viz academy

an online knowledge initiative
by Benjamin Collins

read it all at
www.viz.academy

1st edition

Introduction

Welcome to Viz Academy.

This website outlines the solution to emerging production challenges in modern theatre, as technology pushes the capabilities - and expectations - of all stakeholders in a production team.

We will make the case to for adoption of the emerging technology of **spatial previsualisation**, or previs, to combat issues surrounding digital platforms and increasing complexity of modern production.

We will detail the existing use of previs technology in our industry, with ample context including exploration of practices in other sectors, and a projection ahead of the next decade of technology trends.

The aim of this study is to provide theatre professionals with a broad context of where we are, with the hope to encourage ideals of **best practice** moving forward, to maximise this new potential in tech, in the interest of creative teams and of excellence in storytelling.

Welcome to Spatial Previsualisation.

Navigating the site

You can explore these articles in order, or explore what is most relevant to you. The deeper articles serve as a practical guide for integration of Production Visualisation in to your production.

Navigate using the article headers, or start here at the first chapter of our Overview: 1. The Theatre Industry and Technology.

Viz Academy is a research project! And the 'right answer' will be constantly changing. If you have a case study or a story you are willing to share, get in touch and add to this knowledge base.

1. The Theatre Industry and Technology

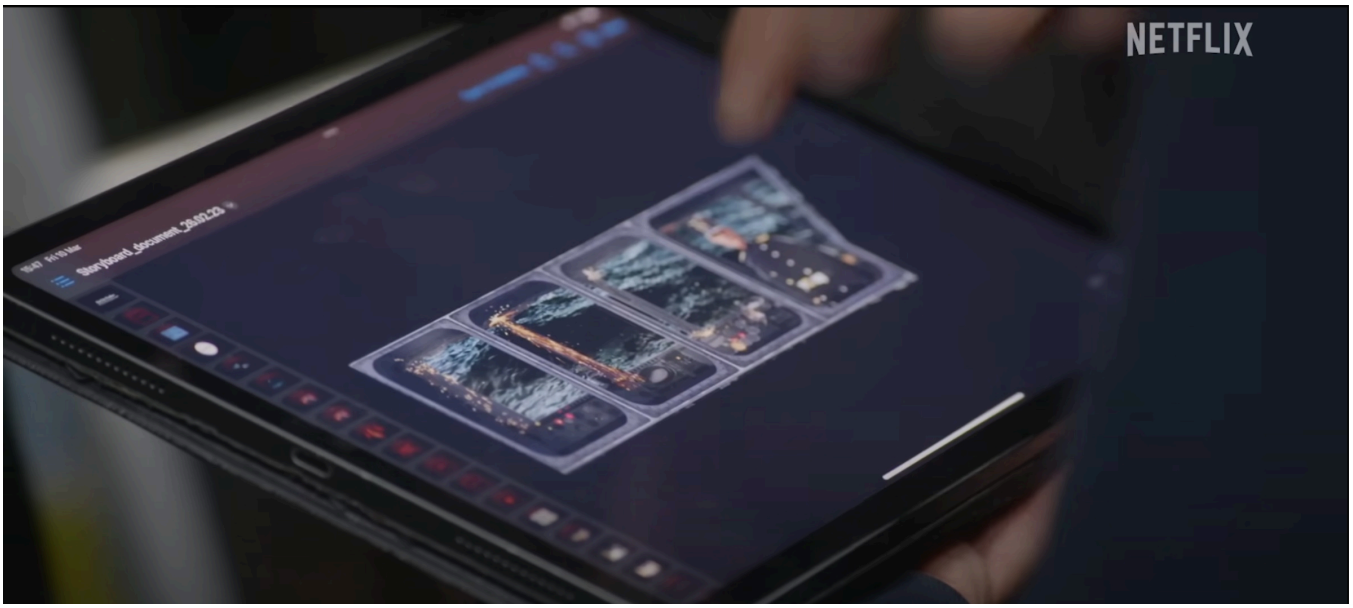
Contents

Introduction: The Ancient Arts Today

The modern **Theatre Industry** emerges from millennia of storytelling on stage. Attracting great artists and craftspeople, we have always relied on **formalised disciplines and processes** to enable cooperation of a diverse crew- all the while creating ambitious, boundary-pushing storytelling.[1][2][3][4]

Standardised practices, while not particularly exciting, are essential for live production of any sort. They enable trained professionals to get right to work after first meeting one another, often for the first time.

A modern theatre team in tech.



Storyboards for Stranger Things: The First Shadow (Still from BTS on YouTube, courtesy Netflix)

Without these practices, creative efforts can become chaotic and unproductive. Limitations, clear direction, and certainty, are crucial in delivering a bold, clear vision to an impressive and high standard. [5]

The theatrical tradition is beyond words on a page. Its success over time, arguably owes its resilience to the respective disciplines that contribute to it- linked by a collective, collaborative culture, likely passed down from long before the time of Shakespeare. [6]

These disciplines, old and new, work together.

For example, a Theatre Director's skill, arguably in part, is the art of **guiding collective attention** to each beat of a cohesive story, at the right time. Whether using a 'stick in mud', as it were, or an arena performance, these principles remain the same.

Moving on through the creative team, we get closer to the 'nuts and bolts' of technical execution. The tools and methods for these roles tend to evolve more rapidly. Levers of operation that are not communication-based, jump between competing technical platforms, hardware and software.[7]

Just walk by a lunchtime chat between Lighting Designers, and you will likely hear an encyclopaedia of 'which control desks' and 'which software' might be used- this year, last year, next year. Who pays for what software packages and why? Who will go the extra mile to ensure a last-minute request is taken care of?

Rapid evolution of technology is so central to our time, that this dynamic - updating, upgrading, compatibility and consensus - will undoubtedly remain the same in our industry. Age-old Arts will sit alongside huge changes. [8]

The consensus of 'Industry Standard' acts as a barrier against the 'hype' that may come with the arrival of new tech.[9]

But suspicion for the new, can be mistaken for stability- and solvable process issues can be mistaken for the everyday struggle of art. By taking a birds-eye view, we can spot the difference.

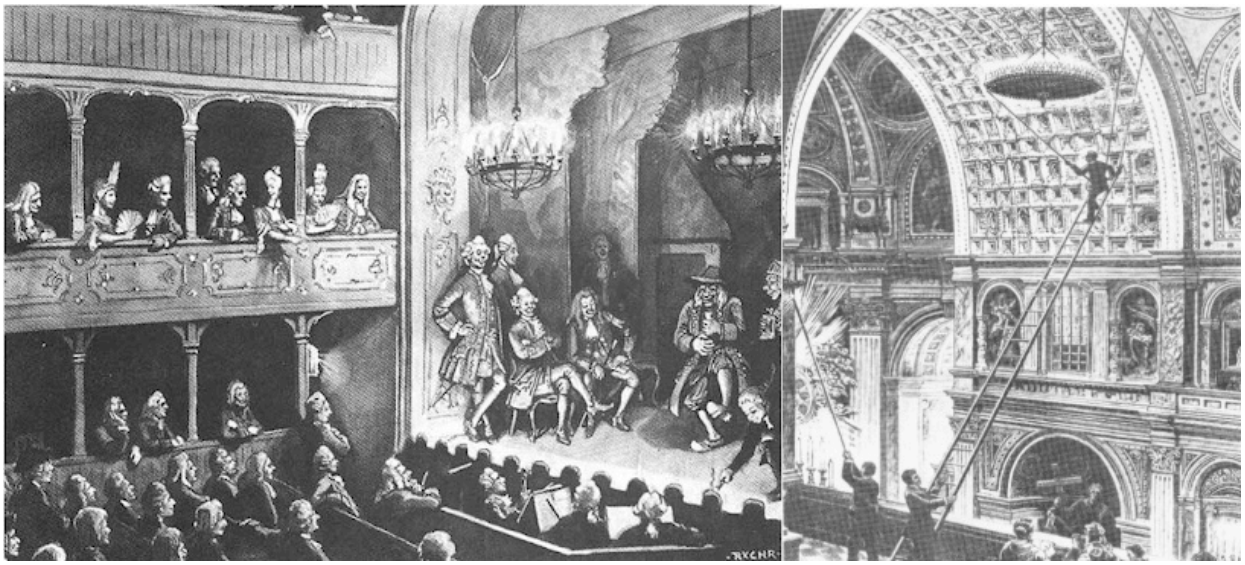
To keep our industry and profession strong, and to avoid needless toil, we must optimize and adapt at every level. [10][11]

How Did We Get Here?

Here is the modern theatre production team as it exists today.

Production	Marketing, Media and PR	Creative
Executive Producer, investors	Marketing Leads/Execs	Author (Writer, Playwright)
Producer	Public Relations	Director
Associate Producer	Media / Content Creators	Dramaturg
Production Management	Social Media Mgrs.	Choreographer
Vocational Roles (HR, DEI)	Camera Operators	Musical Director
Stage Management (CSM, ASM, TSM)	Production Photographers	Designers (Scenic, Costume)
Technical Department		Lighting Designer
Staging Department		Sound Designer
		Other movement-related roles (Movement Dir, Combat, Intimacy)
		Maker Depts. (Set, Scenic, Prop,Costume)
		Musicians (Band, Orchestra)
		Actors (Performers, Singers, Dancers)

Lets zoom in to the role of Lighting Designer in particular. Not long ago, there was no such thing, with Shakespeare or Marlowe exhibited in the open air or under candlelight.



Lighting candles for stage. Courtesy University of Bristol[12]

When was Lighting Design formalised? When, and only when, the technological milieu allowed the innovators of the time to explore that new territory and make it so- in this instance, between around 1899 and 1930. [13]

This lead to the responsibility for Lighting Design taking the form of a dedicated person- or clearly being outlined, one way or the other, with adaptations taking place for smaller productions.

One moment, Lighting Design was not a thing, and then, it was.

Similar fundamentals exist today, in that theatre practitioners and innovators harness and adapt the tools of the day, to get them to work well **specifically for the medium of theatre**. [14]

It's The Same All Over

We could say that this virtuous cycle of technology and art, of theory and practice, drives the development of technology forward in turn, in all creative industries.

In the well-funded film industry in particular, Ed Catmull tells the story of how "every major technological breakthrough" in the early days of Pixar, was the result of a creative vision first. [15]

We discover therefore, that tech is not an 'inevitable thing that we have to deal with'-- but rather, it is shaped by our choices, its inventors **inspired by what we do** as creatives. [16] What could we putting to use from other fields?.[17]

> *“Without great storytelling, technology is a hollow pursuit."*
>
> - Edwin Catmull

References

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1. Please see appendix History of Disciplines in Theatre ↩
2. Confluence of many disciplines has been noted and explored by theatre makers thoughout history, and could be explored as a **genealogy of interdisciplinary art** more broadly. Notable further reading:

   'Gesamtkunstwerk’, or 'Totalising Work Of Art' https://www.thecollector.com/what-is-a-gesamtkunstwerk-examples/

   Study on Tennessee Williams 'A Streetcar Named Desire' and his coining of 'plastic theater', the use of many differing onstage elements to express meaning https://hrcak.srce.hr/file/295898

   "Tennessee Williams envisioned a plastic theater where dramatists construct plays using all the arts of the stage together, relying not just on words as the foundation of the performance text with sound, lighting, and design as enhancements to the text, but a collaboration among the arts which the playwright, as a kind of multimedia conductor, uses to make his or her images. Today, that kind of plasticity has extended beyond the traditional stage arts to which Williams referred to incorporate all the arts and even the technology contemporary artists are also using to push the boundaries of their fields." - Rick on Theater

   Key words for further historical context:
   - *Synesthesia*, *mousikē* (Greek)
   - *Rasa* Theory (India)
   - *Bauhaus Theatre*

   ↩
3. This article is an example of a common understanding of these practices and conventions. Each discipline requires years of specialised study. https://promotionalpropsandcostumes.co.uk/the-eight-steps-to-a-successful-theatre-production/ ↩
4. Further Reading: Essay by Robert Ruffin https://howlround.com/we-need-theatre-exist-and-maybe-research-can-prove-its-necessity

   'The Necessity of Theater' by Paul Woodruff https://global.oup.com/academic/product/the-necessity-of-theater-9780195394801?cc=us&lang=en&

Aristotle's *Poetics* ties theatre's endurance to humanity's mimetic instinct
https://www.goodreads.com/book/show/13270.Poetics ↩

5. Please see appendix Standardisation in Theatre ↩
6. Please see appendix History of Collaboration in Theatre ↩
7. Please see appendix Rapidly Changing Tools in Theatre ↩
8. Please see appendix How Tech Evolution Is Affecting Us Now ↩
9. Please see appendix On Industry Standards Tools and Software ↩
10. Please see appendix When Industry Tools Fail ↩
11. Please see appendix The Power of the Informed Practitioner ↩
12. https://www.bristol.ac.uk/drama/jacobean/research3.html ↩
13. A Brief History of Stage Lighting - Larry Wild ↩
14. In Die Musik und die Inszenierung (Music and Staging) (1899) Appia distinguished three kinds of stage light.
    1. Helligkeit, the "diffused light" which illuminated the general acting space,
    2. Gestaltendes Licht, the "creative light" which creates the highlights and shadows, revealing the three dimensional world, and
    3. Painted Light, the highlight and shadows painted on the scenery by the scenic artist. This static, painted light, was not a part of Appia's vision.

    - A Brief History of Stage Lighting

    ↩
15. Please see appendix Findings from Creativity Inc ↩
16. Art and Technology ↩
17. Blue the Droid, made in collaboration with Disney's storytelling and character design, Google DeepMind's machine learning, and Nvidia's processors. Observe the love, care and attention that has been poured into the movement direction alone of this creation. Jensen Huang reveals 'Blue' at GTC 2025

    ↩

2. Tech and Changing Practices

Contents

Notable Innovations

Below is a small highlight of notable innovations from the last 30 years.

- **Digital Imagery, Digital Sound and Music**
- **The Internet, Cloud Computing**
- **Processing Power and Miniaturisation**[1]

The technology here has revolutionised certain practices in our industry, or at least presented more ways and means to do these things, enabling faster iterations, and for us to work over longer distances. Consider the theatrical production tasks that have been transformed here:

- **Measurement and Blueprints**
- **Set Design**
- **AV Design and Production**
- **Costume Design**
- **Cueing and Automation**
- **Sound Design**
- **Music Performance and Playback**
- **Live Sound Clarity and Fidelity**
- **Meetings and Communication**

Not to mention these innovations having comparable effects on other industries.

What is coming in the next decade will be a similar, huge shift in the way we use technology.**

Don't Worry

All this talk of technology, innovation, transformation and so forth seems to evoke a sceptical Greek Chorus in the mind of the theatre practitioner.

Phrases like:

'Yes, that's all very well, but I prefer doing things on paper.'

'Yes, but I hate Zoom calls.'

'Yes, but nothing beats a big orchestra.'

'Yes, but I don't want my work being done by a computer.'

…

Let's just fully emphasize a particular point before we move on.

This series of articles is not about espousing the unbounded good that technology can do, if we could 'just accept' that the newest way of doing something is always the best.

Far from it.

As we all know, it can be as much of a hindrance!

The case being made here, is that we are **better off with more options**, and we gain those options by *leaning into the piste* of adoption, experimentation and exploration of frontiers.

This series of articles is not about criticising respected professionals and the excellent jobs that they perform in our industry.

Far from it.

One may observe that in the list just now, (Set Design, Measurement etc), most of the fundamental job **roles** have not changed. The theatre-making process still needs these points of accountability. But, arguably, our work is done faster and more effectively with the choice of tools, according to the process and budget.

And by staying informed, we can maintain better relationships with technology developers and vendors.

Only with **options**, **awareness** and a **voice** can we keep a steady hand at the bough of our incredible industry, remain cutting-edge and prescient with our tools, as with our storytelling.

And this is more important than ever.

If technology trends are correct, a new, scary but exciting wave is almost upon our world, a moment akin to the invention of the Internet, the lightbulb or indeed the discovery of electricity itself. The author foresees a period of 10 years ahead, where we will see this great wave upend and change a great deal, visible and invisible, in our daily lives and in the larger world. [2]

More importantly, it is a wave of development that may affect us, as a part of the Theatre Industry, more than ever before.

What's Going On?

Why would such a great proclamation possibly be made? It stems from one key technological change, driving trends you've likely heard of:

- **Cryptocurrency**
- **AI and Machine Learning**
- **Virtual Reality / XR**

These phenomena, whatever our opinions of them, are possible because a **steady rise in processing power**[3]. The computer chips being produced now, have reached a certain threshold: capabilities once only imagined possible in the late 90s or early 2000s, have come to be possible for everyday people.

One of these capabilities, let's call **Spatial Computing**[4]. Realistic, 3D-animated movies like *Shrek* or *Toy Story* were the pinnacle of innovation in their day, requiring rooms full of computing power and millions of dollars to 'calculate' the realistic lighting and materials for each, flat frame. In 2025, comparable visual achievements can be created by a high-spec laptop **in real time**, with the user able to interact dynamically. More than that, we have seen the early development of VR technology that allows users to place themselves directly inside high-fidelity virtual worlds.

In short:

- **What required pre-rendering…**
- **Can now happen in real time.**
- **What was computable only in 2D…**
- **Is now possible in 3D.**

3D imaging technology revolutionised the film industry as early as 1995[5]. In 2025, and as theatre makers, we can identify film entertainment, tritely perhaps, as '2D theatrical entertainment'. One can see the development of **pre-rendered images** for the purpose of exhibiting on **2D screens**, and see that specifically the film industry was primed to be impacted by this technology, and great efforts were made by early innovators to do so.[6]

Astute observers at this point would start to consider theatre's place in this development timeline. We exist, indeed, in '3D theatrical entertainment'! And have been very happy doing so, with or without the invention of the computer, or, indeed, the camera.

It is apparent that this real-time, 3D spatial computing technology will have a different, yet significant impact on the theatre industry than its predecessor did film.

We are not yet, thankfully, at the point of conjuring 3D virtual actors, that interact, play for laughs and compel audiences. But this technology may have an impact in a different way: **in the way our production teams build a show**. Let's consider the tools at the hand of:

- **Lighting Designers**
- **Set and Costume Designers**
- **AV Designers**
- **Directors**
- **Choreographers**

These roles and more, represent experts in **theatre making**, an art form that is fundamentally **spatial** in nature. Audiences, sets and actors exist in 3D.

No wonder audience flocked back to live productions after lockdown[7], where early 'digital theatre' expressions saw theatre makers create, effectively in 2D, for the devices of their homebound audience. Technically speaking, we are a 3D-native medium.

Theatre creatives can recall, in and out of lockdown, squinting at streamed SketchUp models through Zoom calls, negotiating to travel early and 'see the space'; being forced through time constraint into big decisions, poring over set blueprints, and the worst case scenario: being disappointed upon seeing the final creation on stage, too late in the process to change course.

Can **spatial computing** technology help theatre production teams? [4-1]

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1. Please see appendix New Technology (1985-2025) ↩
2. Please see appendix The Next Technological Wave (2025-2035)
   or read through Deloitte Tech Trends 2025, esp. Spatial Computing ↩
3. Further reading: see 'Hardware is eating the world', a part of Deloitte Tech Trends 2025
   Further concepts: Moore's Law, AGI ↩
4. Please refer to appendix How Spatial Computing Could Help Theatre Makers
   or read through Deloitte Tech Trends 2025, esp. Spatial Computing ↩ ↩

5. Toy Story 1 was released in 1995, for the full story refer to Creativity Inc by Ed Catmull and Amy Wallace, or our appendix summary Findings from Creativity Inc ↩
6. Key figures, Pixar, George Lucas (Star Wars), Stephen Spielberg (Jurassic Park) ↩
7. '# Has London's cultural scene recovered from Covid lockdown?' https://www.bbc.co.uk/news/articles/cx20ym48jwlo ↩

3. Spatial Computing and Previsualisation

Contents

Tech for Our Medium

3D Previsualisation tools and techniques have, in the most part, been developed for 2D-screen-focused media like film, gaming and live AV.[1]

Adapted and used in the right way, there may be a pathway for theatre makers to use this tech and be better armed for avoiding production pitfalls.

