, Hunt 2011, 2013, 2014, 2018). Kelli Zezulka's linguistic ethnographic approach in particular offers a detailed account on the lived working practices and human relationships of lighting professionals with a focus on the technical rehearsal, and how these practices and relationships shape the lighting process and outcomes. In the present article I similarly examine the detail of how lighting professionals work,

though my methodology is different, instead drawing primarily on first-hand accounts by James Simpson, Lighting Visualiser[2] at the Royal Opera House in London between 2009 and 2019, and freelance lighting designer Bruno Poet.[3]

3D digital computer models intended as a tool to develop designs of objects (or in the case here, lighting) that will later be made physically are not generally intended to provide the kind of immersive, 'wrap-around' experience typical of virtual reality environments used as a platform for artistic works, where, as Oliver Grau puts it,

> The media strategy aims at producing a high-grade feeling of immersion, of presence (an impression suggestive of 'being there'), which can be enhanced further through interaction with apparently 'living' environments in 'real time.' (Grau 2003, 7)

Gabriella Giannachi and Nick Kaye pick up the theme of time and place when introducing the concept of presence in relation to various artistic practices, quoting Paul Virilio: 'To exist, is to exist *in situ*, here and now, *hic et nunc*. This is precisely what is being threatened by cyberspace and instantaneous information flows' (Virilio 1995 cited in Giannachi and Kaye 2011, 2, emphasis in original). The Virtual Opera House combines a digital, virtual model of the theatre space with a physical room where production personnel can view, control and experiment within the digital model, seen as if from the production desk in the auditorium: Virilio's situatedness and cyberspace are both in play in this hybrid-reality environment. One of the main functions of the Virtual Opera House is to allow space and time to be separated from that of the model's referent, the actual opera house and its production processes. Of particular significance for the kinds of virtuality in play here is the way the Virtual Opera House allows the creation of what I want to call 'interstitial time' and 'interstitial space': additional time inserted into what in a conventional theatre production process would be a continuous

schedule of activity, and additional physical and virtual space that is not part of a conventional theatre facility. This interstitial time and space is both part of the production process and environment, and separate from it.

While a digital model might appear to simply be a software version of a traditional, 'hardware' physical model, virtual computer models of a scenographic design are doubly virtual, for a physical model is *already* virtual, both because of its physical relationship with its referent, and because of its teleological purpose. The physical model made by theatre designers is an established tool for developing, communicating and archiving the designer's intentions regarding scenic space. Compared to the actual stage space and scenery, the model is reduced in scale, is made of different materials (perhaps card and plastic, rather than wood and steel) and has reduced functionality (model doors may not open, and moving scenery is manipulated by hand, not automated). Further, the scenic model as a kind of virtual model both limits and enables certain kinds of relationships and interactions with it: for example, while it is impossible to stand on the model stage and look into the auditorium, it is possible to look into the scenic space from vantage points that are not possible in reality, such as by removing walls. The designer's model is virtual in another sense: it is a model of an *intention*, anticipating a future physical reality. Other types of virtual object may stand in relationship with their referent as a model of an actual, already extant object, or as a model of a fictional reality that does not and will not ever exist in concrete form (in Brejzek's and Wallen's term, an 'autonomous model' [2018b, 3]). The theatre designer's model combines these two types, proposing a fictional reality which must also be capable of being physically realised – the model is thus a vehicle for the *visualisation* of that which does not yet, but later will, exist physically.

This short summary briefly maps the key concepts which frame my account of the Virtual Opera House: diverse kinds of virtuality, interstitial time and space, which combine to give rise to a complex hybridity. At this point I want to make two shifts – firstly, to move our attention to designing with that most immaterial of mediums, light, and secondly to consider the shift from physical models to digital ones.

Lighting Design Visualisation

The immaterial nature of light presents particular difficulties for designers wishing to test, share and document ideas for its use in performance. Unlike the scenic designer's physical model, a lighting designer's sketches, verbal descriptions and reference images (photographs, paintings) can only capture and communicate the qualities and attributes of light they reference in an indirect fashion, rather than being a maquette of the intended light. Furthermore, in experiential terms light only exists in relation to the objects and surfaces that it illuminates, so any means to visualise light (rather than invoking its qualities tangentially or metaphorically) must also include the spatial, material environment in which the light will exist and by which it will become visible.