Recent studies have shown that more technical theatre practitioners find themselves increasingly shouldering the weight of extra technical jobs beyond their purview.[2] If we systematically examine these and other 'pain points' in our modern process, and put them in informed context, we will begin to see a pathway to overcome this needless strain on our workers.

Theatre makers becoming more informed in this area (for example, by reading this report) could result in a higher perceived demand for bespoke software and tools being developed by vendors- and conversely, theatrical organisations who are early adopters could see themselves leveraging much-needed value in their assets and productions in a time where where resources are tight.

This, broadly, is the purpose of this study.

Is it our time?

Architecture is a great example of an industry taking advantage of spatial computing.

One could imagine a similar scenario to present predicament, decades ago: Architecture professionals facing pressure from time, with antiquated tools (or non-specialised tools, or tools specialised for a different industry), which seeded demand for Architecture-focused digital tools, resulting in pressure on vendors to create them, resulting in a new product category[3].

The early adoption of digital tools, exemplified with Architecture, could possibly have been because lead times to view anything closer to 'final product' in this field are considerably longer than most creative industries[4].

And today, in the Theatre industry, a few cutting edge studios are providing these services to high end productions already, and develop bespoke tools.[5]

The case being made in this document, which will be kept up to date as this technology progresses, is that **the time is now** to accelerate **previsualisation** and **spatial computing,** into the standard practice of theatre production: in the spirit, of course, that we are better off having this ability as an option in our toolkit, than watching our colleagues in other industries reach new heights, establishing new standards and practices that **we are subject to**, that are non-ideal for our established art form and ways of working.

Additionally, with nascent existing tools optimising for **high-end production**, it is wise to take notice- as these tools, proprietary though they are, are seeing heavy investment because they are proven to save time and

resources. It is in the interest of the industry at large, for this space to have competitive, consumer-friendly tools, that are cross compatible with existing standards and practices. This is how we maximise value from adopting new technology, and solve, rather than exacerbate, existing pitfalls of duplicated work and unnecessary strain- all too common with advanced use of digital tools today.

Adoption of **previsualisation** industry-wide will be a long process, involving the cooperation of practitioners, key industry stakeholders, organisations, and vendors. If considerable efforts began today, tangible results would likely be returned within 5 years, and lasting change established within a decade. This would coordinate with accelerating technology trends: we will benefit from increased computation power in the coming years to achieve the results we want.

This worldwide trend is guaranteed- whether it will be good for us, will be up to us.

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1. In the context of the Entertainment industry, that is. We explore Film & Television, Gaming and Live Events coming up. Previsualisation has long been in development and use in Architecture and planning, as we will explore, as well as product development and sales, or in the Defence Industry. ↩
2. Optimising Visualisation Practices in Theatre production ↩
3. Autodesk's AutoCAD debuted in 1982. https://www.shapr3d.com/history-of-cad/autodesk-and-autocad ↩
4. Architecture's Embrace of Spatial and 3D ↩
5. Take a look at case studies concerning Preevue and Virtual Stage respectively. ↩

4. Conclusion, Adapting for Theatre

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The Ideal Scenario

Success in this effort will unlock creatives' true potential earlier in the production process, 'unlocking time' ahead of traditional rehearsal and tech.

To take an earlier example, a Director's key 'soft skills' - guiding perception and focus - would **come back into play** if they were able to 'step into' their finished set, or see their actors in costume, earlier in time.

- Practitioners would be able to work within a **digital twin** of a performance space, usable from anywhere, anytime, before any build is commissioned.
- Remote or global workers would provide more meaningful contributions, a two-way street of conveyed nuance opening up online.
- Those who excel in spatial, collaborative settings would be set to thrive and lead, much earlier in the production process.
- Software and hardware platforms we use would be encouraged to converge, and become more cross-compatible with virtualized tools, to service the new market need.
- Smaller creatives and production companies would more easily pitch **big ideas**, securing buy-in from producers for projects that may have been overlooked.
- New software and platform vendors have the opportunity to offer game changing products, or establish new open ecosystems in theatre tech, for the first time since the OSC protocol.

These tools have the potential to empower creatives like never before.

Conclusion

Using Production Visualisation Technology

What we can do right now is facilitate the education of current trends for practitioners. Effective use of visualisation technology has been seen across film, gaming, live AV and beyond - and compelling case studies will shed light on how this tech is providing value for practitioners.

This context awareness will enable you, the reader, to imagine how this could help you in your position -- and prospective vendors dropping in can plan their use in theatre moving forward, as capabilities grow.

To reiterate, recent research shows[1] that practitioners' technical capabilities are growing, but the conventions, platforms and practices they follow are not keeping pace, **creating friction**. This suggests a need to formalise Production Visualisation duties, as with Lighting Design, likely taking the following two forms:

1. A new Production Visualiser role
2. Sharing these tasks across the team

It is likely that because needs of Visualisation will be highly flexible, either of these scenarios could take place at any scale of production.

For example, one production may need to visualise Set and Costume heavily - another Lighting, another would need advanced oversight over Props.

These disciplines are already well specialised, so it is easy to see heavy involvement in use of this tech from almost every department - with a dedicated Production Visualiser (or team) of necessary to assist with file management, conversion, rendering, communication, sharing, or even advanced **digital twin** or **cue-to-cue** management.

Sound has no reason not to gain equal value here, with convolution or spatial audio technology able to simulate acoustic spaces ahead of physical access.

Ryan Metcalfe of Preevue[1-1] has coined the term 'e-tech' to describe the integration and interaction of all traditional departments in a simulation of the final product, saving precious time in tech rehearsal.

The rest of this Overview will comprise of a review of spatial 'pre-vis' technology in other industries, and early innovations in our own.

Let's examine current practices, project their evolution, and lay groundwork for industry coordination in the next decade - read in sequence, or find your own path through this digital report.

'Previs' Uses In Industry

While there are a few emerging signs of previs success in our own industry, let's first cast the net wide open so we can be educated to what possibilities are available. That is to say: With the mind to develop new practices of pre-vis in theatre, let's examine how it has been established in other creative industries.

Film & Television

Public sources show that the vast majority of 'previsualisation' use in Entertainment, and the development of tools for this purpose, has taken place in film & television.[2][3][4]
Read on: 1. Film & Television

Architecture

A similarly spatial industry like our own, the longer lead times in construction, and huge requirements for monitoring and safety, have lead to the early adoption of visualisation to plan and monitor construction.
Read on: 2. Architecture

Fashion and Manufacturing

We take a focused look on mass manufacturing of products and clothing. Can their use of spatial computing help us?

3. Fashion and Manufacturing

Gaming

Interactive Entertainment, including video games, has evolved rapid-iteration user testing to determine behaviours and reactions.
Read on: 4. Gaming

Live Events

Live Events shepherd mass-participation of pop fans, business influencers, or enthusiasts to one common takeaway and experience.
Read on: 5. Live Events

Notable Tech innovations

This chapter summarises the 'industry' findings and focuses on key innovations emerging directly from the Tech industry.
Read on: The Tech Industry - What is New

Next Article: Section 2.1 - Film & Television >

Read on for a look at previsualisation in the film industry. 1. Film & Television

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1. Optimising Visualisation Practices in Theatre production ↩ ↩
2. 3D Previsualization (Previs) Software for Innovative Studios - Perforce ↩
3. 'Previs Pro' Software ↩
4. Previsualization software - AutoDesk ↩

1. Film & Television

Contents

Introduction: Planning the Frame

Previsualisation has fundamentally reshaped workflows in film and television, particularly over the last two decades.

Final frame and previz frame. LOKI, Season 2, Disney+. Copyright The Walt Disney Company. Originally posted to X by Framestore

Modern studios, especially those tackling complex visual effects (VFX), can build out entire sequences digitally, before actors or even creatives see a script. [1]

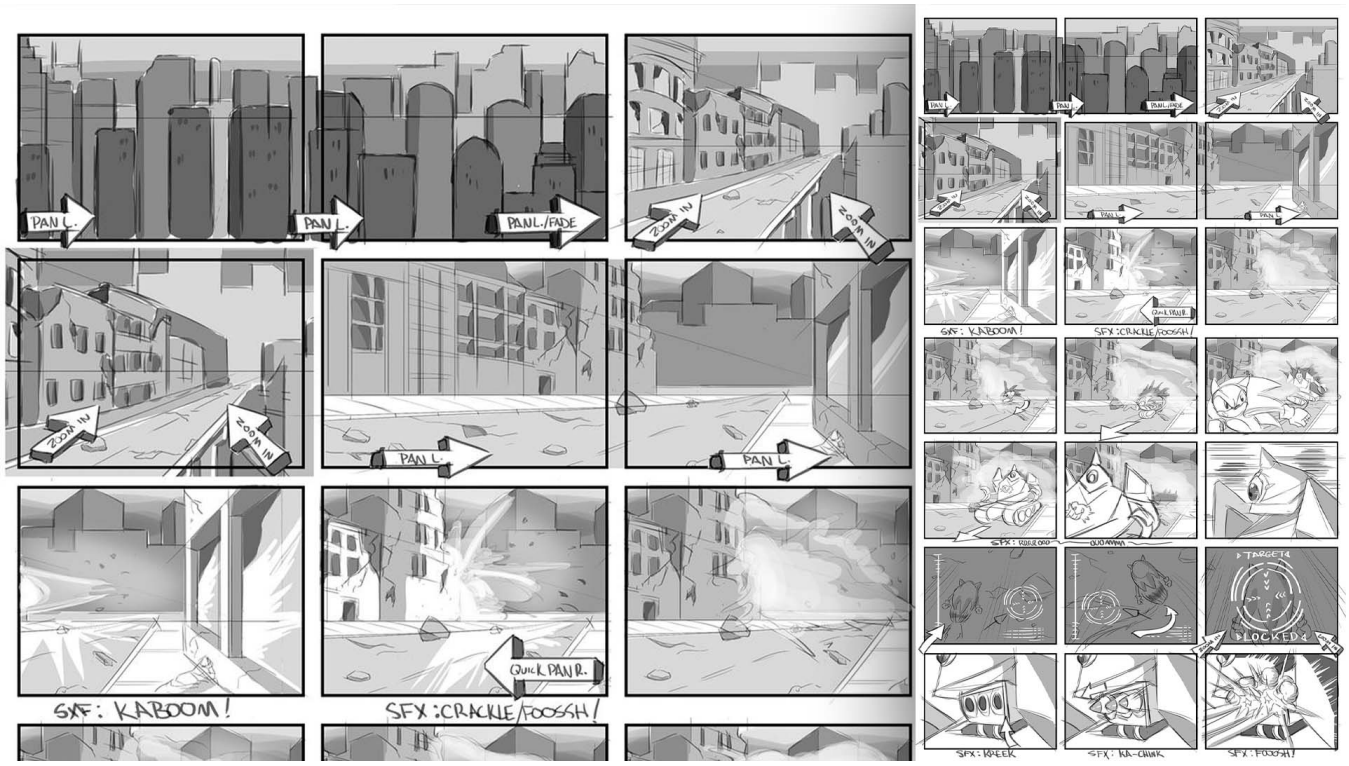
This practice, evolving from traditional techniques like Storyboarding, became industry standard for VFX-heavy features from the late 2000s onwards. This generally crystallizes around **three key areas** of planning for the final frame, where high levels of communication and certainty are needed.

Three Key Areas

The terms below are the author's own invention, to relate these concepts to the reader without jargon.

Area 1: Sequential Visualisation

Visual flow is crucial to a motion picture. Historically, filmmakers employed **storyboards** as a visual blueprint- for scenes where camera composition was paramount- or for entire projects. Whole films like *Gone With The Wind* (1939) were meticulously storyboarded by artists ahead of time, mapping out key shots and sequences [2]. There are many instances where this is not the case, and key changes are often made on set, and in during editing. This process will be familiar to theatre makers, and can be seen in a larger sense to reflect the inherited nature of theatre techniques into the production of motion pictures in the early 20th century[3].



Storyboards for a web cartoon.

With the advent of digital technology and CGI, the Animatic emerged as an intermediate step. This involves sequencing sketches, 'scratch' visuals, or rudimentary 3D animation over dialogue recordings, music, and sound effects, making timing, pacing, and tone more explicit before production begins. [4][5]

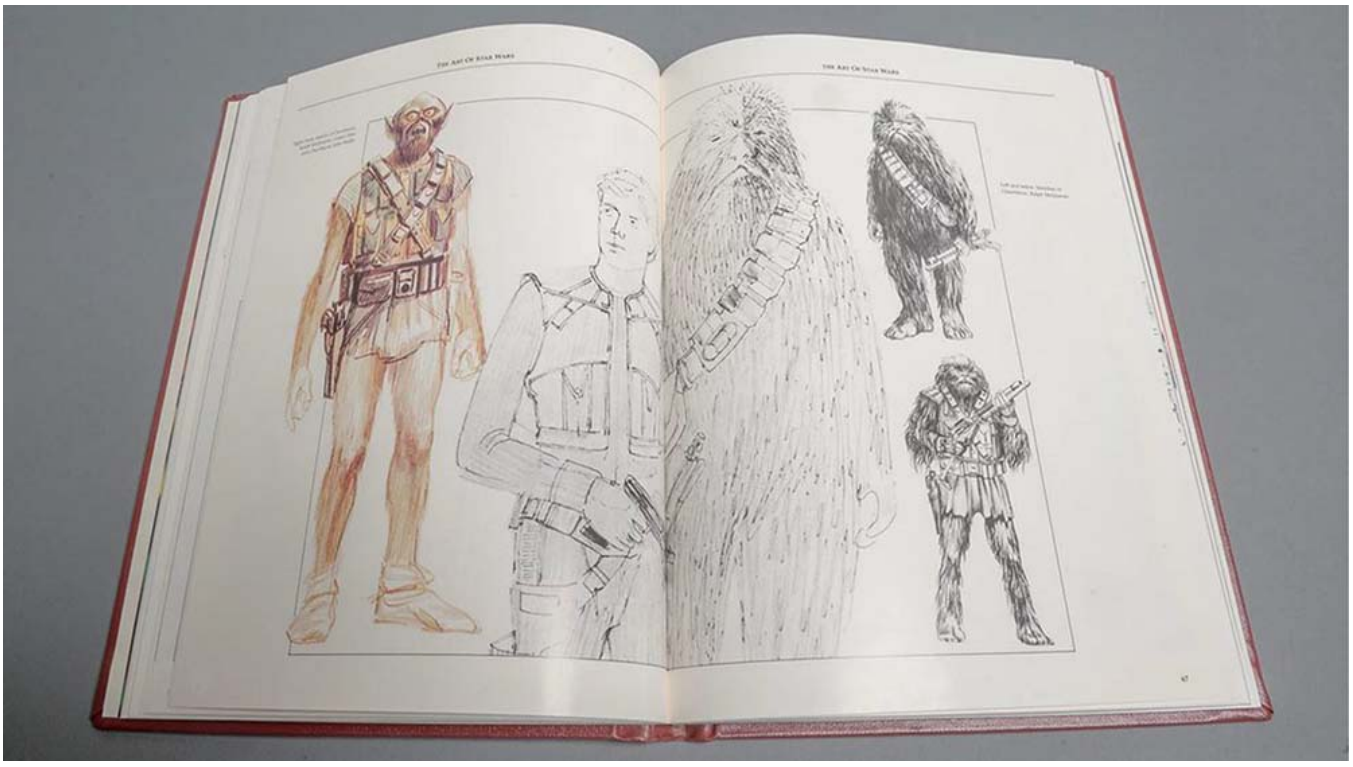
Today, the Animatic, often enhanced with sophisticated 3D assets, forms the basis of what is broadly termed 'Previz' in film and television. Marvel Studios, for example, pioneered its extensive use in films that combine live action talent with CGI. For *Avengers: Endgame* (2019), visualization studio The Third Floor created over 7,300 previs shots, beginning years before filming [6][7], covering not only massive action set pieces, moment but also quieter, emotional scenes[7-1]. Such detailed planning, sometimes matching final shot composition and timing almost frame-for-frame, became indispensable for managing the complexity and scale of modern blockbusters: effectively creating the 'film before the film'.

Area 2: Aesthetic Visualisation

Defining the look and feel of a production can involve several layers of pre-planning.

Concept Art

Detailed concept art created using traditional or digital media, remains vital for department signoff. Films like *The Lord Of The Rings* trilogy famously used extensive, detailed concept art as common visual references for directors and department heads. The image-focused nature of film & TV, with the capability for extreme close ups- not to mention the enormous budgets of these productions, mean that concept art can go beyond the level of detail and quality seen in most theatrical production.



Concept art for Star Wars.

Reference Imagery and Scouting

Location Scouting[8] informs decisions about shooting environments, while collected **reference imagery** and **mood boards** help communicate overall aesthetic goals.

Look Development

In modern digital workflows, **Look Development (LookDev)**[9] or **Visual Development (VizDev)** specifically refers to pre-visualising the final **aesthetics**. Originating in animation, this practice involves defining how the interplay of physical elements (sets, costumes, lighting) and digital factors (camera properties, colour grading, VFX) will create the desired final image.

Area 3: Performance Visualisation

This aspect focuses on planning actor movement and action.

Rehearsal & Camera Rehearsal

Essential for refining performances and blocking, especially in relation to planned camera movements.

Digital Performance Capture

Used in advanced previs or virtual production to drive digital characters or plan complex interactions before filming on set.

Stuntviz

Specialized stunt teams create detailed stuntviz[10], choreographing complex action sequences involving performers, doubles, vehicles, and camera moves, ensuring safety and visual coherence.

Techviz

For highly technical shots, detailed techviz mock-ups, often accurate to real locations and equipment specs, are created during previsualisation to precisely plan camera placements, lens choices, and movements[7-2].

Previsualisation for Hollywood blockbusters frequently features rudimentary graphics.

Digital Previs: Where is it **not** necessary?

While powerful, extensive digital previs isn't always necessary or desirable[11]. It delivers most value when taming complexity, especially in VFX-heavy or logistically challenging productions.

Previsualisation is typically much less of a staple In highly performance focused or **drama films**, for example, due to budget constraints and genre focus. Filmmakers here often rely on traditional **storyboards** or detailed **shot lists** for key moments [12]. The emphasis on character, dialogue, and emotional nuance in these areas often reduces the need for complex visual planning seen in action blockbusters. Conversely, highly technical indie filmmakers have sworn be creating their own animatic previs in free software like Blender- like Colin Levy[13], or David F. Sandberg[14].

To take an example of a drama motion picture which is made used with no digital means whatsoever in the modern era, we could take *Moonlight* (2016) [15]. At a budget of $1.5m, it could be said that it relied on the expertise of its creators for its visual planning and execution. The low budget, and simplicity of execution (filmed on location, small-scale, kitchen-sink drama parameters), likely allowed it to fly under the radar of huge studio interference. It has been documented that producers were present on-set at critical moments. Let's jump through a few more points in detail:

Strong text

- Moonlight was based on a play co-written by the screenwriter, so had a solid textual basis and competent story control behind the scenes, putting production on the front foot.

> "Jenkins and Tarell Alvin McCraney, who wrote the play on which the movie is based, both grew up there in the same part of Liberty City, Miami"

Visual language

- Highly specific, visceral memories of real locations formed inspiration for the film's visuals. Historical truths factor into meaningful choices behind the imagery.

> “Cinema is a little over 100 years old, and a lot of what we do is built around film emulsion. Those things were calibrated for white skin. We’ve always placed powder on skin to dull the light. But my memory of growing up in Miami is this moist, beautiful black skin. So we used oil. I wanted everyone’s skin to have a sheen to reflect my memory.”