Light can be modelled for the purposes of visualisation in two ways: through the use of physical models (typically using miniature light sources in a model theatre – Hunt 2018) or through computer-generated digital models. The use of computers to visualise stage lighting specifically began to become established when in 1994 a Canadian company, CAST Software, was formed to develop a software-based virtual lighting rig. The software, named WYSIWYG after the familiar acronym for 'what you see is what you get', was based on technologies developed in the engineering, industrial design and architecture industries in earlier decades. The WYSIWYG software provides a 3D virtual environment in which the venue, scenery and lighting rig for a production

can be created, and then displayed in wireframe or fully rendered views. Unlike other 3D CAD software familiar from architectural and industrial design applications, a standard lighting control console can be connected to the computer running WYSIWYG to control the virtual lights in real time. This allows a complete lighting plot to be programmed and edited while viewing the results in a virtual stage, and the results transferred at a later time to the physical stage. This capability is particularly useful in situations where stage time for lighting rehearsals is limited, and the desired lighting plot is complex, involving many cues and a large rig of lighting fixtures. This description often applies to large-scale opera production as well as theatre, live music and events, and today there is a small number of rival software products that serve this market, providing similar functionality to WYSIWYG.

As computer graphics power has increased, so has the software's capabilities, so that now visualisation software is able to represent – up to a point – the effects of atmospherics (such as stage haze), shadows, translucency, and so on, with many of these effects available in a real-time rendering of the light in the scenic stage space. While the software's current ability to render light in a digital model is a remarkable achievement from a technological perspective, nevertheless many lighting designers find that it still does not represent the kinds of subtle effects and affects of – for example – grazing light across a textured scenic surface, or the glow of light on a performer's skin. It is such nuanced qualities that are often the principle affective materials from which lighting designers create their contribution to a performance's scenography and dramaturgy, especially for drama and opera. These considerations tend to shape the uses lighting designers make, and do not make, of visualisation software.

The Virtual Opera House

At the Royal Opera House, the visualisation suite is referred to by a variety of names by

the people who use it including ‘Vision Suite,’ ‘Vis Suite’ and ‘Visualisation Studio’ but also ‘Virtual Opera House’ or ‘Virtual Reality Suite.’ I adopt the informal title here of Virtual Opera House to emphasise its function not only as a digital model of the stage but as a hybrid virtual and actual space where various production activities can take place away from the physical stage.

When it was conceived in the early 2000s it was intended as a creative place where designers would come and situate themselves in a virtual production environment, delivered to them through digital models. The designer would be immersed in a simulated theatre environment, complete with a view of the virtual stage equivalent of the same position in the real auditorium. The Virtual Opera House is in a small room designed to emulate the layout of the production desk – the temporary point of command set up in the auditorium during technical rehearsals – with the lighting designer sitting between the programmer and the production electrician, and with space for the director to observe if they wish to attend. A large format screen is scaled to give an equivalent field of view to that experienced in real life – adding to the sense that this is a virtual equivalent of the real production environment. The visualiser, operating the visualisation software, sits to one side, outside the space of the simulated production desk environment (see figure 1).

Figure 1. The Virtual Opera House. Photo: Sim Canetty-Clarke

According to James Simpson, Visualiser at the Royal Opera House 2009-19, the production team may use visualisation for: preliminary design investigation; mid-term review of technical aspects of the show; final programming of the lighting; recording and documenting the lighting after the show has finished; and to 'learn' the lighting of a previous show in advance of it returning for a re-light, within the Opera House's repertoire system. While the majority of uses for visualisation tend to be towards the end of the production process when there is increased pressure on lighting designers to deliver a design within a tight schedule, Simpson states that, 'better technology has made visualisation more useful and attractive for designers and directors to use for investigative work earlier in the process, and this use is growing further as the technology develops.' Simpson describes a typical lighting visualisation process as follows:

> the lighting and scenery are first modelled in the visualisation software or imported from a 3D modelling program which is checked through a standard

coordination procedure to ensure the multitude of theatrical elements in the production are represented accurately. A lighting designer entering the visualisation process would begin with some investigative studies to test their ideas and then proceed to make focus positions which can be recorded into a lighting console and reproduced accurately on the stage at a later time. Designers spending a lot of time working in the virtual system may also build systems of light that can be recorded into cues and referenced to the script or score, ready for playback on stage.