> "While trying to establish texture of the place, Laxton spent eight weeks studying the light and the humidity of the location."

Acting and performance

- Behind the scenes text and video indicates an extensive and intentional rehearsal process. Moonlight's key story beats come from the performances of actors on location- which would prove impractical to plan for using anything other than traditional means of character development, direction and rehearsal.
- The picture was shot using over-the shoulder and other traditional camera operation techniques, capable of reactivity to actors' performance, becoming story voices in themselves.[16] The film makes use of anamorphic lenses, imperfections, flares and racking focus.

> "While filming a scene ... a big part of my job is listening, watching, reacting, and feeling, hopefully, what {the actors} are presenting, as well. The way the camera moves, how wide, tight, or which lenses are chosen, all of those choices speak to emotion, tone. Perspective comes from where you place to camera and how quickly you follow."[17][12-1]
> James Laxton, DOP, Moonlight

> "I try to not intellectualise. I describe it as chopping wood. Filmmaking to me, it's a very blue-collar art form. There are all these cameras and all these people, so much going on, that if you start to think of it in thematic terms, you cannot see the trees for the forest. You can't do the work."
>
> - Barry Jenkins, Director, Moonlight

Other film examples

The improv-heavy films of directors like Adam McKay (*Anchorman*) involve capturing vast amounts of performance footage and 'finding the film' in the edit [18], with planning constraints to allow this.

The production process of critically acclaimed films like *Nosferatu* (2024) [19] or *Blade Runner 2049* (2017) [20], underscore the enduring power of traditional production - and the powerful vision of master filmmakers.

Conclusion

The deep integration of previs in modern blockbusters, while enabling immense scale and complex sequences, has also sparked debate as to its limitations. Extensive pre-planning, sometimes starting years before directors are fully involved[7-3], raises concerns about potentially diminishing the director's on-set creative authority.

Present previsualisation techniques make sense to justify huge, high-budget decisions and communicate them on a large scale. Film technology will continue to evolve: this story is far from over.

Universally, the key seems to lie in judicious application- picking the right tool for the job. Previsualisation offers incredible benefits for planning and communication, but allowing space for creative discovery throughout the filmmaking process may lead to a better product depending on the specifics, and skillsets of the individuals on

the team. As technology becomes easier to use, we may see more directors use 3D previsualisation to communicate their personal ideas, without needing to rely on large external contractors.

Key findings

- Highly technical productions benefit from simulating the all elements together beforehand, for clarity
- These tools have enabled smaller film directors (who are technically-minded) to pitch their ideas, clearly communicating vision to all departments even in larger productions (David F. Sandberg's journey exemplifies this, and is well documented)
- Previs is the map, not the territory, even in screen-based media. Traditional methods reign supreme for certain decisions that concern fine detail imagery and subtle performance
- Regardless, previsualisation shows immense utility in planning and orchestration of large technical sequences involving multiple departments, including producer sign off. The technology will only improve over time

Next Article: Architecture >

Explore further nuance on this topic[21] or move on to explore previsualisation in 2. Architecture.

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*Side-by-side comparison of animatic to final product, Spider-Man, into the Spider-Verse. Copyright Sony Pictures

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1. This article focuses on narrative production in film and television, where visual language and production techniques of the two industries have been converging in recent times. ↩
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20. Discussion likely referencing Cinematographer Roger Deakins' acclaimed work on *Blade Runner 2049*. (Original source link incomplete/generic YouTube). ↩
21. Appendix: Film Previsualization, Control, and Creativity ↩

2. Architecture

Contents

Introduction: Quantity and Quality

Architecture and theatre have a **shared medium**: three-dimensional space, rather than the 2D silver screen. [1]

Stark differences lie in the scale of the industries: Architecture alone ($380–400 billion) overshadows the global Theatre industry ($50–70 billion)- while the larger Live Entertainment sector ($1.3–1.6 trillion) rivals Film & Television in size, it is still dwarfed by the $14 trillion global Construction industry, that Architecture sits within.[2]

A Digital-First Industry

This vast size, scope, and mandate for accuracy required of the Construction sector, means that far more **demand**, and therefore R&D, has gone into the development of tools for Architecture, with 'ArchViz' practices now far more embedded and developed[3] than comparable practices are in any Entertainment sector (e.g. Live Events, Film & TV).[4] This owes as much to availability of dedicated software is it does to education planning, and industry standards & infrastructure.

Typical realtime-rendered ArchViz, likely Unreal Engine. Not 1:1 with reality, but a good representation of layout elements.

Architecture, and the construction process more broadly, operates on very long timelines, with high safety demands on permanent structures[5], far less ephemeral than our own art form.

This may also credit the success of digital ArchViz. Because it may be years or decades before clients see anything close to a finished product, technology may serve as a welcome leap ahead in time, rather than a distraction to a living process.[3-1] As previs tech becomes more accessible and options become more abundant, it could serve theatre makers in similar ways.[6][7]

Indeed, the theatre industry is already using tools developed for Architecture specifically - tools that are deeply integrated into the modern architecture workflow, like 3D modelling, Building Information Modelling (BIM), and advanced visualisation[8][9].

BIM and Digital Twins

The architectural industry underwent a significant shift from 2D drafting to 3D modelling decades ago[10]. More recently, **Building Information Modelling (BIM)**[11][12][13][14] has become central. BIM goes beyond simple 3D geometry: practitioners create a single, intelligent, data-rich digital model shared by architects, engineers, contractors, and other stakeholders.

This term Digital Twin[12-1] has seen more prominence in recent years across industries, acting as a powerful common goal about how we can use technology in simulating aspects of our own reality. A Digital Twin for BIM or Architecture contains not just spatial information, but also data about materials, systems (like electrical and plumbing), costs, and scheduling. This facilitates coordination throughout the project lifecycle. A look at headlines over the years shows the advanced stage of this technology and implementation[15].

High-fidelity photorealistic renderings, animations, and increasingly, real-time 3D walkthroughs using game engines like Unreal Engine, allow clients and stakeholders to "experience" a space long before construction begins. This helps secure approvals, refine designs based on feedback, and minimize costly

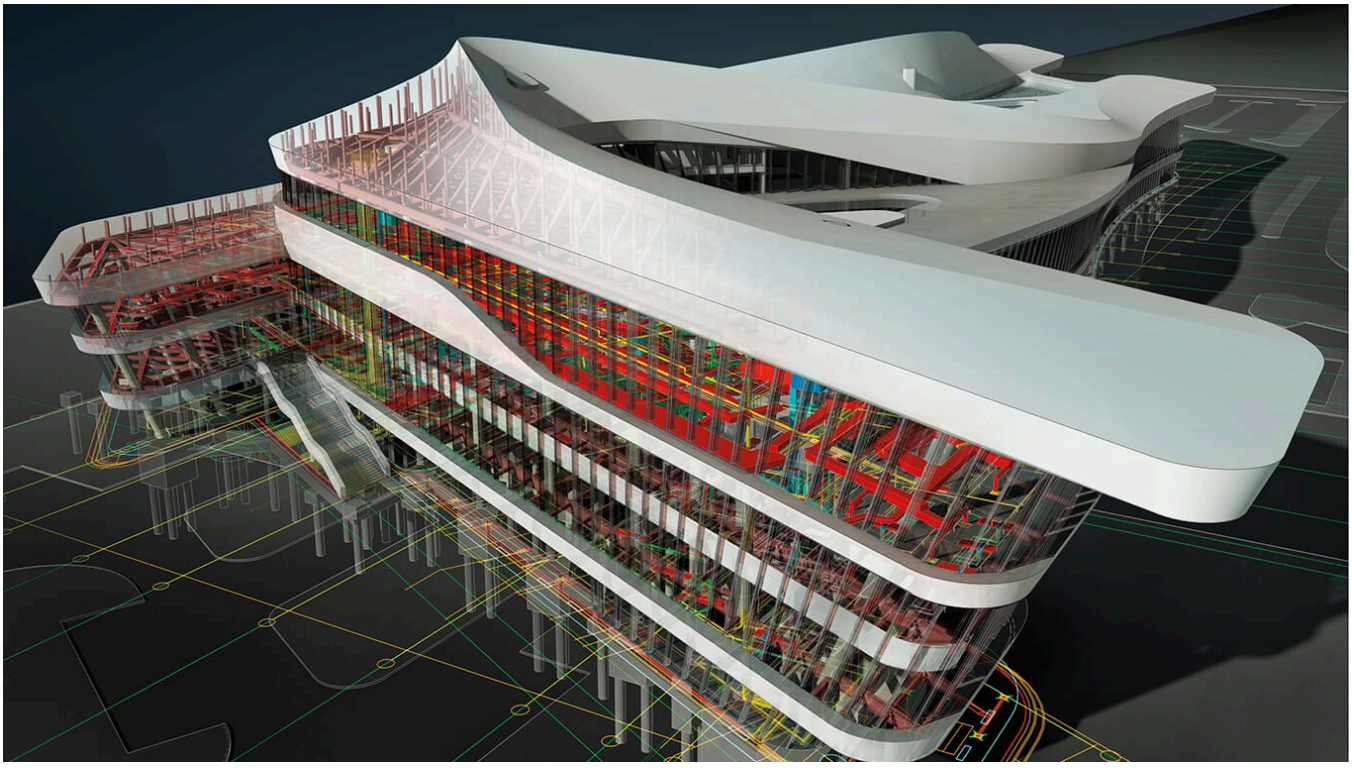
misunderstandings[3-2]. **Virtual Reality (VR)** and **Augmented Reality (AR)** further enhance this[16], enabling immersive design reviews, collaborative sessions with remote teams, and evaluation of factors like ergonomics and accessibility.

This longer lead time, and permanence of construction, means that this tech is more rigorously employed for client persuasion and detailed multi-disciplinary review, very early in the planning process.

Digital Twins for the Entire Lifecycle

Architecture and the wider sector (Architecture, Engineering, and Construction, or AEC) have embraced the concept of the **Digital Twin** more comprehensively than perhaps any other field outside manufacturing. [12-2]

Once construction is complete, the digital twin remains active, receiving data from embedded sensors within the building. Live 24h feedback and simulation enables clash detection between building systems, structural integrity monitoring, or energy performance. Predictive maintenance recommendations are possible, and long term 'lifecycle facility management' is the result: [13-1] a deep, data-driven use of a digital twin throughout the building's life.



BIM Digital Twin models contain all necessary information to simulate a building's safe construction and maintenance, and can be updated in real time from sensor data indefinitely, during the building's lifespan.

Conclusion

Architecture's deep integration of digital tools is a response to the complexity, cost, and longevity of building projects [5-1]. These workflows are for comprehensive pre-planning and clear communication, through high-fidelity digital representations of the final product [3-3].

Key takeaways

- Digital Twins go beyond planning: an integrated data model throughout a product's lifecycle could improve pre-emptive fixes, and allow closer coordination between departments.
- High-fidelity visualisation can streamline comms and speed up approvals.
- Virtual testing of physical elements can help detect issues early, if access to them is limited.

- Standardised digital workflows can optimise ad-hoc processes, including software and collaboration.

While theatre production operates under different constraints, and primacy is placed on performance, theatre makers face similar challenges in coordinating complex designs and managing resources effectively.

Perhaps there are a few principles that could be useful here, though. This inter-industry view could seed demand for innovation: What are the barriers to more advanced tools that suit the workflow of live performance? Could process infrastructure lead us to smoother productions, clearer communication, and greater creative freedom within demanding schedules?

Next Article: Fashion & Manufacturing

Let's explore 3. Fashion and Manufacturing next.

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3. Fashion and Manufacturing

Contents

Introduction

We have touched on how the Construction and Architecture industries have embraced previsualization tools. Digital twins, simulations, and virtual prototypes are emerging as common practices and terms. We can see that within industries of scale, simulation and spatial computing is used to streamline workflows and reduce waste. [1]

In this article we will explore the both Fashion industry, and the Manufacturing industry more broadly. The Fashion sector must optimise for irresistible design at affordable scale. Manufacturing, driving clothing production alongside all other product, is a world often driven by precision, repetition, and efficiency [2]. Let's investigate.

Fashioning Virtual Threads

The fashion industry's adoption of previs, and digital workflows in general, has been steadily building as it absorbs tech from the megatrends of each recent technological era[3]. AI adoption attitudes have been optimistic, yet wary[4]. The rise and fall of 2020s Metaverse hype saw somewhat of a false summit in fully 'digital fashion', roughly following the COVID-19 pandemic.[5].

2020-2023 saw a wave of 'metaverse'-style fashion content. Here, supermodel Eva Herzigova's digital twin poses for a photoshoot.

Today, designers can sculpt garments in virtual 3D spaces using software like CLO3D Marvelous Designer [6] or Browzwear [7], testing drape, fit, and texture on digital avatars[8]. Virtual prototypes allow for near-instant iteration, and reduced physical sampling[9].

On the customer side, 'Virtual Try On' tools were AR focused early on[10], with AI image generation leading the charge in recent years[11].

Luxury brands have been seen to create virtual showrooms, offering immersive buying experiences[12].

From initial concept to e-commerce storefront, previs tools are being touted to minimize physical waste, speeding time-to-market, and enhancing customer experience.[13]

The Bigger Picture: Manufacturing

The manufacturing sector more broadly (one of the largest market sectors, accounting for 16% of global GDP[14]) leverages previs tech from cradle to grave.

Computer-Aided Design (CAD) is standard, but increasingly, sophisticated digital twins allow for complex simulations of products and equipment alike [15][16]. Engineers can stress-test virtual prototypes, optimize ergonomics, plan assembly processes, and even train staff in VR environments without physical mock-ups [17].

Promotional image displaying a technician monitoring assembly robot performance.

For sales and marketing, Augmented Reality (AR) lets customers visualize a new sofa in their living room or understand how a complex piece of machinery operates, simply by pointing their phone [18]. Efficiency, risk reduction, and enhanced communication are the key drivers.

Recent McKinsey surveys show that 44% percent of manufacturing firms had implemented digital twins, with a furth 15% planning to.[19]

Virtual Goods

The online era of Web3 marks an important note in this story[20]. In the time period between 2021 and 2023, a huge amount of buzz was generate for the ideas of 'web3', NFTs, virtual goods, virtual fashion, and the Metaverse.

Virtual goods were to be designed, released, and sold, in the same way that real goods would be, allowed for by the merging of physical and digital technology. Many digital design tools, and the impressiveness reached, were seen as hugely important enablers to this, continuing to improve to the present day.

This phenomenon has since died down in the public consciousness, however. Articles referencing 'Virtual Fashion' have not appeared in Business of Fashion magazine for 2 years[21]. Overall interest seems to be holding level after a steady decline. It seems that the Metaverse was pitched to the world, and the world said 'no, not right now'.

> *"the biggest criticism is that it looks a bit rubbish - akin to graphics from the 2006 Nintendo Wii rather than the lavish VR experience that Zuckerberg promised."*
>
> - BBC, 'Metaverse: What happened to Mark Zuckerberg's next big thing?'[22]

In the background, away from the headlines, we are seeing the technology that powered this initial wave is being refined and improved. The Metaverse may not have panned out as hoped, but its core pieces will continue to work their way through to us.

Conclusion

Exploring the previs and design tools used in Fashion and Manufacturing offers valuable perspective for an industry optimized for scale. There's potential for enhanced visualization, better resource management, and perhaps more accessible collaboration, particularly through digital asset libraries.

This industry's goals are, notably:

- accurate, cheap mass production
- safety oversight at scale
- marketing - generating user excitement, and quickly identifying product fit

The technology has been optimised for these purposes. Entirely new Virtual Goods market sectors indicate a future uptick in rendering technology for web distribution, which we are beginning to see.

Key Findings

- Virtual Prototyping: Digital tools allow for detailed virtual creation and testing of physical products (like garments), reducing waste and speeding iteration.
- Digital Twins & Simulation, a common understanding across different industries
- Manufacturing prioritises efficiency and scalability for the production of objects of desire.- with an undeniable level of talent and craft behind the scenes.
- AI: Recent, impressive imagery from diffusion models and GANs, combined with its huge accessibility, has proved a hit with consumers. This has sparked debate in professional sectors and creative industries with ethics & copyright concerns[1-1]

Next Article: Gaming >

Let's take a look at previsualisation practices in modern game design - as a digital-first medium, the terminology and process is a little different. 4. Gaming

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4. Gaming

Contents

Introduction

While the term "previsualisation" carries specific connotations from other sectors, the world of gaming and interactive entertainment is **already virtual**, so tends not to use these exact terms.

Intensive pre-planning processes do occur, for these interactive experiences that while sometimes being intensely driven by narrative story, are nonetheless driven by **player agency**[1].

Unlike designing for a passive viewer, creators of interactive experiences must anticipate and shape these player actions within dynamic, real-time environments. This necessitates distinct approaches and tools, centred around powerful game engines. In a familiar sense, these crafted story experiences must also navigate technical glitches and robust visual language that optimise for repeatability.

Prototyping and Playtesting

Rather than 'previs', game development terminology often favours terms more borrowed from the software world, like

- "prototyping" [2][3]
- "vertical slice" [4][5]
- "playtesting" [6][7]
- "level design" [8]

While concept art and storyboards might feature early on, the emphasis quickly shifts to building functional play prototypes within game engines like **Unreal Engine** or **Unity**. [9] Previsualisation happens in the same 'world' as the final product.

The primary goal in development is yes, to develop visuals and story, but to do this in harmony with the creation of core **game mechanics**, player interactions, control schemes, and the fundamental "feel" of the experience to its audience. Subtle changes in timing, animation, sound and controller-mapping can change the feel, satisfaction, even meaning of each action and interaction.

A hands-on, iterative[10] approach of extensive play-testing, allows critical feedback for visual and audio cues that the players should register in relation to their actions- not to mention fixing unwanted software bugs.

Valve Software is known for extensive, technical playtesting from early titles like Team Fortress 2, to VR thrillers like Half Life: Alyx. Technology is developed alongside character, story and gameplay, with feedback from player testing sessions.

Utilising High Tech On A Budget

Smaller teams, (like Ninja Theory with *Hellblade: Senua's Sacrifice*[11]), demonstrated how focused artistic vision and guerrilla workflows (including performance capture in the office boardroom) can deliver incredible story experiences on tighter budgets.

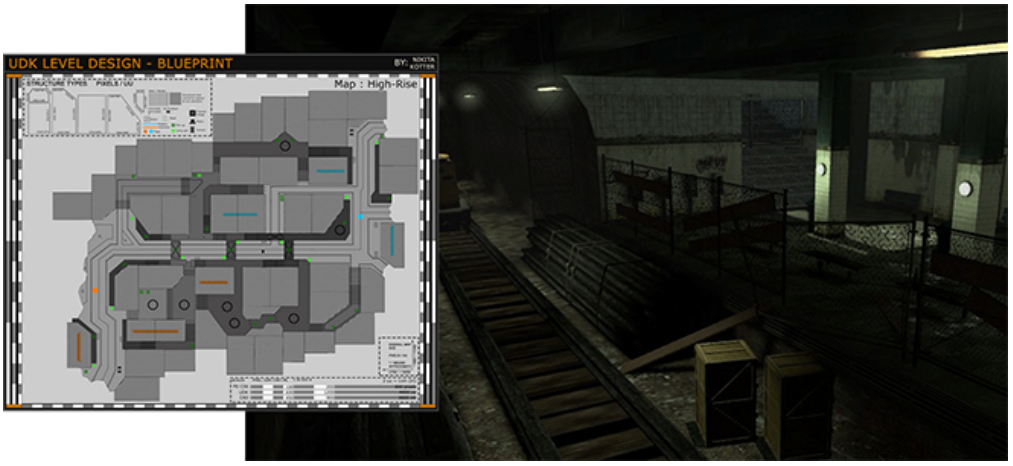
Rendering techniques, and successive generations of hardware, have optimised video games' ability to render photorealistic graphics in real time. This 'realtime-rendering' technology is the basis of Spatial Computing and more, which is revolutionizing modern industry.

Level Design

Creating the game world itself - the 'level' - is an exercise in spatial and experiential presentation[12]. Designers map out player journeys, craft environments that convey atmosphere and tell stories through exploration (like *BioShock*'s Rapture[13])

These environments set the pace for encounters and challenges, and guide player attention, all while offering feedback, achievement and progression - within freedoms that the game's mechanics allow. Elements in play here include combat, character design. cinematic events, performance capture, and voice acting.

Development of large-scale worlds like those in *Fortnite*[14] or *Roblox*[15] requires sophisticated, endless modular design, scalability, and user-generation tools.[16]



Levels (aka stages, or environments) are designed to communicate information, and facilitate fun, for free-roaming players.

Post-Launch Updates

Issues with gameplay mechanics, level difficulty, narrative clarity, or technical performance are identified and addressed continuously. When a film is released, it usually does not change. When a theatre show is mounted, it would be unusual for major changes to occur after opening for the run. Even years after launch, video games often receive patches and updates based on player data and feedback, reflecting a continuous development cycle.

Conclusion

Pre-planning in gaming and interactive entertainment is a distinct discipline, with practitioners designing robust, engaging systems that respond dynamically to player input. Thisi is driven by real-time engines, the capabilities of which have had transformative effects on other industries.

The agile, feedback-driven, and systems-oriented approach, borrows as much from software development as it does from arts. This does offers intriguing parallels and potential lessons for other fields.[17]

As a side note, it cannot be understated how powerful the impact of gaming has been on successive generations in terms of computer proficiency. From Millennial to Gen Z to Gen Alpha, one can imagine a higher natural skill floor in future, tech-native creative professionals. [18]

Key Findings

- Game development prioritizes planning for player interaction and responses within dynamic environments, rather than fixed sequences.

- Emphasis is placed on building functional prototypes early to test gameplay.
- Planning often involves designing interconnected systems (AI behaviour, physics, game rules) rather than just linear narratives or visual sequences.[19]
- Game engines (like Unreal, Unity) serve as the central environment for everything: from prototyping, iteration, to final production. Extensive real-world capture, such as performance capture, animation, and voice acting, feeds into these digital platforms.

Next Article: Live Events >

The industry that is closely related to our own. 5. Live Events

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5. Live Events

Contents

Introduction

Live events encompass everything from pop concerts and corporate launches, to immersive installations and theatre spectaculars. Overall we see a unique intersection of performance, technology, for the experience of an audience in the space.

Meticulous planning is required to manage unpredictable variables, and synchronise complex tech elements flawlessly - to communicate key ideas. This field can frequently by high-budget and high-stakes.

Previsualisation, amongst other digital planning- is becoming beneficial, in particular for client liaison[1]. The tools that are used, reflect the specific challenges of this sector, particularly the need to integrate diverse technical disciplines in real-time.

While live events can have long lead times, the execution stage (kit prep, transport, 'get-in', the event itself) is short and sharp in comparison. The more complex, the more moving parts, the more preparation is necessary.

Live events, like concerts and conferences, increasingly rely on digital platforms, like Vectorworks and Disguise d3.

The Live Event Planning Ecosystem

Successfully planning a complex live event requires coordinating numerous layers of design and tech.

Spatial & Structural Planning

Foundational planning frequently starts with CAD software (like Vectorworks or AutoCAD). This allows for precise drafting of venue layouts, stage designs, seating plans, and rigging plots, ensuring physical elements fit and are safely supported, to be signed off by all parties.

Lighting Visualization

Dedicated lighting previs software (such as Vectorworks Spotlight or WYSIWYG) can be employed to develop looks, simulate fixture behaviour, or pre-program complex sequences ahead of time.

Audio System Design

Skilled engineers calibrate and tune microphones and loudspeakers to the venue- the the hardware itself usually being state-of-the-art, and 'tried-and-true', its capabilities known intimately by sound engineers.

Specialized tools and systems, like newer Spatial Audio platforms, exist for designing and predicting the performance of complex sound systems within specific venue acoustics, ensuring even coverage and clarity.

AV Integration & Media Servers

Events are increasingly reliant on video, projection, and synchronized media playback across multiple surfaces. Specialise AV techs manage complex video routing, mapping, and playback control. Media server hardware can range from dedicated laptops running Qlab and PowerPoint, to real-time AR integration. In the case of more advanced platforms like Disguise or Pixera, full 1:1 AV previsualisation is possible ahead of time.

Previsualisation in Walkthroughs

Increasingly, real-time game engines like Unreal Engine or Unity are being explored for creating comprehensive 3D simulations of the entire event space ahead of time, allowing stakeholders to experience the environment virtually for signoff[2]

Remarkable Innovations in AV

Platforms like **disguise** (formerly d3) have achieved significant prominence for their capabilities in previsualising all aspects of AV integration. Video playback, projection mapping, real-time effects, and lighting control are created and deployed within a 3D spatial and timeline-based interface.[3]

This allows designers and technicians to:

- Visualize precisely how media content will appear on complex stages, bespoke screens, or mapped onto architecture.
- Synchronize playback flawlessly across numerous, often unconventional, display outputs.
- Manage and sequence control data for lighting and other elements alongside media.
- Integrate camera tracking and real-time rendering for sophisticated extended reality (XR) productions - this extends to live broadcast applications e.g. sports or news.

This powerful focus on **Audio-Visual (AV) integration** and real-time control has made disguise an industry standard for many high-profile tours and events. Its strength lies in managing final visual output, and ensuring pixel-perfect alignment and playback across complex display canvases, acting as a central hub for the visual elements of the show - an AV **digital twin**.

Disguise operates best on bespoke hardware and requires a software subscription, and these come at a high cost.

Interoperability Challenges

While specialized tools excel in their respective domains, the major challenge in live event planning often lies in **integrating** them effectively. CAD drawings are imported directly into lighting visualisers or projection mappings, often isolated from each other. Audio cues, onstage coordination, and more exist within their own ecosystems operated by respective specialists, working under pressure.[4]

Achieving a unified digital twin of a live event remains a distant vision, for planning or execution. Specialisations, the cutting edge of excellence in sound, vision or simulation, are confined to major vendors.

Interoperability standards are steadily improving today- for instance, major vendors Vectorworks, MA Lighting and ROBE recently collaborated to create the unified file standards of GDTF and MVR, to define 3D, functional lighting fixtures and lighting rigs. The quote below gives a contextual reading.

> "... this unifying open-source format is impacting the entertainment industry.
>
> In a somewhat fragmented and labyrinthine industry, in which the design of a production is often shrouded in mystery and so far removed from the knowledge of an average audience member"
>
> - Jacob Waite, TP Magazine, 2023 [5]

Conclusion

Planning for live events demands tools that can handle real-time synchronization, complex integrations, and high-stakes execution. These specialisations are often confined to vendors, with 'vendor lock' and standardisation being seen as challenges.

AV-centric platforms like Disguise hold a prominent position, showing a certain 'leapfrogging' of systems integration ahead of the status quo. Broader planning and execution relies on teams of specialists and ecosystems to achieve quality.

Key Findings

- Planning must ensure flawless synchronization of multiple live elements (audio, video, lighting, effects, performers) in an unpredictable environment.
- Tools specializing in integrated Audio-Visual control, playback, and mapping are a key recent development, and central to many large-scale events. Previsualisation capability leans heavily on simulating AV and lighting within different ecosystems.
- Effective planning involves a combination of tools: CAD for spatial layout, specialized lighting platforms for programming, AV platforms for media, and potentially game engines for simulation in client liaison.
- Seamlessly integrating diverse specialised tools into a cohesive planning and control workflow does not exist as it does in other industries.

Concluding Summary >

Continue on to the Concluding Summary of our industry comparison, or detour via a brief catch up on the latest technology: The Tech Industry - What is New

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6. Concluding Summary on Industries

We have seen many interesting technologies emerging across industry, many with the direct pressures to do so, many with abundance of funds and pressure to innovate at scale.

It should be noted as well, some platforms, like Unreal Engine, are common across different industries. Large tech providers and platforms are offering similar spatial tech, optimised in different ways. But beyond these products and organisations, we should stay focused on the underlying trends that are enabling them.

If we are to learn anything from these examples, we must first understand our own processes in the Theatre Industry, then moving to identify pain points in process. These process issues can be optimised, removing barriers to the pursuit of creating great art.

Read on for articles in **Section 3: Our Industry As It I**s.

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1. Rules and Conventions of Modern Theatre Production [>] ((1.%20Rules%20&%20Conventions%20of%20Modern%20Theatre%20Production.md)

We establish a ground truth of established practices in process. Read on: 1. Rules & Conventions of Modern Theatre Production

2. Pain points in modern production >

We examine modern theatre production to parse out any pain points in process. Read on: 2. Identifying pain points

3. Proposal >

With process and pain points established, we have formed a framework to look at a collections of Case Studies of previsualisation for theatre, from early academic study to product releases. Read on: 4. Proposal

1. Rules & Conventions of Modern Theatre Production

Contents

Introduction

Let's establish a shared understanding – a 'ground truth' – of how things typically work today. [1] These are the core conventions of modern theatre production.

Conception and Pre-Production

Before creative work begins, a project's parameters are established by key players.[2]

- **Rights & Concept**:
  - Performance rights or secured or new work is commissioned.
- **Budgeting**:
  - Overall scale of the project is defined
  - Financial plans are put in place
- **Core Team & Vision**:
  - Producers, Director, Production Manager attached.
  - Dramaturgs or Casting Directors may join, depending on scale.
- **Initial Recruitment**:
  - Availability checks carried out for cast and creatives against timelines.
  - Contractual process begun

Rehearsal takes place on Broadway.

The Standard Production Pathway: From Meetings to Rehearsals

Early production meetings start months before rehearsals, remotely or in-person. The Production Manager coordinates schedules, budgets, and logistics, often using their own digital platform. The Producer, Director, Designers, and Stage Management align on story concepts, aesthetics, and deadlines.[1-1]

It's worth noting that key freelance creatives are often balancing **multiple** projects during this phase. This reality can sometimes constrain communication and availability, adding complexity right from the start.

An overall project momentum begins.

A typical first production meeting in 2025

Siloed Workflows: Rehearsal and Parallel Development

Once rehearsals begin (typically 10am-6pm daily), the Director's focus shifts intensely onto the **performers and the text**. They become relatively insulated, reachable mainly via the Stage Manager (SM) or AD (if present). Communication with the wider team often shrinks to hurried meetings during breaks or, after hours.[1-2]

Meanwhile, technical elements develop in parallel. While **placeholder sound or video cues** might feature in the rehearsal room, primary focus remains on honing the actors' performances in relation to the text. Designers may visit in to observe blocking, gathering information for their own off-site work.

The **Stage Management team** (SM, DSM, ASM) becomes the centre of communication and information management, running the rehearsal room, documenting blocking, and logging changes. On smaller productions, the responsibilities of these small teams can be significant in keeping everything together.

Technical Rehearsal

The **technical rehearsal** ('tech') phase marks the convergence of all production elements, with all relevant cast and creatives being present to build the show on-stage.[1-3]

Actors often spend hours holding positions while lighting cues are built. The process involves slow **'step-throughs'** and **'stagger-throughs'**, sequencing the show **cue by cue** under the guidance of the team. The Deputy Stage Manager's (DSM's) prompt book becomes the operational bible.

A station in theatre tech.

Tech week is notorious for **time pressure**, as the true canvas of the show's creation emerges, constructed out of highly detailed cue plans, software, and equipment.

At the moment that all can be seen together, and the director's vision becomes clearer with proximity, changes become more difficult. Unforeseen conflicts arise and are squashed. Key decisions are made that balance practicality with concept. Snags and tech failures can require pauses and resets.

Large productions (£1M+) may have months for tech, employing dedicated specialist crews (AV teams, automation operators), and exhibiting to preview audiences to hone the production ready for opening night. Mid-tier (£250k-£1M) and small-scale shows (£50k-£100k) must compromise and compress these timelines.

Smaller shows, that rely on multi-tasking SMs and creatives, and may tech and open in just 48 hours.

Evolving Tools and Practices

Many variations or differing emphasis to the process described above do exist, some of which are listed below.

- **Immersive Theatre** demands new strategies for rehearsal and build.[3]
- **AV Integration** is an increasing staple, with the bar for visuals raising along with technology.[3-1]
- **Staging Automation** in staging is of growing use in large productions.[4]
- **Solo Operation** of mid-tier shows, with DSMs triggering LX and sound sequences via Qlab, requires extensive preparation and can restrict changes.
- **Less Performers**: Due to constricted budgets, some orchestras blend topline musicians with track, multi-roling and musicianship is more common for actors.
- **Social Media** is now essential, with teams needing to share and document their process for promotion.[5]

Conclusion

We have now fresh in our minds a bird's-eye overview of the production process, combining elements old and new to create theatre in the modern day. Our pursuit to investigate how spatial technology can help us, can

only be clear if we first identify issues with how theatre is made today that are purely process-related, which we are calling 'pain points' in this study.

If previsualisation can ease any of these 'pain points', and can prove to be a net positive, than that could be very valuable to out process moving forward.

Next Article: Identifying Pain Points >

Let's zoom into areas of friction in this process today: 2. Identifying pain points

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References:

Further reading: research appendix for this article

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2. Identifying pain points

Contents

Introduction

The creation of theatre can be described as uniquely collaborative in the context of industry, reaching almost magical levels of craft, leaving behind-the-scenes practitioners and actors alike with a deep love for what they do.[1]

We have compared digital previsualisation practices for other industries, and theorised how the **spatial** and **live** nature of theatre could present a barrier when it comes to creating a **digital twin**, already revolutionising other sectors.

Beyond this acknowledged complexity, it is worth keeping in mind the unique set of challenges theatre-makers face that cannot easily be replaced with technology:

- Perhaps no other art form asks audiences for such a profound **suspension of disbelief**, transporting audiences with disparate resources. The simplest prop and complex technology, working in symphony, are relied upon for spectacle and story.
- Few creative ventures operate with fewer **safety nets**; live dramatic performance is inherently risky, relying on consistent engagement and flawless execution, night after night.
- The sheer number of **potential points of failure** relative to budget, and the immense **cognitive load** of 'things to remember' for everyone involved, are exceptionally high.

This is the level that all theatre production - and the production process - must achieve to be effective. So, we can safely assume that it is never going to be easy, and overcoming impressive challenges is, really, the name of the game.

But which challenges will **always** be there - and which are needless process-related issues, that can be fixed?

We have identified 5 key pain points that will be used as a framework for improvement. They are listed below for clarity, where you can explore each in further detail.

1. Communication and Coordination

Bottlenecks in data-sharing and time early on, mean that problems and conflicts at a later stage. Read more: 1. Communication & Coordination

2. Resource Scarcity

Sometimes, you can't just throw resources at a problem. Recent world events have left a theatre industry needing to cut costs and work with less. Read more: 2. Resource Scarcity

3. Late-stage Integration

Last minute fixes can lead to compromises in vision and an unpleasant loss of perspective. Read more: 3. Late-stage Integration

4. Managing Complexity and Expectation

A great idea pitch can lead to ambitions varying ahead of delivery. Read more 4. Managing Complexity and Expectation

5. Burnout

Sheer effort can lead to compromises in health and wellbeing, which can affect production unexpectedly. Read more: 5. Burnout

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3. Pain points in detail

Let's see where the natural flow of our process might be building up in places where it could be eased.

Contents

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1. Communication & Coordination

Production relies on bringing together diverse teams of specialists, on and off the stage. Specialisation itself lends itself to a freelance business model for many, consisting 70% of the theatrical workforce in the UK 2. Specialisation requires years of education before joining the workforce. With this, comes a unique culture, lexicon, and set of responsibilities for each profession.

An additional factor here, not helped by larger economic trends, is that key creatives and technicians are often juggling multiple projects **simultaneously**, especially early in the production process. Small windows of time open for meetings and delivery of assets well ahead of rehearsals, requiring a huge contextual switch.[1]

Despite a culture of excellence and hard work, this asynchronous, brief, often remote communication can lead to misunderstandings or delays in approvals.[2]

Key roles in production coordination (PM, Producer, SM) in well-meaning efforts to keep things organised, can act as **bottlenecks**: the consequence being that critical creative decisions 'in the back of mind' of the Director can emerge at a late stage. Loose reins on process, on the other hand, can lead to precious effort and time being spent on 'red herrings'.

Both sides of this knife edge represent **information silos** - production-critical information that is behind barriers, often with no documentation, and no point of accountability.

Impact

- Delays in delivery
- Errors - actions taken based on incomplete or misunderstood information

- Duplicated effort, i.e. teams unknowingly redoing work or chasing down information already available elsewhere

2. Resource Scarcity

Recent world event have had negative downstream effects on arts funding, with organisations that have spent a generation receiving subsidy, left to fend for themselves.

Resource scarcity is a difficult topic to discuss. At its core, the premise is simple: the funding allocated towards a production is not sufficient. However, knock on effects such as improper compromise, or lack or adaptation, can be entirely avoidable process issues that can be tackled. The rest of this article will discuss knock-on effects, sudden changes and culture surrounding resource scarcity.

Hidden issues

While scarcity is a very real thing in our industry today, the *experience* of a lack of resources or funding within a production can be completely relative, based on prior expectations, or be caused by not tackling hidden process issues. This can be a sign of recent change (culture or training-based), intentional and baked in (project risk-based) or acute symptoms of personal barriers (communication based). Let's try and break these issues down into different categories.

Culture or training-based issues

- Issues that can arise from organisations' sudden cutting off from resources could be termed 'resourcefulness scarcity': teams are faced with problems that have not been relevant to prepare for or solve in their entire professional careers.
- Disunity can emerge and mindsets can clash at these times due to cracks in accountability.
- Ultimately this is downstream from the recent, larger change.

Project risk-based issues

- Artistic ambition can stretch beyond stated means - calculated risk necessary for a 'breakthrough' project.[3]
- Resources may get channelled unevenly due to historical habits.[4]
- Venturing into new territory carries an 'opportunity cost' which can be hard to measure.[5]
- Ever-increasing audience and stakeholder expectations can create a *perceived* scarcity from the team's perception of 'not having hit the mark'.[6]
- Hiring of inexperienced or unsuitable people can present their and other departments with unforeseen barriers.

Communication-based issues

- Inefficiencies fuelled by communication breakdowns, a lack of transparency or trust that hinders true collaboration, or simply outdated workflows – these can burn through available resources at an alarming rate, leading to scarcity.[7]
- Scarcity also manifests when talented practitioners withdraw their full engagement, or leave the project or industry altogether, due to unsustainable working conditions or unresolved conflicts.[8]

Impact

- Lack of resources but pressure on labour being the driving force. This is a 'downward' pressure to the workforce that can decrease morale in 'below deck' and in small teams overall.[9]

- The Peter Principle is also at play here - those who are efficient in a resource-scarce environment, end up with more to do.
- As has been explored: resource scarcity can occur at any level, and cause impacts downstream to any lower level, that can be hard to quantify or measure.
- Burn-though of cost can be hard to rectify: once it's gone, it's gone.