Simultaneous futures and interstitial time

Based on the above brief description, the most obvious role for the digital model created by the visualisation software might seem to be as a 'stand-in' for the physical stage – in this sense it is both a virtual model of the actual stage, and a virtual version of the traditional, physical designer's model (though with an integral virtual lighting system). Created in advance of the actual, physical scenery and lighting installation, the model can allow ideas to be developed, experimented with, tested and evaluated. This process may take place at different stages in the design and production process, which in large-scale opera can extend over two years or more. While in principle a physical designer's model with miniature lighting would allow similar time to think and work away from the stage, the digital model makes it practicable because the lighting console used for the visualisation shares its data with the console used on stage, so the lighting in real and virtual environments are always in sync. Changes made in the digital model appear on stage at the next rehearsal, so work done in the virtual environment is not *preparatory to* the next rehearsal, but is a (virtual) lighting rehearsal in itself. In that sense the lighting data does not distinguish between virtual and physical stages; it is always already virtual, and can be deployed anywhere – a familiar feature of virtual,

digital objects. I want to emphasise the hybridity of the Virtual Opera House here: an actual, physical lighting console – identical to the one in the opera house itself – is located in a physical, full-sized recreation of the production desk area, from which the lighting team can see a depiction presented life-size of a digital model of the stage and scenery, complete with virtually rendered light. The Virtual Opera House does not occupy a single point on Milgram et al's 'reality-virtuality continuum,' but rather combines multiple elements that are at various points along it.

Despite Brejzek and Wallen's assertion that models can both produce and communicate knowledge (2018a, 11), for many lighting designers the virtual stage created by visualisation softwares is not – unlike the traditional set designer's model – a place of demonstration. Bruno Poet states, 'it's definitely useful for me in a technical way, but I've never found it useful to show someone "this is what the show is going to look like" because it doesn't really ever represent that.' For all the advances in 3D rendering, and the claim of the manufacturer on its website that WYSIWYG is a 'platform to design in 3D with real-time visualization … to create looks, lighting cues and scenic images offline,' for Poet 'there is almost no point at all in doing it [for shows] where it's all about the quality of the light and what the light feels like in the room, because it just can't represent that in a particularly meaningful way, because [the visualisation software] can't understand intensity or colour or how surfaces really work.' Instead the digital model is a space for technical tests and checks: for Poet, visualisation 'as a planning tool in opera [is] incredibly useful for me because you can check that the rig is going to do the job you think it's going to do, presuming it's then rigged in the same place as it was when it was modelled in 3D.' Simpson concurs, stating,

> the most common experimentation a designer attempts in visualisation is to discover the best position for a light to be in to achieve a given effect … The process for finding a suitable lighting position will normally start with a brief discussion with the lighting team about the intent and what look the designer wants to achieve; this discussion may include some ideas the designer already has to try to achieve what is wanted. Through discussion, other possible positions that can be used to achieve the look are identified. The lighting programmer and visualiser will then create the various solutions in the digital model for the designer to review and – unless there is a clear reason why something won't work – each will be saved as a position in the lighting console or a rendering taken which can be passed to the lighting team for recreation on the physical stage. Every valid solution is considered and recorded irrespective of whether there is a favourite, as this allows for more choices on stage.

For Poet, this preparatory work, establishing individual lighting positions and focuses, is critical to successful lighting rehearsals once the production is on the physical stage:

> Opera is very much about what the feel of the light is … the way I tend to build opera cues is I start with whatever light is shaping the stage, say it's a three-quarter back light HMI,[4] and that's the main shape, and that's causing shadows of all the trees, or whatever. So that's one light on which is dominating the whole look for that moment, and the rest of my job for that scene is just picking out the details, whether that's getting a little bit of light on the chorus' faces and seeing how we see the principal [singer] when they're standing down stage, and then going, 'okay over there we need to get a little bit of light into the trees and pick out those branches.' Then we're just finessing details, and WYSIWYG can't really do that in terms of cue plotting, but it can make sure that I've got all

> of the lights in the right places so I'm able to do that [once on the physical stage].