3. Late-stage Integration

Tech Week is when design, performance, and technology converge physically for the first time under immense pressure. Here we reap what was sown in rehearsal and pre-production, the effects being:

- Discovery of unforeseen spatial/technical conflicts only when elements meet on stage.[10]
- Inflexibility - Difficulty adapting to changes or solving complex problems within the compressed timeframe. Can leads to unforeseen cuts or other compromises.[11]

Impact

- Intense stress
- Costly last-minute fixes
- Potential artistic compromises
- Inefficient use of valuable venue/crew time[12]

4. Managing Complexity and Expectation

Modern forms like musical theatre inherently combine multiple complex elements – songs, dialogue, acting, dance, *and technical aspects* (set, costumes, props, lighting, sound) – into an "integrated whole". Coordinating these requires sophisticated management and technical oversight.[13]

The documented skills shortages across *multiple* technical disciplines (sound, lighting, automation, carpentry) in the UK theatre industry highlight the high level of specialized technical skill currently required to stage professional productions[14], as well as:

- Increasing technical demands of modern productions (multimedia, automation etc.).
- Pressure to deliver high production values across different scales.[15]

Impact:

- Increased cognitive load and stress on specialists, higher potential for critical failures if systems aren't robustly planned.[16]
- It stands to reason that current conditions may act as a deterrent for specialists to enter or stay within the theatre industry. 'You have to love it'.

5. Burnout

The cumulative effect of these interconnected pressures – communication struggles, resource strain, late-stage crunches, and escalating complexity – takes a significant toll. **Widespread burnout** and mental health challenges are increasingly recognized across the industry.[17]

This is compounded by:

- Precarious work insecurities of freelance life can add financial and emotional stress.[18]

- Challenging communication dynamics or pressured environments can impact workplace culture, and individual wellbeing.[19]

Impact:

- **Unexpected project errors**: A burnt out workforce is less reliable in terms of judgment, timekeeping and many aspects of professional discipline
- **Trust and risk taking imbalance**: Burnt out team members may err on the wrong side of the knife edge of risk management: playing it too safe by not speaking up, or seeking a shortcut by cutting corners.
- **Talent Drain:** Experienced professionals leave the industry, seeking more sustainable careers.[20]
- **Ethical Concerns:** Questions arise about the industry's duty of care to its workforce.
- **Sustainability Crisis:** The long-term health of the art form depends on the wellbeing of its people.

Conclusion: Necessary vs Unnecessary

So, back to our central question. Creating theatre will always involve challenges, as is the case with any artistic process. Discipline, immense creativity, and deep collaboration is required in the pursuit of excellence.[21]

However, many of these specific pain points - particularly those rooted in **communication breakdowns, workflow inefficiencies, fragmented information management, and late-stage integration conflicts** - feel less like artistic striving and more like process-related problems.[22]

This is where the opportunity lies. Exploring new workflows and technologies, or adapting those from elsewhere, shows promise for genuine improvement.[23]

> *"{Overcoming challenged related to} delays, errors, and duplicated effort, highlighting areas where improved information flow could yield significant benefits."*
>
> - American Theatre Magazine[24]

These pain points are a key reference for us, as we deem whether, and how, previsualisation and spatial technology can help theatre moving forward. Let's get ready to do that in the next article.

4. Proposal >

We set up a means of exploring real instances through the lens of addressing existing pain points in the production process. 4. Proposal

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4. "10 Big Challenges Facing Performing Arts As An Industry... - Wakeman Consulting Group" - Discusses uneven resource allocation in theatre. ↩

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7. "10 Big Challenges Facing Performing Arts As An Industry... - Wakeman Consulting Group" - Identifies inefficiencies from communication breakdowns wasting resources. ↩
8. "r/Theatre on Reddit: What are the biggest challenges you're facing in your theater career right now?" - Notes freelancers withdrawing due to unsustainable conditions. ↩
9. "AMERICAN THEATRE | In Challenging Times, Our Theatres Can Rise to the Challenge" - Discusses downward pressure on workforce morale. ↩
10. "Round-Up: Dealing With Production Challenges - TheatreFolk" - Describes unforeseen conflicts during tech week. ↩
11. "Stage of the Times: How Modern Theatre is Reimagining the Classics with E-tickets and New Approaches - Captitles" - Notes difficulty solving problems in compressed timelines. ↩
12. "10 Big Challenges Facing Performing Arts As An Industry... - Wakeman Consulting Group" - Highlights costly fixes and inefficient venue use during late-stage integration. ↩
13. "What unique challenges come with designing a set for a modern theatrical production? - Quora" - Discusses complexity of integrating multiple elements in modern theatre. ↩
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15. "What Is The Greatest Challenge Facing Theatre Today? - EQ Smart Plus" - Notes pressure for high production values across scales. ↩
16. "Stage of the Times: How Modern Theatre is Reimagining the Classics with E-tickets and New Approaches - Captitles" - Highlights cognitive load and potential failures from complexity. ↩
17. "r/Theatre on Reddit: What are the biggest challenges you're facing in your theater career right now?" - Identifies widespread burnout and mental health strain. ↩
18. "AMERICAN THEATRE | In Challenging Times, Our Theatres Can Rise to the Challenge" - Discusses precarious freelance work conditions. ↩
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23. "Stage of the Times: How Modern Theatre is Reimagining the Classics with E-tickets and New Approaches - Captitles" - Suggests technology as a solution for process improvements. ↩
24. "AMERICAN THEATRE | The Field and Its Challenges" - Identifies delays, errors, and duplicated effort due to poor communication. ↩

4. Proposal

Contents

Introduction

We've established the conventional workflows of modern theatre production, and pinpointed recurring pain points that can cause friction or strain our resources. We can now see ourselves in wider context of creative industry: one of emerging innovations that could help us save time and solve issues.

But unless we are directly addressing process issues, we cannot guarantee a net benefit to adopting new technology or changing practices, as has been observed elsewhere.

Luckily, we are seeing instances of previsualisation already taking hold in our own industry, along with academic research, that we can study to see how they can help.

Framing the Core Challenge

Theatre's production timeline, typically 6-12 months for large shows, demands rapid iteration and coordination across deeply specialized departments.

Unlike film, where previs can be a linear, pre-shoot process, theatre's essential creative period happens during rehearsal, with all elements converging in tech. Research suggests theatre's 'slower' tech adoption stems from this complexity, and relatively small scale so as not to be targeted by tech innovators[1]. There's also the fact that all software and technology must work live, every night, a high bar for a small world[2].

Examining Case Studies

Before proposing definitive pathways forward for adoption, let's examine a series of case studies, spanning academic works, new companies, and observations of standards adoption.

Each case study will be compared against process pain points we have established, making further comparison if necessary.

1. 2010- present - National Theatre
2. 2015-present - Preevue
3. 2018-19 - University of Bremen Studies
4. 2023 - Finnish National Opera and XR Stage
5. 2023 - University of Lapland Study
6. 2024 - Practices Report - Metcalfe, Preevue
7. 2025 - Lighting Previs Today
8. 2025-01 - Younite and Virtual Stage
9. 2025-02 - XR Network+ - Theatre Virtually Everywhere

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2. "Tech Fails in Theatre: A Modern Anxiety — Live Design" - Article on technology risks in live settings. ↩

2010- present - National Theatre

The National Theatre (NT), a globally recognised leader in theatrical production, is renowned for its artistic innovation and technical excellence. Public evidence suggests prominent use of Autodesk AutoCAD and 3DS Max, capable of high fidelity textured and realistic, raytraced renders, to visualise set designs.

Visit: nationaltheatre.org.uk

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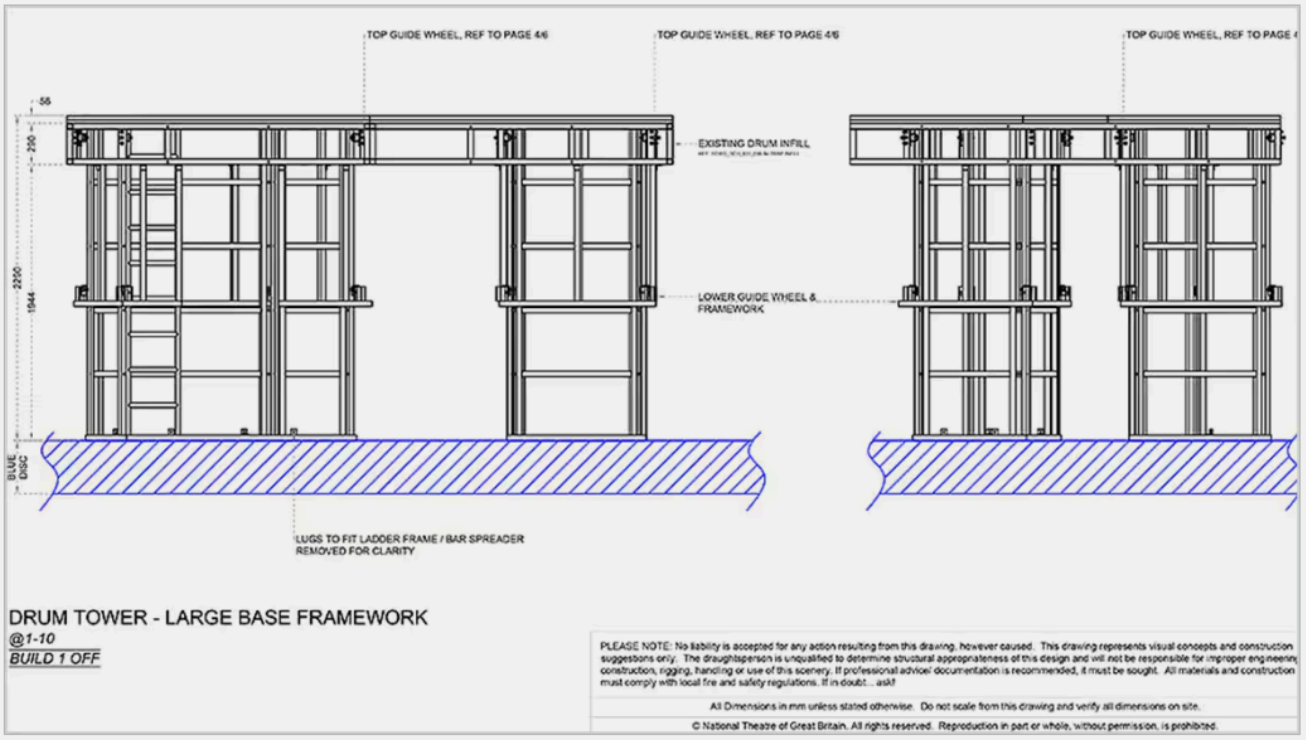
AutoCAD Use

National Theatre is featured on Autodesk's website as a successful 'Customer Story' owing to the work of project draughtsman Oli Cooper[1] . This is notable to us due to its profile and the light it sheds on AutoCAD as industry-standard practice in London Theatre for highly technically accurate design of functional staging.

Cooper's role sits parallel to set designers, meaning that technical draughting of sets has a single point of accountability. With smaller or mid-level productions, technical draughting of set can be shared between in-house technical team and the set designer.

> “I take 1/25 scale models that designers have produced, or even just design concepts, and turn them into full design drawings, where they can edit and update their design based on budget, functionality, and material economy,” he explains.
>
> “Then, from that, I take it to what we call a bench drawing, where we actually manufacture the piece in a carpentry or metal workshop for the stage. Alongside that, I also produce ground plans—what are essentially the architect’s drawings—of the theater with all these elements in and see how they coordinate together, essentially choreographing their dance around the stage.”
>
> AutoCAD Customer Stories, Oli Cooper, 2019



AutoCAD drawing of large base framework for a drum tower. Courtesy of Oli Cooper.

AutoCAD drawings from National Theatre

Online wording surrounding NT exhibitions like "Playing with Scale" (2018) suggest that while digital drafting was fully integrated into workflow at this time, production teams revolved around traditional model boxes to express ideas.

> "With AutoCAD as his foundation, Cooper and his peers are starting to branch out a bit, adding in other Autodesk programs such as 3ds Max to test sightlines."
>
> AutoCAD Customer Stories

3ds Max Use

Senior Digital Artist Daniel Radley Bennett's professional profiles and portfolio provide direct evidence of advanced 3D previs work with National Theatre using **3ds Max**, industry standard 3D software with realistic rendering capabilities similar to Maya or Blender.

His experience explicitly includes "Creating 3D Previs for shows in the Olivier, Lyttleton, Dorfman and Temporary Theatre Space" during his time as Digital Artist (2015-2018).[2] Specific productions where 3ds Max previs was employed are cited across his various platforms, including:

- **Angels in America** (Lyttelton)
- **King Lear** (Olivier)
- **Jack Absolute Flies Again** (Olivier)
- **The Plough and the Stars** (Previs storyboarding using CAD models for set/cast movement)
- **The Silver Tassie**

> "using CAD models to assist stage management and the creative team with set and cast movement planning"
>
> "sightline verification"

> "integrating projection design"
>
> *Daniel Radley-Bennett, Portfolio, The Plough and the Stars*

Radley-Bennett appears as **"previs artist"** for the **National Theatre Live: Twelfth Night** broadcast in 2017. This may confirm the use of 3D assets to plan camera angles and visual sequences for broadcast.

Image courtesy Daniel Radley-Bennett, National Theatre

> "As much as possible I try to texture and light the models which help the creative teams really connect with the previs. All texturing in this case was made via Adobe Photoshop."
>
> - Daniel Radley-Bennett, Portfolio, The Plough and the Stars

The above instance in 2016 shows detailed texturing and raytraced rendering, performed in parallel to the set design team. This level of oversight undoubtedly provided a level of confidence and signoff for the creatives and key stakeholders. Radley-Bennett effectively performs the 'communication' responsibility of the previsualisation artist; this is closer to the vision that is in the set designer's mind than a traditional 'white-card' model box would be. In this instance, and at a period of early adoption, the expense in hiring a previsualisation professional was justified, which continues to this day evidenced by the NT's continued practice of it to this day.

Additional remarks

Both Cooper and Radley-Bennett's positions (project draughtsman and previs artist) indicate parallel role positioning - i.e. this work occurs by dedicated technically-minded people separate to the creative team[3].

This shows a successful case of a previs artist being a long-standing member of high-level theatre production.

Analysis

Pain Points addressed

Late-stage Integration

The use of AutoCAD for accurate drafting, combined with 3ds Max for photorealistic imagery, sightline studies, and sequence planning, directly addresses **Late-Stage Integration** challenges by allowing earlier, more detailed spatial and temporal validation.

Communication & Coordination

Likely enhances **Communication & Coordination** by providing clearer visual references for complex sequences or designs.

Resource Scarcity

Potential **Resource Scarcity** is likely mitigated by reducing errors caught late in the process and enabling more efficient planning.

Where it falls short

Screen-based

A level of abstraction is still needed to imagine and position sightlines, and overall visual impression to the audience. The option to view in stereoscopy or VR/mobile AR would be a plus, as this is closer to real expeirnce

Pre-Rendered

All decisions (e.g. set movements and sequencing, positioning of overhead view, lighting) will need to have been made ahead of time, with each revision incurring more time/cost.

High Skill Floor

Technical specialists required to produce this level of work in 3ds Max. Libraries and rendering tools are emerging[4] with lower skill floors. This will only continue to enable accessibility by non-technical creatives. Imagine a lead designer could employ a previs artist but hand them over a working prototype first, or make changes to the previs artist's work after the fact. This fluidity and 'everyday use' aspect of the tools is important, and moves towards visionary ability and accountability (i.e. role) being the deciding factor of use, rather than technical ability.

Lack of Cloud/Sharing/Interactivity/Feedback

Platforms have since emerged for easy sharing and feedback of animated, interactive 3D assets, many featuring pre-baked raytraced lighting. [5]

Colour Gamut

The 3D asset is seen above compressed to WEBP/GIF format from a source video (which has since been removed). Some further gamut restrictions have taken place between the source video (rec709) and GIF (256-colour). Regardless of this, we can still see that the source material likely rendered raytracing in rec709 or sRGB natively, rather than in a Linear or ACES space, likely as a default option or to save processing time. This can be observed from the luminance range typically exhibited by this rendering method. A linear colour pipeline and HDR exhibition capability is far more preferable for asset, but is only now becoming viable and affordable. This dovetails with previous remarks VR Getting Brighter in HDR

Conclusion

Evidence confirms the National Theatre employs advanced 3D previsualization, using 3ds Max for dynamic planning (including sightline studies, storyboarding, and broadcast integration) alongside established AutoCAD drafting and traditional physical models.

While the NT successfully leverages these sophisticated tools, demonstrating a practical model for a major institution, the reliance on specialist digital artists and complex software presents scalability challenges for the wider industry.

Currently, the interest in and application of such advanced previsualization appear concentrated in high-level productions; longer timelines on these larger shows perhaps make the significant effort involved, including detailed texturing and potentially duplicated modelling work, a worthwhile investment, contrasting to lack of historical adoption elsewhere.

Nonetheless, the National Theatre exemplifies how advanced digital visualization can be actively integrated into theatre production workflows.

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5. Sketchfab, p3d, RealityMAX, Nvidia Omniverse, Connector Suite, Vectary ↩

2015-present - Preevue

As the theatre industry grapples with optimizing production processes, companies like Preevue Ltd. are carving out a specialist niche, bringing advanced visualization technologies typically associated with film and architecture into the heart of theatre and live event planning. Preevue's website was created in 2013 and shows higher profile activity from 2016.[1]

Their stated work focuses on creating highly accurate "digital twins" of performance spaces and leveraging Virtual Reality (VR) to unlock new efficiencies and creative possibilities.

The sign of this term emerging shows an expertise alignment with the other industries we have studied, as well as with larger global trends as observed by Deloitte[2] or McKinsey.

Visit: preevue.com

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The Preevue Process

Preevue's team utilizes LiDAR (Light Detection and Ranging) 3D laser scanning technology to survey performance venues, mapping the physical space in depth and colour [3]. This technology has seen an accessibility boost in recent years, though benefits from skilled operators, photogrammetry professionals, 3D artists and data wranglers.

For Preevue, detailed point cloud capture data becomes the foundation for their core offering: the creation of meticulously crafted 3D CAD **Digital Twins**.

Preevue's artists build these virtual replicas piece-by-piece, balancing high photorealistic detail with size and efficiency. This ensures the models are compatible with industry-standard software like AutoCAD, Vectorworks, and various lighting visualization packages (Capture, WYSIWYG, Augment3d) [4].

An accurate digital twin will serve multiple purposes of the theatre production process.

- It allows production teams to conduct virtual site visits,
- plan complex logistics,
- integrate designs from various departments into a single, reliable model

And all of this, years before a show might open [4-1].

VR Inclusion

Preevue are optimistic in the future of XR, and attempt to bridges the gap between traditional planning and digital potential in the present day.

Detailed digital twins can be used to create immersive VR experiences, allowing creative and production teams to 'step inside' a true-to-scale, true-to-perception virtual replica of a venue or set design [5].

This addresses a key challenge highlighted in industry discussions: flat screens' inadequacy for certain insights into spatial data, i.e.:

- truly understanding spatial relationships,
- audience sightlines.

In VR, team members can physically look around, walk the stage, or sit in any seat, gaining an intuitive understanding of the space without needing specialized CAD skills. This capability has proven invaluable for productions involving transatlantic teams, such as *Harry Potter and the Cursed Child*. Preevue set up VR suites in both New York and London, enabling split creative and production teams to collaboratively review design iterations within the virtual model of Broadway's Lyric Theatre [5-1].

High-Profile Productions

Preevue's impact is demonstrated through their involvement in numerous high-profile theatre productions, including *Bat Out of Hell The Musical*, *Come From Away*, and *Moulin Rouge! The Musical* [5-2].

Digital twins have been created for an extensive list of prestigious venues, including The London Palladium, Glyndebourne Opera House, the Royal Shakespeare Theatre, Manchester Opera House, and many West End theatres like the Lyceum and Savoy [4-2][6].

They also provided VR visualization for Southwark Playhouse's planned new venue, enabling internal design review and impactful fundraising presentations long before construction was complete [5-3].

Addressing gaps

The services offered by Preevue directly address many of the workflow challenges identified within the theatre industry, and that dovetail with the premise of this study. Specific challenges addressed here:

- fragmented data
- difficulties in exchanging information between departments

- underutilization of visualization due to time or resource constraints

By providing a high-fidelity, centralized digital asset, and the tools to explore it effectively, Preevue's 3rd party service essentially offers an integrated visualization solution.