Although Poet and other lighting designers do not create full lighting plots in the visualisation software, the digital model can do more than answer technical questions – it provides an opportunity to explore and play which is rarely available on the physical stage due to time constraints. Poet says,

> In WYSIWYG I would work through the whole show … so that for each scene I've got the lights that I actually want set up, and also I would do a few wildcard things just in case. And it's also a chance to go, 'oh I hadn't imagined using that light,' so there's also a little bit of a happy accident session. You can sometimes find surprise little bonuses that you don't have time to find when you're in the theatre so it's useful just to play with what's in the bag and make sure you haven't missed any opportunities that you might not have time to look at [on the physical stage].

For Simpson, 'something we always found useful and surprising was when we gridded a lighting bar[5] because we thought we wouldn't need it and then discovered that one of the lights from that height was the only way to squeeze a beam through a crack in the scenery to reach a point on the stage where no other light could.'

Like a physical designer's model, the digital model therefore has, in Brejzek and Wallen's terms, a capacity for *cosmopoiesis*, to be world-producing (2018a, 1). Further, it is *teleological* – its purpose is not only to help the lighting designer and others to visualise an imagined future, but also to help bring that future into being by guiding choices. However, the number of parallel alternatives that can be held in play at the same time is radically greater than with a physical model, allowing a wide range of possible options to be deployed and finally either chosen or discarded once the

production is on stage. The digital model is therefore able to contain and visualise multiple possible futures and switch between them almost instantly: another aspect of its virtual nature. This capacity might prompt us to think of the design as not only that which is eventually seen on stage, but also all the discarded alternative choices that are nevertheless still virtually present (Hunt 2008).

An investigation to discover the optimal fixture placement which can allow a light to achieve a particular look may also have ramifications for other design elements. In one example described by Simpson, a lighting designer wanted to find a way to bring a strong backlight through a doorway at the back of the stage:

> The position of the lighting bar was almost directly overhead and the light needed to appear to come through the door as if lit from behind. The designer experimented with different positions across the bar to determine which one created the strongest sense of directional light. The obvious position for strong directional light is furthest away to create a long scallop of light that comes out of the door sideways, but this presented a new problem. The side of the scenery had structural framework which could not be seen from any angle by the audience but created a shadow which clearly looked like engineering framework and spoiled the effect. The alternative was the opposite extreme, coming in from directly above and behind which gave the least shear angle but the strongest amount of light grazing across the set. This option didn't produce any unwanted shadows, but it also lacked the strong directional look the designer sought. The choice was to either settle for the less satisfactory look or ask the engineers to re-design the framework to eliminate the shadows, which was possible in this case as the design investigation was being carried out well in advance of the scenery being built.

For this kind of situation, the modelling not just of the appearance of the scenery but it's engineering construction in precise detail is critical to identifying and solving the problem. Physical models are rarely created with this type of detail, and in any case have their own structural requirements in terms of their cardboard and glue engineering, whereas the digital model can present as much detail as is wanted. A further aspect of the digital model's virtuality is revealed: it represents not only the future *appearance* of the scenography, but also models its *engineering*, extending the Virtual Opera House's hybrid nature in a new direction. And again, the digital model has enabled possible futures to be visualised and evaluated – a kind of time travel to multiple alternative futures – but in this case the model allows a decision to be made in the real present that prevents an unwanted future from coming into being.[6] As Oliver Grau notes, 'in a virtual space, the parameters of time and space can be modified at will, allowing the space to be used for modelling and experiment' (2003, 7). It might be assumed the digital model of the stage would be used primarily to model *performance* time, by allowing lighting states and cues to be created and replayed on the virtual stage for review and editing. My interest here, however, is in *production* time and how – as in the above example – the digital model enables production time to be modelled and manipulated. In conceptualising production time, a linear model of time is inadequate: it is not a matter of merely contracting or extending time, or moving along a singular, linear timeline, but of mapping multiple branching futures and making them available for consideration, adjustment and selection simultaneously.

In the context of the Royal Opera House's operations, the Virtual Opera House offers a further kind of time manipulation, in which time is inserted into the normal theatre production process: 'interstitial time.' The repertoire model for opera means that new productions are rehearsed on stage in the mornings only, with an afternoon turn-

round to a production of another opera which is performed that evening, followed by an over-night or early morning turn-round back to the production in rehearsal. Stage time for rehearsal – including lighting rehearsals – is therefore very limited, but the lighting designer and the lighting team for the new production have time to work in the digital model *between* stage rehearsals. Often, a designer is using the visualisation studio as a space to think between the sessions on the physical stage. The designer may use the digital model to test some ideas prior to time on stage, and then afterwards they take a few moments to consider what has been seen during the rehearsal. According to Simpson, the behaviour of the designer in this context can be revealing:

> the designer may be quiet for quite a while and then suddenly ask for a particular set of lights on the visualiser which they look at for a moment, then make a few notes and go quiet for a while longer. This can go on for a while until eventually the lighting designer will (sometimes quite theatrically) show their exasperation and explain the problem as they see it. By talking about the problem to the visualiser and lighting console programmer, even without requiring a response, the designer starts to see around the problem or decide on how best to approach the director or choreographer in discussion to resolve the issue. If the remainder of the lighting team offer advice, it is usually of a technical nature and not related directly to the creative problem, which is usually left to the lighting designer, but their thoughts about how something might be achieved technically may provoke new ideas and solutions.

Thus, the normally fraught and time-pressured process of stage rehearsals alternate with the interstitial time made available by the Virtual Opera House – or, more accurately, the Virtual Opera House makes the interstitial time already present in the repertoire production schedule greatly more productive by making the stage and its lighting

virtually available. This interstitial time allows for thoughtful discussion, alternative solutions to be devised and tested, and for progress to be reviewed. In a real-world rehearsal, there is rarely time to 'dwell with' a problem to allow a solution to emerge, while during interstitial time the digital model is available to be an object of both contemplation and action.

In two ways, then, the Virtual Opera House virtualises not just space but also time. Firstly, the digital model allows the designer and other members of the production team to move forward in time to investigate and select from multiple possible futures that are made simultaneously available. These ideas and solutions can be retained virtually and returned to at any later time, even if they are not immediately deployed. Secondly, the Virtual Opera House enables the production team to make use of the interstitial time of the repertoire production schedule, activating additional working stage time. Production time is thus virtualised, converting what is otherwise linear, contiguous time into a temporal network that the lighting designer and production team can navigate with some freedom (figure 2). In the Virtual Opera House, the actual stage time of the repertoire schedule is no longer the sole determinant of production time.