Their work spans beyond theatre into events and media, recently signing a multi-year deal with Paramount Pictures, demonstrating the widening application of their expertise [7].

Analysis

Pain Points

Communication & Coordination:

Preevue directly targets this by creating a **centralized, reliable digital twin** integrating multi-departmental designs. Their VR solutions facilitate collaborative reviews, even across geographically dispersed teams (e.g., transatlantic productions), breaking down communication silos and ensuring everyone is working from the same accurate model.

Late-Stage Integration:

This is significantly mitigated. Preevue's accurate digital twins, created via **laser scanning**, allow for detailed planning, virtual site visits, and crucial **sightline analysis** using VR long before physical set load-in, drastically reducing the risk of late-stage spatial surprises.

Resource Scarcity:

Preevue aims to improve efficiency. Accurate upfront planning reduces costly errors and changes later in the process. Virtual site visits save time and travel expenses. Providing intuitive VR access potentially speeds up design comprehension and decision-making for non-technical team members.

Managing Complexity:

The service helps manage the complexity of modern productions and venues by providing accurate spatial data (digital twin) and an intuitive way (VR) to understand intricate designs and sightlines without requiring universal CAD proficiency among the creative/production team.

Tools & Workflows

Preevue employs **LiDAR 3D laser scanning** for initial data capture, specialized software for building accurate **Digital Twins** (3D CAD models), ensures compatibility with industry standards (**AutoCAD, Vectorworks, lighting viz software**), and utilizes **VR platforms** for immersive experiences.

Cross-Industry Comparison

Preevue brings technologies and approaches common in **film and architecture** into the theatre space. Their expansion into **live events and media** (evidenced by the Paramount deal) demonstrates the cross-pollination of these visualization techniques across related creative industries.

New Challenges & Opportunities:

Opportunities:

Preevue represents a market-validated **commercial solution** addressing known industry pain points. They enable effective **remote collaboration**, provide accessible **spatial understanding** (especially sightlines via

VR), and allow detailed planning long before venue access. Their extensive client list (major shows/venues) signifies growing **industry adoption** and trust.

Challenges:

The primary implied challenge is **cost and accessibility**. As a specialized commercial service, utilizing Preevue requires a budget allocation that may be prohibitive for smaller theatre companies or productions operating on tighter margins (£50k-£100k range). Clients are also dependent on a third-party provider for a critical part of their planning data and tools.

Transferability & Scalability:

Transferability:

The *benefits* offered (clear communication, early problem-spotting, better sightline understanding) are highly transferable and desirable across the theatre industry. Preevue's *service model* makes the *outcome* transferable without requiring clients to develop specialized in-house skills.

Scalability:

Preevue's *service* has demonstrated scalability to high-end productions and prestigious venues. However, scaling this *level* of service across the *entire* industry, particularly to lower-budget segments, likely depends on the cost of their services versus perceived value, or the emergence of lower-cost alternatives. The underlying technologies (scanning, VR) are becoming more accessible, but Preevue's value proposition lies in the *expertise* to deploy them effectively, which is what their service model scales *for those who can procure it*.

Conclusion

Preevue stands as a clear example of how specialized expertise can leverage clear value at the top of the theatre and live events industries - particularly those concerning unique venue characteristics, and high artistic design installations[8]. This is being met positively by the industries, and Preevue's star appears to be on the rise.

By focusing on the creation of accurate digital twins through laser scanning, and focused VR sessions if necessary, Preevue are beginning to provide tangible solutions to long-standing production planning challenges outlined earlier in this series.

Their work with major productions and venues demonstrates a growing adoption of these techniques, pushing theatre workflows towards greater efficiency, enhanced creative communication, and more informed decision-making.

It is important to take note that this success is currently taking the form of a service contractor to professional productions. There are several characteristics here

- Highly specialised offering provides niche performance
- High skill ceiling and low osmosis model is optimised for providing value to the high end of theatre production
- Many projects can be taken on at once

This model looks similar to the way a movie VFX vendor would work. It can be reasoned that the only difference between the form of an 'external vendor company' and a 'freelancer on a creative team' is not as great as one might think. Could we see a future where optimised miniaturized forms of the service Preevue offers are taken on by a single Previs artist, or effectively shared on a centralized platform between a theatre technical team and show creatives, like CAD models would be in the present day?

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7. Paramount Signs Multi-Year Deal With Digital Twin Studio Preevue - Preevue News: https://www.preevue.com/news/paramount-signs-multi-year-deal-with-digital-twin-studio-preevue ↩
8. This is a general way of describing a typical West End or Broadway show. Pop concerts tend to run lighter on design, and need to build in more venue get-in, than this so less impacted by the highly detailed approach as in this value-prop. ↩

2018-2019 - University of Bremen Studies and first.stage

These theoretical studies by the University of Bremen, explore using VR as a means of previsualising work for professionals working across different creative industries.

The two papers have been published as 'Extended Abstracts' of the 2018[1] and 2019[2] CHI conferences. The project received funding as part of 'first.stage', a grant agreement of the European Union's Horizon 2020 research and innovation programme.

first.stage aimed to create software for use in film, animation, and theatre[3]. The project shows its last progress being in 2019[4], and seems to have influenced motion capture products from Rokoko.

Working VR software was created by this project, but is not available in the public domain at present. Demonstrations of the software are shown in full functionality[5], and in use of theatre specific tools[6], showing a single-person VR user interfaces operated by handheld controllers.

The theoretical and survey work around this project is interesting and validating to our present thesis and context. We proceed with a surface level summary of the study papers, moving into contextual depth with industry analysis, and finally addressing Pain Points from the previous section.

Read the reports on ResearchGate:

- 2018 Paper: Empowering Creative People: Virtual Reality for Previsualization
- 2019 Paper: Analysis of Previsualization Tasks for Animation, Film and Theater

Visit: first-stage.eu

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VR for Spatial Understanding (Muender et al., 2018)

An early study testing VR previs prototypes yielded encouraging results. Theatre professionals engaged with tools designed for tasks like exploring virtual stage designs and assessing sightlines. Notably, the technology proved accessible even for those without extensive technical backgrounds. Participants found VR intuitive for navigating virtual spaces and manipulating elements, quickly grasping its utility for spatial planning tasks inherent to theatre.

> As the researchers noted, *"Even participants with little experience in 3D tools were able to use the prototypes after a short introduction and stated that they found VR useful for professional work"* [7].

However, the way theatre professionals used these tools differed significantly from their film counterparts. While film users focused on camera work, reflecting mature previs pipelines, theatre users concentrated on stage layout and physical constraints – highlighting the unique spatial demands of live performance. Practical issues like headset comfort and limited multi-user functions were also identified as hurdles.

Tailoring Tools for the Stage (Muender et al., 2019)

Further analysis comparing previs tasks across animation, film, and theatre reinforced these distinctions. Film and animation rely on standardized workflows and generalized 3D software (like Maya or Blender) for detailed scene and camera planning. Theatre shares some goals, like lighting or scenic layout, as well as roles in the creative team, but requires functionalities specifically addressing its unique context on-stage.

Crucially, theatre previs must account for the live audience experience and the physical reality of the stage space. This involves unique considerations not central to screen-based media;

> *"theatre experts emphasized the necessity to consider the visibility from the audience's perspective and the limitations of the stage when setting up a scene"* [8].

This study underlined that theatre is still adapting previs tools, needing solutions tailored to its specific spatial challenges, indicating a less standardized approach compared to film.

Analysis

Contextual Analysis

Historical context and notes on use and adoption

It is important to consider the historical context of these studies: Film previsualisation with conventional technology had already seen a golden age by the 2010s, and spatial technology in film was debuted in 2009 with James Cameron's Avatar. Since then, VR has not itself become a standard in creative industries, but the virtues of XR and Spatial Computing have propagated through those areas which teams can interface with easily during normal collaborative settings.

It seems that the progress vector pursued with these studies, was in developing intuitive user interface processes for non-technical creatives in XR space, an essential step for mass adoption in any case, with VR's assumed virtues, during the time period (2018-2022, post Oculus Meta acquisition), that VR could be said to have been in its 'honeymoon phase'.

What time may have proven is that the limitations and isolation of VR disqualify it from most creative teams at most times.

> while VR offers many advantages, it also conveys challenges in user acceptance, exhaustion in long term use, and potential motion sickness.
> *- Introduction, 2018 Study*

Hope for VR, in theatre production

There have been documented instances in 2025, with full case studies on the way, in which that a single Quest Pro headset has been employed during an early 'meet and greet' that creatives can take turns to 'peep through' and take a look at a set visualisation of a stage play, in a non-interactive way, that has added value to the production process. But this is not unseating laptops and iPads just yet in being absolutely essential.

Another instance is Preevue's key advantage, seen in a later case study, of sightline and QA signoff for remounted shows, performed by key stakeholders, at times where they cannot visit venues in person (e.g. global tours).

Barriers

> "Against our expectation, we found that our participants were predominantly positive towards VR for previs and rated it as a useful technology. Our prototypes showed that all users could perform typical 3D previs tasks even after very short learning times. Using the prototypes also convinced participants of the practical use of VR for previs and removed certain doubts."
> **- Conclusion, 2018 Study**

This excerpt shows a clear positive signal. Contrasting with a lack of mass adoption of VR in theatre production arenas suggest a few scenarios:

VR seems to be successful in bespoke, purposeful projects that optimise for its use, but as yet not in the hybrid, in-person environments that make up theatre and other creative production environments. Ultimately VR, in its isolating nature, puts a physical barrier between the user's perceived reality and others around them.

It brings to mind the popular party VR game 'Keep Talking and Nobody Explodes', where a single user in VR tasked with diffusing a bomb, and the party around them have the instructions on how to do it. The panic and frustration that emerges is all part of the fun in this instance, but one couldn't help but imagine why VR use is avoided outside of highly controlled settings.

This is not to mention that in the popular consciousness, viral videos feature VR users as woefully out of touch with their physical surroundings, the results ranging from hilarious to injurious.

> "VR is mostly limited to one user at a time, making it not suited for every situation - previs is a collaborative process often including multiple persons."
> *- Discussion, 2019 Study*

Theoretically, AR or mixed reality would also present social difficulties to collaboration in-person. Communicating creative visions is hard enough with words alone within a team; let alone one or a few members of a group having access to certain corporeal phenomena that the others are not.

Successful applications of VR seem to be when everyone shares the same 'space', whether physically or virtually.

And even as the human limbic system is fooled by the transportation VR provides, practitioners who are creating for the live stage in mind, will face limitations in 'visualisation', when the full spectrum of colour and luminance to the human eye is not represented in the tech - especially with critical lighting applications.[9]

To re-iterate. it is evident that the 'solution horizon' was closer to VR use for filmmaking at this time:

- most academic references in the studies were Film-related
- At the time of publishing of the studies, many high profile films were in production using early VR tech (HTC Vive in the case of The Lion King)

Other remarks

It is worth highlighting the excerpt below, as it echoes the aims of our Industry Studies Overview.

> "Previs has been used for decades in all visual design disciplines such as film, product design, and architecture and gains increasing popularity through the steady advancement of technology. Although previs has many advantages for production, it is time consuming and requires trained personnel."
> *- Introduction, 2018 Study*

> "Typically, complex 3D tools such as Maya, Blender, and recently game engines such as Unity and Unreal are used for previs. However, the operation of these 3D applications and game engines is very complex, time consuming and requires skilled technical users or programmers. Thus, excluding creative, non-technical users such as directors and producers from the previs production process, requiring many iterations of design and communication between creative personnel and technical staff."
> *- Introduction, 2018 Study*

This information is critical for a realist, practical view on previsualisation. In our Film Industry analysis, we noted an improper consolidation of power that can occur towards senior management and visualisation technicians, and away from creatives, that can occur in large productions due to the high skill ceiling currently demanded from 3D tools.

VR could be seen, in these studies as one example, as an attempt to remedy this, and will be key to remember as we look to later studies and success stories, especially the recent development of 'Virtual Stage'.

> "Eight domain experts were interviewed in the process of identifying tasks typical in theater previs. The main difference in theatre productions compared to film is the fact that staff members are working on a single immobile asset - the stage."
> *- Identification of Previs Tasks, 2019 Study*

This echoes the thesis put forward in the first article in section 1, and later developments as we will see. These are deceptively simple facts. The stage is a real experience, not a screen. It cannot be easily prototyped, like a product created with CAD. And it must facilitate immersion by a living company of actors, unlike large scale Architecture projects.

Pain Points Addressed In Detail

Late-Stage Integration & Spatial Conflicts:

The studies strongly suggest VR's potential in this area. Participants intuitively used the prototypes for "exploring virtual stage designs," "assessing sightlines," and understanding "stage layout and physical constraints."[7-1]

Communication & Coordination

By providing a shared virtual space that even non-technical users found accessible[7-2], VR shows promise for enhancing collaboration and shared understanding of designs between directors, designers, and potentially other stakeholders, potentially reducing misunderstandings that arise from interpreting 2D drawings or static models.

Resource Scarcity

While not a direct focus, identifying spatial issues or facilitating clearer communication *earlier* could reduce costly late-stage fixes and wasted effort, thus making more efficient use of limited time and budget.

Tools & Workflows:

Tools

The core technology was purpose-built **VR prototypes** running on standard VR hardware (implying headsets). The limitations noted ("headset comfort," "limited multi-user functions")[7-3] highlight the dependence on the capabilities of the hardware available at the time.

Workflows

The observed workflow differed significantly from film. Theatre professionals focused on **navigating the virtual stage, manipulating elements to understand spatial relationships, and assessing audience sightlines**.[7-4]

This contrasts sharply with film's camera-centric previs workflow. The 2019 study reinforced that theatre requires workflows considering the "visibility from the audience’s perspective and the limitations of the stage."[8-1]

Cross-Industry Comparison:

The comparison is explicit and central to the findings. While sharing goals like lighting/scenic layout, theatre's use of previs fundamentally diverged from **film and animation**. Film/animation rely on mature, standardized pipelines often using generalist 3D software (Maya, Blender) for detailed shot planning.[8-2]

Theatre's focus, as observed, was uniquely **spatial and experiential**, centred on the physical stage and live audience perspective, indicating a need for tailored approaches rather than direct adoption.[7-5][8-3]

New Challenges & Opportunities:

Opportunities

The key opportunity identified was VR's **intuitive nature and accessibility**, even for users without prior 3D software experience.[7-6] This lowers the barrier to entry for leveraging visualization for spatial understanding and collaboration.

Challenges

Several hurdles emerged: **practical hardware limitations** (comfort, multi-user capability)[7-7]; the fundamental realization that **generic tools are insufficient** and theatre requires functionalities specifically addressing its unique context[8-4]; and the implication that theatre **lacks the standardized previs pipelines** seen in other fields.

Transferability & Scalability:

Transferability

The finding that the tools were intuitive for non-experts is positive for transferability across different roles within a production team. The *concept* of using VR for spatial checks seems broadly applicable.

Scalability

Significant challenges exist here. The identified hardware limitations (though potentially lessening with newer tech) and the crucial need for **theatre-specific software features and workflows**[8-5] hinder immediate, widespread, scalable adoption. Off-the-shelf film/animation tools aren't a perfect fit, meaning true scalability might require further development of bespoke theatre solutions or significant adaptation of existing platforms, which could pose cost and expertise barriers, especially for smaller (£50k-£100k) productions. The lack of standardized workflows also complicates scaling across the industry.

Conclusion

The Bremen studies serve as a foundational benchmark. They clearly demonstrated VR's potential for tackling core theatre pain points related to spatial planning and communication in an intuitive way. However, they crucially highlighted that theatre cannot simply copy-paste tools or workflows from film. Success hinges on overcoming practical limitations and, more importantly, developing solutions *specifically tailored* to the unique spatial and experiential demands of live performance. This case study underscores the need for theatre-centric innovation in the visualization space.

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2023 - Finnish National Opera and XR Stage

Finnish National Opera (FNO) in Helsinki has emerged as a distinct leader in advanced previsualization techniques, drawing inspiration initially from practices in film & TV.

Their innovative approach included the development of '**XR Stage**' began a greater reshaping of complex opera productions, moving from an open-source Unreal Engine based tool to closed source USD-based, in a partnership deal with next-gen tech startup **Younite**. XR Stage was then renamed as '**Virtual Stage**', and this is chronicled in its own article later on.

XR Stage was developed as an open source software project by Finnish National Opera and Ballet, after receiving a FEDORA Next Stage grant of €60,000.

Read more here.

Contents

Developing XR Stage

Recognizing the challenges of planning large-scale opera productions, the FNO invested in creating its own previsualization tool. XR Stage, built within Unreal Engine (likely as a set of **plugins**), this system allowed the building of digital twins of their stage sets long before any physical construction begins [1].

It is worth saying that descriptions at the time of developement, including marketing material, state the previsualisation to be 'photorealistic'. In can be argued that in the present day, the quality bar is considerably higher. Unreal Engine 5 (XR Stage likely used UE4) has since integrated new technologies like Lumen and Megalights, with Nvidia RTX bringing true real-time raytracing to the market. XR Stage does not observably exhibit this level of realitme quality, instead resembling typical interactive VR experiences of the time, complete with user interfaces tracked to handheld wand controllers.

Users of XR Stage, observed in many videos documenting this process[2], are equipped with Varjo Aero[3] headsets, dubbed best VR headset of 2022. Varjo Aero support 200Hz refresh rate and 115 degree visibility, which is on par with today's best hardware. Pixel density would just fall short of Apple Vision Pro, though on par with modern headsets like Bigscreen Beyond 2. Varjo Aero lacks HDR support.

XR Stage requires a PC and SteamVR to operate.

Users can navigate stage and sets, assess sightlines, and interacting with digital props and scenery as if they were physically present [4].

"Turandot" proof of concept

The FNO first deployed the XR Stage comprehensively for their ambitious production of Puccini's "Turandot," which premiered in January 2023. This marked a significant milestone, making them reportedly the first opera house globally to utilize immersive XR/VR technology throughout the entire production lifecycle [4-1].

Designers, directors, technicians, and performers could inhabit the virtual set from the earliest stages, testing staging ideas, refining lighting concepts, and identifying potential issues months in advance [5]. This early, shared virtual access was touted to enable a deeper, more intuitive understanding of the final production's look and feel.

Benefits beyond design

It is reported that the implementation of XR Stage for "Turandot" yielded significant practical advantages beyond traditional creative planning. As a co-production with Malmö Opera in Sweden, the digital twin facilitated seamless collaboration between the international teams.

Virtual meetings and reviews within the shared digital environment drastically reduced the need for international travel and associated costs [1-1] [4-2].

Furthermore, planning complex technical elements and safety procedures within the virtual space contributed to improved workplace safety, and **more efficient use of materials and labour** once physical construction began.

It is probable that the FNO used XR Stage for subsequent productions. Their 2024-2025 season features a complex new opera, Alexander Raskatov's "Animal Farm," another international co-production. [6] [7]

Analysis

Pain Points

The FNO's XR Stage initiative, and implementation documented for "Turandot," directly tackled several core production pain points:

Communication & Coordination:

The shared virtual environment provided a crucial platform for the international co-production team, enabling "seamless collaboration" and reducing reliance on travel. Allowing diverse team members (designers, directors, technicians, performers) to inhabit the virtual set fostered a unified understanding from early stages.

Late-Stage Integration:

By allowing teams to test ideas, refine lighting, assess sightlines, and identify potential issues "months in advance" within the virtual replica, XR Stage aimed squarely at preventing the spatial and technical conflicts that often emerge only during physical tech rehearsals.

Resource Scarcity:

The project demonstrated clear resource efficiencies by reducing costly international travel for the co-production team. Furthermore, enhanced planning for technical elements and safety was reported to lead to more efficient use of materials and labour during the physical build phase. Early identification of problems also prevents expensive late-stage fixes.