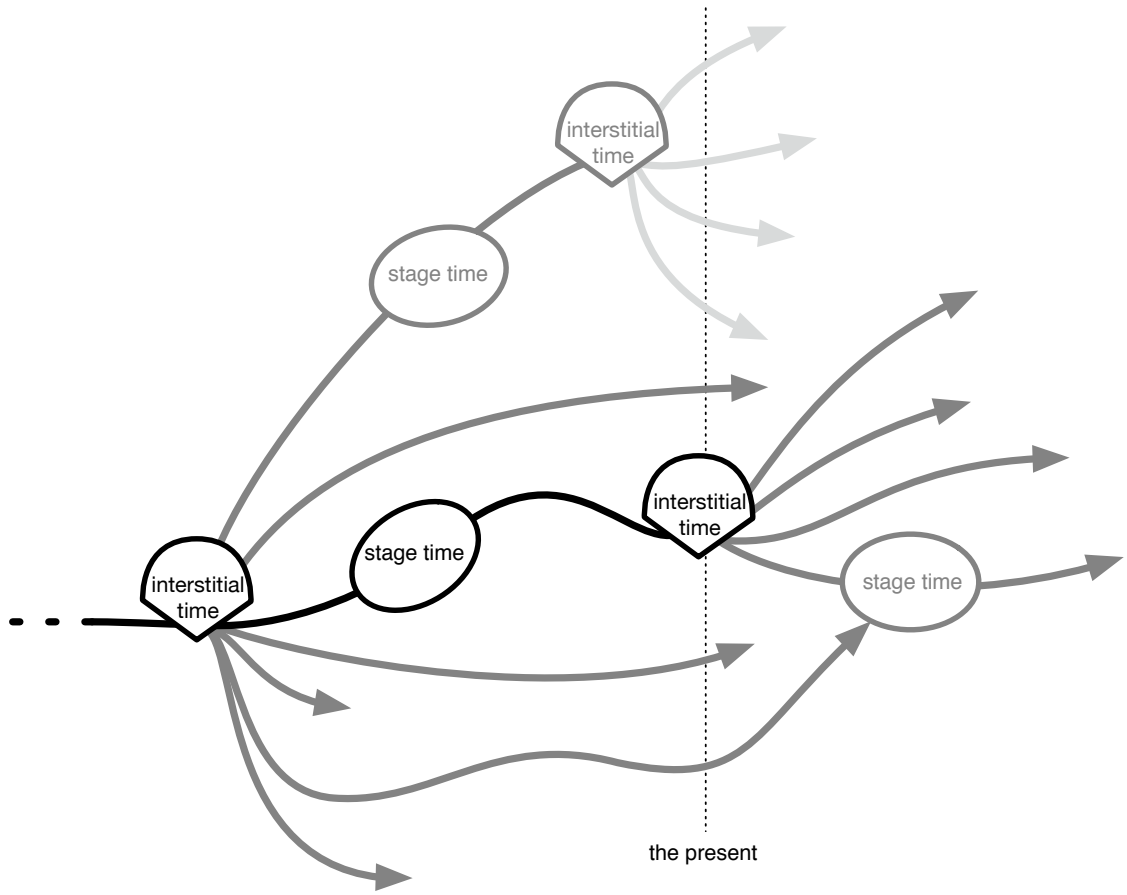

Figure 2. Interstitial time and simultaneous potential futures – a partial diagram. Image: Nick Hunt

Hybrid realities

I want at this point to examine in more detail the idea of the Virtual Opera House as a *hybrid* reality that brings together the digital computer model and the inhabited, physical space of the visualisation studio. This hybridity arises not simply from the combination of a virtual model in software with the physical, technical hardware required to support it, but also – and I would argue, more importantly – from the combination of the digital model with the human-real of the designers and other members of the production team, and with the physical Opera House stage – a combination of Virilio's cyberspace and 'here and now' situatedness, cited above. It is the very fact that the Virtual Opera House is *not* entirely contained within an immersive

virtual reality, and has complex external referents, that gives rise to its rich hybridity.

The production desk is a temporary point of command located in the auditorium during lighting, technical and dress rehearsals; typically, it is occupied by the lighting designer and lighting programmer with the console, and on larger productions there may be separate production desks for lighting, sound, and video designers and associated personnel. Directors will often also use the production desk, but they and the scenic and costume designers tend to wander the auditorium, only returning to the desk for its technical facilities such as light and power, or to refer to plans and other production documents. For the lighting designer, however, the need to be in almost constant communication with the programmer means they tend to be at the production desk most of the time, with limited opportunity to view the rehearsal from other positions in the auditorium. The Virtual Opera House provides a virtual production desk, serving as a point of command from where the lighting of the virtual model stage can be controlled. While the layout is not identical to that of the production desk in the auditorium, the key features are present: it is a place for the lighting designer to see the (virtual) stage and its lighting, to communicate with the lighting programmer and sometimes with the director, other designers, the choreographer, members of the lighting team, and so on. I focus here on how the primary users (lighting designer, lighting programmer, visualiser) work with the digital model and each other in the Virtual Opera House.

Large scale opera is an international art form, and it is common for lighting designers to be of diverse nationalities. As a result, they may have approaches to the production process which are specific to the professional practices in their home country, which can cause difficulties for those not familiar with their style of working. According to Simpson,

> US lighting designers have a different relationship with their lighting programmers to those in the UK: they are required to know the lighting desk just as well as the programmer and will call out the keystrokes and labels, so the programmer enters exactly what they have been asked for. A British lighting designer will describe a look, for instance 'can you give me a down stage wash from my back light and let it spill onto the portals' and will let the programmer do the work and only interject when they want to make refinements.

In the Virtual Opera House, the interstitial time it makes available provides an opportunity to model and rehearse working relationships and methods. For Poet, one of the most useful things time working with the visualisation does is to 'build up a rapport with the programmer before you get on stage – that's an important part of the process at those institutions where I'm not bringing someone I've worked with before, and I've got no kind of shorthand with them.' Simpson agrees:

> It is particularly valuable to establish a shared language and identify any miscommunication away from the real Opera House and away from other members of the design team, so confusion can be resolved through moments of humour and without undermining the confidence of other production personnel in the effective communication of the lighting department.

Kelli Zezulka, in her detailed analysis of how lighting designers, lighting programmers and others work together during the technical rehearsal describes 'the often "hidden" ways in which collaborators co-construct their practice *in the moment*' (2019b, 138, emphasis in original). Zezulka also points out that the technical rehearsal itself can be a fraught environment, where working relationships are tested and there is a period of 'substantial negotiation and adjustment as creative teams learn the artistic "language" of a production' (132). The Virtual Opera House provides additional, interstitial time and a

virtual production space where team members can – in Zezulka's terms, 'co-construct their practice' without the pressures of stage rehearsals she identifies.

Like its 'real' referent in the actual Opera House auditorium, the virtual production desk is also often a place of human contact – a place to exchange gossip or share sweets and snacks, so helping to establish a shared culture and commitment to the work. However, as Simpson points out,

> the real production desk may not be considered a safe space for some conversations due to the headsets, microphones and show relays that might allow others to overhear inadvertently. The more isolated environment of the visualisation studio can be a place for designers to work with the lighting team to share frustrations, think through problems and devise solutions without the pressure of being observed.

In this respect, the fact that the Virtual Opera House is not an exact model of the real opera house in every respect is a benefit: it enables the interstitial time before and between stage rehearsals to be activated in new ways, both as additional production time and as time during which working and social relationships can be negotiated and established. We also see in the accounts above the Virtual Opera House acts as an interstitial *space* – a partial model of, but separate from, the actual Opera House. This interstitial time and space is a relatively protected and less pressured environment where the production can be worked on, but also a place where 'lighting designers and other members of the creative team [are] constantly negotiating the creative, interpersonal and linguistic boundaries of their collaborations and the hierarchies in which these occur (Zezulka 2019b, 128).'

The Virtual Opera House also differs from the real one because of the presence of the visualiser – the person who operates the visualisation software. While the

visualiser is in the physical visualisation studio space, they are not part of the hybrid physical-and-digital model, since the role has no referent in the actual opera house. Nevertheless, the visualiser is a part of the Virtual Opera House, since they interact with the lighting designer, members of the lighting team, and other production personnel present. These interactions are partly procedural, as the visualiser provides views of the virtual stage as requested, but may also contribute to the design process, sometimes in significant ways. Simpson describes one example:

> It is common for the design team to look at the virtual stage from the front on, 'production desk' view they are familiar with, but on occasion the visualiser who is controlling their point of view might take them to a different point of view that they feel the design team may want to look from. This might be contrived as an accidental slip of the virtual camera, or a movement for the benefit of something that the visualiser themselves are trying to work on, but the result is that the design team start to look at their work from a point of view they hadn't looked from before. Although design teams study physical model boxes from every angle – many of which would never be a view the audience would experience – model boxes typically don't include the auditorium, or if they do it is physically difficult to place the eye in positions the audience will occupy. The design team doesn't get to see the scenery in location on the stage with the auditorium until it is there in physical reality. Even at this point, many design teams don't take a walk around the auditorium to view the stage from many points of view, preferring to stay mainly near the production desk and the cast on stage so they can communicate clearly with them.

Even in a visualised environment, this apparent reluctance to view the stage from the position of 'imperfect' seats at the extremes of the auditorium leads design teams to

prioritise the view from the 'production desk' perspective. The visualiser may take on a responsibility for the audience members whose view isn't being considered, and demonstrates the views that might be a concern. However, as Simpson points out, 'it must be done tactfully to allow a director or designer to discover the problem apparently for themselves, as an awkward and un-trusting relationship will develop if they feel that their design is being over-analysed and criticised by a technician on their production.' The example Simpson offers here echoes my description of a lighting operator similarly 'accidentally' drawing attention to a possible solution to a design problem (Hunt and Melrose 2005). In Simpson's example, the visualiser takes on a new role, outside the model of the Opera House production apparatus but interacting with it – a kind of mentor or 'critical friend,' subtly guiding the thinking of designers, directors and others as they develop the production design. We might conceptualise the visualiser as being located in an interstitial space, between the physical model of the production desk and the digital model of the stage. The visualiser manages the relationship between these two models, and so how the lighting designer and other members of the production team experience the digital model. Again, we see how the rich hybridity of the Virtual Opera House fosters novel practices that support the creation of performance lighting by including an additional collaborator and contributor to the developing design who is not present in the physical opera house itself.