Managing Complexity:

XR Stage provided an interactive, immersive tool to help the large, dispersed team grapple with the inherent complexity of a large-scale opera production and international co-production logistics.

Conclusion

The Finnish National Opera's approach mirrors the dynamic, sequence-based previsualization common in film [8], moving beyond static 3D models to create immersive, interactive planning environments.

This contrasts with many other major houses, which might use digital tools more for archival, streaming, or specific design elements rather than comprehensive production previs.

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2023 - University of Lapland Study

This academic study explores previs-based solutions the unique hurdles faced by traditional stage design for theatre. Production teams often face limited access to the actual performance space until late in the process, making planning, especially for interactive or complex shows, a significant challenge.

How can technology help bridge this gap between imagination and physical reality?

UOL's report offers results based on the research tem acting as sidecar to a small-scale professional theatre production.

There are some insights and valuable data points here, based on a now-familiar context: the team explores how a detailed **digital twin**, combined with VR use by creatives, impacted the design process for an interactive theatre production.

Read the report on ResearchGate

Contents

Building a Virtual Stage

The UOL researchers meticulously created a **digital twin** of the physical theatre stage, capturing dimensions down to the centimetre, including backstage areas and architectural details. Using standard modelling software and Unreal Engine, they built an environment that mirrored the real space, viewable through VR headsets.

This model served as a dynamic planning tool for the production team, comprising designers, actors, choreographers, and technicians.

During design workshops, this VR experience was presented alongside traditional tools like sketches, physical models, and blueprints, offering a new way to engage with the design.

Enhanced Collaboration

For the theatre creative team, stepping into the virtual theatre was reported to yield immediate benefits, particularly in **spatial comprehension**.

The study reported that viewing the digital twin via VR headsets allowed team members to perceive the stage space more effectively than with other methods.

This was especially true for those unfamiliar with the physical venue, who could gain a clearer, more intuitive grasp of scale, layout, and sightlines. Participants felt this early, shared visualization helped unify the team, enhance the transparency of the design process, and allowed potential staging problems to be identified and adjusted much earlier than usual.

The **digital twin** also proved a valuable communication tool. It created a common ground where the team could discuss movement, set placement, and design choices with a shared visual reference, in a unique way not possible otherwise. This was said to streamline discussions and iterative changes, offering potential savings in time and resources.

The usability of the VR system itself was rated favourably, suggesting the technology, while new to the participants, was not overly cumbersome once introduced.

Options and Acclimatisation to Spatial Tools

It is also notable, that along with being provided access to Quest 2 headsets, the team was provided access to the 3D models and assets on their laptops and mobile devices. It was documented that the creative team more frequently 'checked' these more familiar devices for design or blocking reference, than they did don the VR headset.

This is both a positive signal; and reasoning can be clearly seen from the creatives here: they are getting used to using **spatial** assets to aid decision making in theatre production; infrequently visiting immersive tools for virtual walkarounds, enhancing their spatial understanding well ahead of time, and reinforcing this awareness with commonplace digital items we all carry. This is critical information, and a testament to how familiarisation and presentation of options, can empower creatives to find their best way through challenges and the creative process.

> "Despite none of the participants having prior experience with VR tools in theater production design or specific expertise in using them, they generally viewed the VR model very positively. The participants reported that the use of VR and 3D models reduced the time and cost compared to the traditional design process. The traditional process involved the creation of physical mockups, which were time-consuming and expensive to produce. However, with the use of VR and 3D models, the team was able to create a virtual mockup before any material was used, which was more cost-effective."
> *- Findings, UOL Study, 2023*

Reality Check

Despite the clear advantages, the study underscored that VR **wasn't a complete replacement** for established methods.

While participants appreciated the virtual exploration, getting accustomed to the VR headsets and navigation required guidance and time. None of the participants owned VR headsets personally, relying on equipment provided for the workshop.

Furthermore, the technical expertise needed to build and manage the digital twin requires specialist skills, indicating a potential barrier to use dedicated support, with the current technology, public familiarity and platforms in existence.

The tactile sense of materials, the atmosphere of the physical space, and the ease of simultaneous group discussion around a physical model were missing elements. [1]

Participants noted that while VR offered an excellent preview, it didn't eliminate the need for physical site visits to check details like safety routes, or experience the space first-hand.

Interestingly, while VR was highly valued for initial immersion and understanding, the team also frequently referred to simpler 3D models on laptops or phones for quick checks, especially when practicality demanded portability (like verifying materials at a hardware store).

> The theater group had previously used physical miniature models as an aid in stage design, but in the future, felt that this could be replaced, at least partially, by VR.
> *- Findings, UOL Study, 2023*

Analysis

Pain Points

Late-Stage Integration & Spatial Conflicts

This was a primary focus. By providing early virtual access to an accurate replica of the stage space, the digital twin/VR combination allowed team members (especially those unfamiliar with the venue) to gain a much clearer, intuitive grasp of scale, layout, and sightlines. This enabled potential staging problems to be identified and adjusted significantly earlier than traditional methods might allow, directly mitigating the risk of late-stage discoveries during tech.

Communication & Coordination

The study highlights substantial benefits here. The shared virtual environment served as a "common ground," fostering unified understanding, enhancing transparency, and streamlining discussions about movement, placement, and design choices. This shared visual reference reportedly improved collaboration effectiveness.

Resource Scarcity

While not measured quantitatively, the study suggests potential efficiencies. By facilitating earlier problem-solving and potentially clearer communication, the approach offered savings in time and resources compared to the iterative process of building and modifying physical mock-ups.

Managing Complexity

The immersive nature of VR helped the team grapple with the complexities of the stage space, particularly relevant for the interactive production being designed.

Transferability & Scalability

Transferability

The demonstrated benefits for spatial understanding and communication seem highly transferable, particularly for complex productions, remote teams, or when working in unfamiliar venues.

Scalability

This remains a major challenge. The requirement for **specialist skills** to create high-fidelity digital twins presents a significant barrier for smaller organizations (£50k-£100k) lacking technical staff or budget. **Hardware costs and accessibility** are also factors.

Contextual analysis

It could be said that this study is a theoretical exploration of Preevue Ltd's professional experience in providing this service on a larger scale. The theatre project targeted here seems to be smaller-scale than a West End show. The managed 'digital twin' service is offered to the theatre creatives in parallel to traditional methods, i.e. as an option, and the results and insights are measured under normal circumstances of building a show.

It is compelling how the data points, and points of analysis and observation, dovetail well with those explored in the rest of this series of articles, theoretical and case studies alike. Take this excerpt nothing the spatial nature of theatre as relates to use of technology, as well as referencing other studies in similar ways. This excerpt could have been taken from the first article in this study, "The Theatre Industry and Technology".

> "Theatre production involves various teams working independently towards a shared goal. Set design and script-based production, for instance, are conducted separately, with actors rehearsing off-stage before the final assembly. Disciplines like film, animation, and theatre rely on a detailed planning phase, known as previsualization (previs), to explore ideas, plan technical solutions, and communicate a shared vision (Okun & Zwerman, 2010). Previs is a key part of pre-production, aiding in cost-efficient scene and shot planning (Ardal et al., 2019). However, in theatre, most of the team doesn’t see the staging until final rehearsals, despite some previsuals like sketches being shared earlier."
> *Introduction, UOL Study, 2023*

University of Bremen studies are referenced frequently, along with further studies concerning human interface design.

> Although prior work on digital twins has predominantly focused on manufacturing systems, the value of the approach in socio-technical design has been noted (Barricelli, Casiraghi, & Fogli, 2019). The use of VR-based tools for film and theatre previsualization tasks has been reported as beneficial, especially for non-technical personnel who can naturally explore the build space (Muender, Fröhlich, & Malaka, 2018; Muender et al., 2019).
> *- Background, UOL Study, 2023*

Sentiments are echoed here about VR's honeymoon phase and how previsualisation technology should enable decision making, rather than dazzling users in professional settings.

> Although emerging technologies such as VR offer new opportunities for creative work, it is crucial to have a good understanding of the tool's features and controls to fully benefit from its positive effects. In their study exploring VR tools in design education, Häkkilä et al. (2018) report that it is essential to look beyond the effects of novelty and unfamiliarity with the technology to recognize its long-term value.
> *- Background, UOL Study, 2023*

The following quote outlines disparity in the levels of 'immersion' or 'realism' provided by VR.

> Participants reported conflicting levels of realism for the VR experience. Whilst some felt it was very realistic and admired its similarity to reality, others believed that VR could not provide the same feeling as reality. VR and reality were perceived to complement each other in terms of space modeling and experiencing the space.

Hardware analysis

Appearances show that the study utilized Meta Quest 2 headsets, decent, practical VR models for the consumer market, retailing at about £300 at the time, far and away from £1500 cost of the Varjo Aero headset seen in other studies. It should be noted that the Quest 2 is a completely 'standalone' VR headset, not needing a high performance PC to operate. The VR 'app', build in UE5, was likely sideloaded into the headset ahead of sessions with the theatre creatives. This lack of a wired, PC-tethered experience, may have put forward a more practical and accessible impression, as opposed to experiences with XR Stage or early in Preevue's life[2].

Public perception may have affected experience; creatives or members of the public may have been more familiarised with VR as an activity by 2023, than they were in the years before.

Conclusion

The Lapland study paints a realistic picture of digital twins and VR in contemporary theatre design.

> "Our results indicate that VR and the developed 3D models played a crucial role in the staging team's workflow. The digital twin also facilitated communication and collaboration among team members, as it enabled them to share a common understanding of the design."
> *- Conclusion, UOL Study, 2023*

The technologies offered compelling benefits for visualizing complex spaces, fostering shared understanding, and potentially improving efficiency, empowering a small creative team.

The research firmly concludes that these tools, as they exist at the time of the study, are most effective as complementary aids. enhance, the invaluable insights gained from physical models, material samples, and physical venue visits.

One could imagine how, as photo and video have become commonplace tools used in remote communication and the expression of ideas, spatial tools may join these ranks as tools become more accessible.

References

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2. The standalone Quest 1 headset was released in 2019, and Preevue has activity dating back to 2013. XR Stage (FNO) is documented to be build for use of PC VR platforms, often using large desktop computers. ↩

2024 - Practices Report - Metcalfe, Preevue

The "Optimising Visualisation Practices" report, authored by Ryan Metcalfe (Preevue Ltd) for the RSC, examines why potential of visualisation is unrealised, and proposes a structured framework for improvement.

Core issues discussed:

- A lack of dedicated roles and resources, with visualisation tasks often falling to designers or programmers as an added burden, perceived merely as a cost rather than a cost-saving investment.
- While the increasing availability of 3D venue models provides a foundation, awareness gaps and departmental silos hinder effective use, leading to duplicated efforts.

The report argues that visualisation must become an essential, integrated component of production - a unique view from an industry insider, to where previsualisation responsibilities currently sit with creative teams.

Read here: OptimisingVisPractices-Metcalfe.pdf

Note: complexity of subject matter necessitates analysis being dispersed within generally commentary segments of this article.

Current Tools & Workflow Challenges

The report analyses common software tools, noting many weren't designed specifically for theatre, which in cur difficulties and workaround often swept under the rug by time-pressed technical freelancers, even as prominent as Lighting Designers and Set Designers. Looking at these particular software packages is important and speaks to larger issues that Metcalfe goes on to address

CAD

AutoCAD is the current industry standard for set designers and draughtsmen exchanging DWGs, despite its AEC focus and 3D limitations requiring workarounds.

Vectorworks, favoured by lighting designers, offers useful entertainment toolsets (like Spotlight), but its capabilities are often underused.

SketchUp provides easier entry but is less robust, while Rhino's powerful modelling is gaining traction. A key challenge is exporting 'solid' or 'spline-based' models from CAD to 'polygonal mesh' formats used by common 3D rendering engines, which is often a one-way, data-losing process.

Lighting

Tools like WYSIWYG, Capture, Depence, Augment3d, and GrandMA 3D exist, but often require significant, unbudgeted setup time practicioners, leading to duplicated effort as data is rebuilt.

Import compatibility varies; game-engine-based tools like Augment3d handle imports better, while Capture is noted for photometric accuracy. No single tool dominates due to setup demands.

Proposed Solutions & Best Practices

Metcalfe proposes a framework to overcome these issues of best practices across the industry moving forward:

Dedicated "Production Visualiser" Role

A standalone role, acting as the central custodian for all digital visualisation assets, integrating departmental data, ensuring integrity, and managing distribution.

"Visual Twin" vs. "Digital Twin"

Maintaining two complementary master files is recommended:
Visual Twin: *A photorealistic representation (e.g., in UE5) for communication, sightline analysis, clash detection, and approvals.*
Digital Twin: A CAD-accurate model preserving technical details and properties for departmental workflows and archiving.

It is possible that, like ArchViz/BIM tools, that there will come a single platform with the capability to hold one 'master twin' for the purposes of theatre production, that holds all assets associated with itself, for CAD, practical or rendering practices.

Workflow & Data Management

Emphasis on **standardized file formats** (DWG, VWX, FBX, MVR, exploring USD/glTF) and **interoperability** over enforced single software solutions. Requires strict **version control**[1], consistent **world space positioning**, and best practices for **3D modelling** (optimisation, clean topology, UV mapping). Data distribution should be tailored to each role's needs (e.g., specific file formats, pixel streaming, executables).

This may be remedied by future cloud platforms. Industry standard, next-gen file type are beginning to emerge across industry now that will aid standardisation.

Asset Capture & Archiving

Utilizing **LiDAR or photogrammetry** to capture sets/venues is vital for digital twins and reuse. Archiving **raw scan data** is advised. A centralized system is needed to avoid data siloing between departments. Consider

compression (Draco, 7zip) for large datasets.

Future ML tools may automate the currently laborious point-cloud-to-CAD conversion. In the time between the writing of this report and now, these ML tools have started to emerge, with machine-learning libraries being utilised by Artec 3D for traditional photogrammetry, or new startups like Luma Labs and technologies like Gaussian Splatting, along with MCP technology beginning to use AI to build detailed models from scratch.

"E-Tech" (Digital Tech Rehearsal)

This future scenario envisions formal virtual tech rehearsals led by a stage manager, bringing all departments together in the Digital Twin environment for early, cost-effective, collaborative problem-solving before entering the physical venue.

A thorough study and simulation of the technology to develop workable 'E-Tech' is highly exciting and highly ambitious. The prototype would require enhanced interoperability layers built between typical theatre platforms and protocols (Artnet, OSC, DANTE), along with cross conversion, virtualisation or re-creation of commonly used sequencing software, on top of improved standards in 3D file formats, and online streaming & rendering.

Virtual Reality (VR) in Theatre: A Focused Tool

Metcalfe views VR as powerful but with specific, limited applications. Its key strength lies in **bridging the understanding gap** for non-technical stakeholders (e.g., producers) and enabling intuitive, accurate **sightline assessment**, overcoming the distortions inherent in flat-screen representations.

Successful use cases (like *Harry Potter and the Cursed Child*) involved VR for communication and approvals, not as a primary design tool, as designers prefer existing software. Practical implementation demands **simplicity and speed** for busy stakeholders, often requiring an operator's assistance.

While VR integration exists in some lighting software, its benefits for typical proscenium setups are debatable and are beyond the performance expectations of current systems; poor implementation of VR especially is unacceptable for user comfort levels. VR is valuable when used strategically for communication and spatial analysis.

It may be possible that further down the line of e-tech capabilities - i.e. once sequencing, audio, lighting, and movement capabilities are more possible to tangibly display, the limited value offered by this format at present may be vastly extended.

Analysis

Pain Points

Metcalfe's proposed framework directly targets key production pain points:

Communication & Coordination

Addressed by the central Production Visualiser role, shared twin models, data standards, and conjectured to be assisted in future by collaborative E-Tech sessions.

Late-Stage Integration

Mitigated by early, accurate visualization, clash detection within the Visual Twin, and VR sightline reviews

Resource Scarcity

Improved by reducing errors, eliminating duplicated work, saving travel time, and making physical tech time more efficient via E-Tech prep.

Managing Complexity

Handled by providing intuitive visual tools (Visual Twin, VR) for holistic understanding and precise technical data (Digital Twin) for specialists.

Conclusion: A vision towards integrated Visualisation

The Metcalfe report advocates strongly for elevating theatre visualisation from a fragmented, undervalued task to an integrated, essential production discipline.

It argues that realizing its potential requires dedicated **Production Visualiser** roles, structured **Visual/Digital Twin** workflows, a focus on **interoperability** and data standards, and strategic, appropriate use of tools like **VR** and **E-Tech**.

While necessitating cultural shifts and investment, this integrated framework offers a clear path towards more efficient, collaborative, and visually sophisticated theatre production.

Interviews in Metcalfe's report confirm that visualisation is often an 'extra-mile' addition to workloads from certain team members, hampered by time constraints and lack of dedicated personnel or streamlined processes. This argument rings true with our overall picture of things.

3 scenarios utilising previs seem to emerge, taking all of this into account:

1. Previsualisation responsibilities shared throughout the team
2. A dedicated Production Visualizer, or previs artist
3. A sidecar contractor, like Preevue, with a dedicated team to provide this service.

Each of these scenarios have their own associated costs and capabilities, and different applicable uses-- all of which will morph and develop in the next decade on technological development.

The key thesis of Viz Academy is that the theatre community of practitioners and key stakeholders should realise their role in shaping this future, and in influencing future innovators of previsualisation. We examine this in detail in the next section, in particular 4. Roles, Impact on Process.

References

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1. Similar to practices in the software and technology industry. ↩

2025 - Lighting Previs Today

Instead of confiding this data within an appendix to be referred to in passing, the state of Lighting Previs is being treated as a Case Study due to it being significantly advanced compared to other areas.

Leading previs solutions for stage lighting are propagating throughout the industry, with asset libraries for different fixtures and integrations with existing hardware. Vendor lock is present with many parallel ecosystems, likely due to existing value models.

Regardless, lighting designers and their teams can now simulate complex lighting setups, program cues, getting a first look at rigs and setups within virtual environments before stepping into the physical venue, saving time and resources if used effectively.

Contents

Introduction

Established platforms like WYSIWYG and Vectorworks Spotlight continue to be industry mainstays, while newer competitors such as Capture and Depence2 are introducing alternative approaches and challenging the status quo.

These platforms indicate in interest for lighting designers to engage in previsualisation with digital asset libraries from many lighting manufacturers. However rendering integrations today still means that we are not seeing complete photorealism - and a lack of open standards mean that designers are tied to the rendering their vendor is capable of.

No major lighting previs platform currently supports OpenUSD, with GLB and MVR being the preferred standards for lighting previs at present. GLB and MVR have emerged as a valuable common standard between major platforms.

> At LDI 2022, GDTF & MVR originators – Vectorworks, MA Lighting and Robe – put aside their competitive differences to provide TPi with an exclusive update on these developments and how this unifying open-source format is impacting the entertainment industry.
>
> - GDTF and MVR: Unlocking the potential of data driven design ≥

Terms

The following fact sheets detail file types supported by different software and hardware platforms. While full documentation can be found online or in the Glossary, a short reference for these terms is below

Digital Control Protocols

- DMX (aka DMX512-A or historically DMX512)
  - a basic control protocol which was created in 1986 and subsequently became standard across industry
- Art-Net
  - A way of transmitting multiple DMX signals across a network.
  - It is proprietary, but royalty-free, being owned and operated by Artistic License Inc.