Conclusion

Software for visualising stage lighting has been available since the nineteen-nineties, and although its use is routine in the events and live music industries, it has not been so widely adopted in theatre. However, the particular production requirements of large-scale opera and its repertoire system make visualisation through digital modelling a valuable means of moving parts of the production process away from the physical stage,

with its limited and pressured rehearsal time. At its inception in the early 2000s the Virtual Opera House was – as far as I have been able to establish – a unique facility for a producing theatre or opera company.[7] The system has been subsequently adopted by other major opera houses including the Royal Swedish Opera, Santa Fe Opera, the Metropolitan Opera (New York) and Dubai Opera, as well as the larger theatre companies such as the National Theatre in the UK. The spread of the use of visualisation has been promoted in part by lighting designers who have used the facility at the Royal Opera House and requested it when designing for other companies elsewhere.

The Virtual Opera House is, in Brejzek and Wallen's terms, *cosmopoietic*, but the world-making it enables is not limited to the digital model in the visualisation software. Rather, it provides a complex virtualisation of the production *process*, not just the scenography in performance. Instead of simply modelling digitally the stage and its lighting, it offers a hybrid physical and virtual model of the production environment – or at least the main elements of that environment that support the process of lighting design and realisation. While the computer visualisation of the stage is a non-immersive virtual reality model, the Virtual Opera House as a whole is an immersive, hybrid production environment. This hybridity gives rise to complex and diverse virtualities, which not only replicate the physical environment of the real opera house and allow conventional production processes to take place away from the stage, but also activate both interstitial time and interstitial space. Novel and advantageous ways of working are thus promoted. Experimentation and play can lead to creative opportunities, while extended time for contemplation can enable problems to be solved; in either case, multiple possibilities can be held open simultaneously for consideration in a way that is impossible with a physical model or on the stage itself. Existing working relationships

between personnel can be developed and nurtured in a virtualisation of professional-social space, and new models of collaboration – in particular with the addition of the visualiser's role – are fostered.

As a response to the challenges of sustaining lighting design as a creative practice in the industrialised system of large-scale opera production (Hunt 2014), the Virtual Opera House is far more than a digital model of a theatre. Conceptualising it in terms of hybridity, virtuality and interstitial time and space reveals the Virtual Opera House's substantial and productive impact on the often-hidden practices of lighting professionals.

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[1] James Simpson distinguishes between 'pre-visualisation and technical visualisation. Pre-visualisation represents the contextual, subjective view of a production that is discovered through a collaborative process of discussion and ideation, as opposed to technical visualisation, which is a methodical process of delivering data and information to create the most efficient use of stage time.' (Simpson 2018). For the purposes of this article, I will use the term 'visualisation' to include both types.

[2] The role of 'Lighting Visualiser' is an unusual one in theatre and opera production. The title is used at the Royal Opera House for the person who is responsible for maintaining and operating the facilities that offer digital modelling of lighting for productions. The Lighting Visualiser is responsible for creating digital models in the lighting visualisation software, including the theatre building itself, the scenic elements and the lighting system. These models are often made using existing digital assets that come from other departments, such as CAD drawings of scenery. The Lighting Visualiser will work with the lighting designer, lighting programmer and others to ensure the digital model provides what they need, and

operates the model – for example, to show different views of the model to the production team.

[3] Unless otherwise noted, all quotations from James Simpson and Bruno Poet come from interviews and personal correspondence undertaken during 2020.

[4] Hydrargyrum Medium-Arc Iodide – a type of high-intensity light source, often used in stage lighting applications when a very bright, single source light is required.

[5] To 'grid' a lighting bar is to fly it out to the highest possible height – a position normally only used for lighting bars not currently in use.

[6] Playfully, we might see this as a kind of time travel by the lighting team back from the virtual future to the real present, in order to eliminate that future eventuality – a subversion of the familiar paradox of time travel in which one goes back in time and murders one's own parents.

[7] Prior to the creation of the Virtual Opera House, visualisation software was used by individual practitioners such as lighting designers and programmers, or made available to clients by lighting hire and production companies, rather than by theatres.