Show Design File Standards

- GDTF
  - General Device Type Format
  - "a unified way of listing and describing the hierarchical and logical structure and controls of any type of controllable device (e.g. luminaires, fog machines, etc.) in the lighting and entertainment industry."[1]
  - Developed by the GTDF Group[2]
  - It is possible to attach sidecar files to define the fixture when creating the GDTF file
    - PNG for a photograph of the fixture
    - SVG for a 2D vector projection of the fixture
    - GLB (binary glTF) files define the fixture's 3D geometry in low, mid, and high resolution
  - This standard has also been adopted by the film industry, by manufacturers like Arri[3] and Aputure[4]
- MVR
  - My Virtual Rig
  - Developed by the GDTF Group
  - Container file that holds CAD geometry and fixtures, in the form of GDTF files

Both GDTF and MVR are recognised by ANSI (DIN spec 15800 2022)[5]

3D File Standards

- glTF
  - Referred to as 'the JPG of 3D'
  - GLB is an efficient, binary form
- OpenUSD
  - Interchange format developed by Pixar

    - Various 'flavours' of delivery encoding, including usdz (uncompressed) or usdc (binary)
- Legacy formats (Alembic, OBJ, FBX)

See also[6]

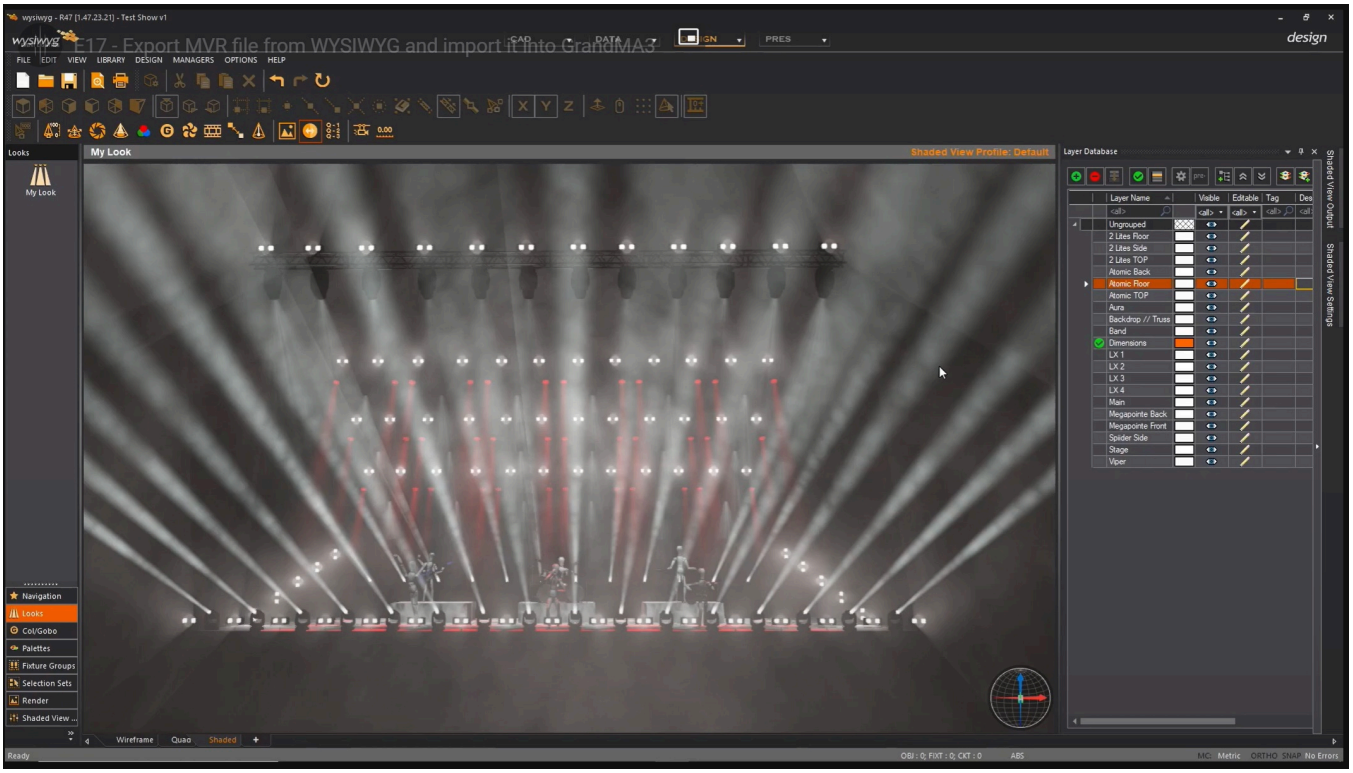
The Lighting Previs Landscape

The market offers a range of tools with a dynamic of established leaders and new challengers.

WYSIWYG

A long-standing industry benchmark since 1994, WYSIWYG by CAST Software offers an integrated suite combining CAD, plotting, documentation, and real-time animation with visualisation, that is translatable to DMX control. [3-1]

- Extensive fixture library (>25,000 items) in GDTF and MVR mainly, supports import
- Robust console connectivity
- VR capabilities
- Lacks raytraced lighting
- WYSIWYG Design: CAD Software
- WYSIWYG Perform: Cue programming, previsualisation, 1:1 programming to DMX universes
- Previs capability touted as a 'powerful sales tool' for designers
- Limited export functionality via FBX, Alembic, or Collada
- High cost



wysiwyg's realtime rendering engine showcasing volumetric effects

Vectorworks Spotlight and Vision

Vectorworks Spotlight (first launched 1996) is a CAD tool that incorporates previs features, like its 'Showcase' real-time visualization engine.

- No cue programming

- Extensive internal fixture library, and import via GDTF
- Integration with Architecture platform Enscape - enhances realism through raytraced lighting and HDR display support.
- Various 3D export formats (FBX, OBJ).
- MVR support
- Vectorworks Spotlight: CAD Software for theatre
- Vectorworks Vision: Cue programming, previsualisation, 1:1 programming to DMX universes
- Limited export functionality via FBX or Alembic
- High cost

Capture

Positioned as a more accessible, user-friendly alternative, Capture is popular for its intuitive object-oriented drafting, quick rendering, and reliable DMX/Art-Net support at a considerably lower price point.

- Basic CAD tools, High visual fidelity
- GDTF, MVR
- Realtime engine supports HDR, reflections, PBR
- Supported model export formats as **DWG/DXF, glTF (.gltf, .glb), and My Virtual Rig (.mvr)**. No mention of OpenUSD support.
- Supports animation and sequencing via DMX/ArtNet

Depence2

Windows-only visualizer distinguishes itself with a focus on high-fidelity, physics-based rendering, delivering superior photorealism for lighting visualization.

- It is gaining recognition for its visual quality but is less suited for comprehensive drafting or plot creation tasks.
- Basic CAD
- No native GDTF support, uses proprietary format. Supports MVR
- Cinema4D and Sketchu DWG import
- Excels in cue creation multimedia sequencing
- High visual fidelity
- Supports animation and sequencing via DMX

Console-Specific Tools

(Light Converse, GrandMA 3D)
These tools prioritize seamless integration with specific lighting control consoles

- Light Converse offers support for DWG imports
- GrandMA 3D provides tight integration for pre-programming MA systems
- Both are primarily focused on visualization for programming rather than broader design and drafting capabilities.

Analysis

Digital Twins terminology

The concept of accurate "digital twins" for lighting fixtures is becoming more concrete. Initiatives like GDTF aim to standardize fixture data, allowing simulation of real-world fixture behaviour (photometrics, colour, gobo parameters) with greater accuracy.

Film lighting firm ARRI recently released digital twins of their lights in Unreal Engine.[7]

Addressing Pain Points

Late-stage integration

Previs is beginning to designers and programmers to identify and resolve cueing issues, fixture conflicts, or undesirable looks before entering the venue - though ease of use, and communication make in-person development preferable.

Managing Complexity

Extensive libraries, clear imagery and 1:1 programming allows designers to get ahead with complex systems.

Communication & Coordination

Visualizations provide a clear, shared reference point for discussion between the lighting designer, director, other designers, and programmers. VR features promise to further enhance collaborative understanding of spatial lighting effects.

However, **interoperability issues** between different software packages can still create communication barriers between departments using disparate tools.

Resource Scarcity

Previs aims to save valuable **time** (especially during tech rehearsals) and potentially **physical resources** (less need for physical mock-ups).

However, the high **cost** of leading software packages and the demanding **hardware** required for photorealistic rendering create significant resource barriers, particularly for smaller productions.

The considerable **learning curve** also represents a time/training resource investment.

Conclusion

Theatre lighting previsualization in 2025 is a sophisticated field, essential for modern productions. WYSIWYG and Vectorworks Spotlight continue to offer comprehensive, albeit costly, solutions. Several parallel software solutions exist, that have recently taken steps to establish common standards.

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1. https://gdtf.eu/gdtf/file-spec/scope/ ↩
2. a group comprising of Vectorworks, MA Lighting, and ROBE ↩
3. https://www.arri.com/en/lighting/led-spotlights/l-series-plus/downloads ↩ ↩
4. https://gdtf.eu/blog/sidus-link-pro-with-gdtf-import/ ↩
5. https://webstore.ansi.org/standards/DIN/dinspec158002022 ↩
6. Read more in the appendix 5. 3D File Formats - USD, glTF, Others ↩
7. https://www.ibc.org/virtual-production/news/arri-skypanel-offers-unreal-improvements/20467 ↩

2025-01 - Younite and Virtual Stage

The Finnish National Opera (FNO) entered into a strategic partnership with Younite, a Finnish AI startup, in late 2024, securing a rights deal to develop and commercialize the **XR Stage**[1] platform, rebranding as **Younite Virtual Stage**.[2]

The stated goal is to establish Virtual Stage as a global standard for stage design and production planning within the performing arts, moving from Unreal Engine to a more advanced toolset, based on the open source OpenUSD platform. No software release strategy is stated, with a Younite offering a service-based collaboration as the Virtual Stage offering at present.

Currently, the project seems to be in an early stage of exposure, with initial videos released on the product's capabilities, similar to FNO's campaign surrounding XR Stage in 2023.

Younite is a well-funded, international organisation that operates across several industries, accomplished in tech and creative projects.

Read more in this January 2025 article, or on the Younite website.

Contents

Introduction

During the time period of our studies, we have witnessed a Theatre Industry that has shown measured interest, and development, into previs technology. We have seen positive feedback from creative teams, and success stories emerging from leading organisations and vendors, who have begun to look towards future potential.

Two delivery models of this technology exist in the industry. Service-based previs, like what is offered by Preevue or freelance teams, and software-based previs, which is offered by CAD and lighting platforms at

present, for the creative use of lighting designers and 3D artists.

The business models, and nascent stage of the tech, mean that both delivery models exist as walled gardens, confined either to

- a single discipline (e.g. lighting or set design)
- as a service, with in-house skills and custom workflows

The scale simply has not been there for companies to go beyond one model or the other. Let's briefly point out where the restrictions lie in this scenario, showing a gap to wider adoption of previsualisation in industry.

Service model

A luxury service for the highest-end productions in the Theatre Industry, whether through

- a 3rd party vendor (ex. Preevue)
- employing specific freelancers (ex. National Theatre)
- or developing in-house technology (ex. FNO, XR Stage).

Adoption of these more advanced service practices remains low, and full previsualisation software workflows from freelancers are constricted by timelines. We could point to a few barriers:

- High cost of entry
- High knowledge & skill barrier
- Lack of awareness
- Lack of standard protocol in the use of emerging technology
- Skepticism of new vs. traditional practices
- Lack of easy to use tools and training
- Real inefficiencies ('opportunity cost') associated with early adoption

Software model

Previsualisation capabilities are found in specific platforms:

- Lighting software
- CAD software
- Cinematic 3D software
- Specific custom software developed for research / R&D

Some of these platforms can ingest lighting plots, some can render well, some support cue creation. But none all at the same time.

A potential next stage in development

The limited scope at present, leads to:

- limitations of current delivery models
- limited demand for capable tools
- limited appeal and utility
- limited adoption.

Where the tools and skills exist, there are good results. But each tool that is created, each skill barrier removed, requires enormous investment and research.

Taking these steps is required to move closer to mass adoption in industry.

What we have seen in recent months, in the case of **Younite Virtual Stage**, may spell the next stage in the process, laying the groundwork for a commercial offering that may eliminate barriers to both Service and Software.

The technology landscape around Virtual Stage

In 2023, XR Stage was developed as a "groundbreaking virtual design tool" for opera. At the time, it was the most ambitious 'productisation' of spatial previs technology into software for the Theatre Industry, generating some buzz- though its scale impact and adoption rate was low[3]. In the present day (Spring 2025), service-based delivery for previs using existing tools (e.g. National Theatre using 3ds Max, or Preevue using Unreal Engine), remains the standard.

In the wider world today, ambitions for the use of 'compute' power have since expanded from the prospect of VR, XR and the Metaverse, which dominated the popular discourse at the turn of the 2020s. Global trends indicate a 'honeymoon phase' of VR/XR optimism, and we can even look at organisations and figures once enamoured entirely with the prospect of VR and the Metaverse[4], expand and spearhead into the megatrend of recent years: AI.[5]

Industry does have a more pragmatic, mature view of VR/XR today than it did yesteryear. The underlying hardware infrastructure that made it possible, however, has been expanding steadily since. VR, XR, spatial computing, social media, and now 'web3' and AI all rely on this effective use of the latest **compute power**, at a huge scale. Building on top of existing cloud infrastructure,[6] large data centres containing Graphical Processing Units (GPUs), have been very powerful for building the latest AI tools - but, these can also be used for:

- Graphical processing, and pre-rendering
- Running large online platforms
- Developing new software

This modern infrastructure, taken as a whole, spells out a new set of capabilities that are wielded by the latest generation of technology startups- which have the ability to achieve scale and impact for many industries.

Younite's website shows photorealistic, interactive previsualisation for sales of a variety of products, taking an immersive approach to retail of high value items.

Who is Younite?

Younite seems to be emerging as one such tech startup in this new generation, their USP seemingly being to deliver highly specific, original solutions for high profile clients in many different fields - including, the in-house creation of highly complex **digital twins** of large systems, like megayachts, vehicles, even entire cities.

Virtual Stage is now being developed as part of Younite's service offering. Younite's theatre services look very similar to Preevue's and others at present, offering previs delivery by their team, without selling their software- but the scope to expand beyond this is built into their organisation in a different way.

The Virtual Stage Platform Shift

XR Stage, Virtual Stage's predecessor, was built on the Unreal Engine platform, likely using custom plugins, asset libraries and compiled projects in a way commonly used for small VR service apps.

A pivotal aspect of Younite's strategy appears to be the shift from this practice towards a custom toolset, built around the OpenUSD[7] standard. This small detail indicates a much larger investment in a platform like this than ever before, and aligns with industry calls for greater interoperability and efficiency.

OpenUSD, developed by Pixar and now backed by an alliance including major players like NVIDIA, Autodesk, and Adobe, aims to be the "HTML for 3D," providing a common framework for describing, composing, and collaborating on complex 3D scenes.

Younite is an NVIDIA Partner, indicating a strong incentive to build Virtual Stage alongside NVIDIA Omniverse: a platform built upon OpenUSD, that leverages NVIDIA's RTX ray-tracing technology[8].

Unreal Engine, though a giant boon for 3D creation owing to its fidelity, community and asset library, is ultimately a closed platform with game development at its core - itself facing competition from Unity and others.[9] Unreal's Lumen lighting engine, and MegaLights features, are impressive and can yield photorealistic results - yet all will be optimised for realtime performance only, this incurring a certain 'fidelity cap' which necessitates workarounds to true realism.[10]

Using OpenUSD, and likely NVIDIA Omniverse, Younite is primed to use its substantial resources to develop a highly **optimized application specifically tailored for theatre use cases**, which could help to establish OpenUSD as an open-source file interchange standard for other platforms, practitioners and vendors to build upon.[11]

Virtual Stage, formerly XR Stage, finds a new home as a commercial offering.

Potential Impact

Industry in general

These foundational pieces are certainly intriguing at the early stage of this platform, and it is certainly worth understanding what they mean, so we can calculate future impact.

If developed and scaled successfully beyond its current service model, Younite has the potential to follow AutoCAD or Disguise to establish **Virtual Stage as a de facto standard for previsualisation**. Key factors like early market presence, strategic partnerships, and broad compatibility are all in place.

Other factors will strengthen long term value of this previsualisation platform from the industry at large:

- 1st/3rd party generation of large asset OpenUSD asset libraries (e.g. staging or set pieces from rental houses, props)
- Cooperation of other vendors and tools in partnership or independently
- Positive case studies from diverse organisations and productions
- Interoperability with existing standards, e.g. GDTF and MVR standards for lighting

For this capability to 'break through' and extend past high-end clients, Younite would need to commit significant cost to create a software platform for users beyond their in-house team.

However, Virtual Stage does have potential to expand past theatre into the Live Events industry more generally (even Immersive or Virtual Events), which would yield significant ROI in the event of adoption in this industry. Success stories like Disguise or Qlab are the result of breaking new ground.

Adoption and standards

This overall potential however, is looking like a good thing for previsualisation adoption in our industry.

Risks for Younite can be seen as benefits for the practitioners who will be the consumers of this software. This may encourage other players to get in on the action: competition from other vendors will incentivise quality, value and functionality.

MVR and GDTF are de-facto industry standards for lighting fixtures, and are open source. Future prominence of Virtual Stage could mean that OpenUSD becomes the de-facto industry standard for previsualisation. If compatibility was established between OpenUSD and MVR and GDTF, greater re-purposing and sharing could occur between all modern 3D creation software and vendor specific tools like VendorWorks Spotlight or WYSIWYG.

The above photo from the Younite website, shows a technician operating a grandMA2 console, which is adjusting lights within a 3D environment. This direct control from lighting desks was not observed in prior versions of the software. This hints at possible HID control or integration already built unto Virtual Stage via ArtNet or DMX- and evidences interoperability goals we have theorised.

Pain Points

While Younite Virtual Stage is still in its early stages, its stated goals and technological foundation suggest it aims to address several core theatre production pain points:

Communication & Coordination

By adopting OpenUSD and potentially NVIDIA Omniverse, Virtual Stage would establish an open standard for previsualisation - moving beyond the limitations of Unreal Engine. Direct HID control from lighting desks signals a move towards complete cross-platform integration for the creative team.

Late-Stage Integration

The platform's core function as an advanced previsualization tool, allowing teams to build and interact with complex digital twins early in the process, is fundamentally designed to catch spatial conflicts, design issues, and technical challenges long before costly physical tech rehearsals.

Managing Complexity

Younite's expertise in creating complex digital twins for other industries, combined with Omniverse's capacity for handling large datasets and complex scenes, positions Virtual Stage to potentially simplify the management of intricate opera and theatre productions within a unified virtual environment.

Resource Scarcity

Although initially a high-end service likely targeting well-resourced productions, the *potential* for Virtual Stage to eventually become accessible software holds promise for reducing resource strain more broadly.

If adopted widely, standardized workflows and reduced duplication could save time; however, the significant **cost and skill barriers** associated with such advanced platforms remain a major hurdle that needs to be overcome for this benefit to be widely realised.

Conclusion: A Potential Catalyst

Younite Virtual Stage, born from FNO's XR Stage and rebuilt on the promising foundations of OpenUSD and NVIDIA Omniverse, represents a significant investment signal in this field, and could move theatre previsualisation towards broader use through its services and software.

Younite's reliance on OpenUSD holds the key to potentially overcoming **interoperability challenges** faced by increasing 3D asset use in theatre, by its endorsement of the technology alone.

Currently offered as a high-end service, a future transition to licensable software will be dependent on platform maturity, market demand, and competitive strategy. This could **partially democratise** access if cost and training barriers are mitigated.

Virtual Stage signals a new level of technological ambition, potentially acting as a catalyst for transforming digital workflows in theatre.

References

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1. As detailed in the earlier article 2023 - Finnish National Opera and XR Stage ↩
2. Finnish Opera's XR stage goes global with Younite partnership - Helsinki Times, accessed April 9, 2025, https://www.helsinkitimes.fi/themes/themes/science-and-technology/25954-finnish-opera-s-xr-stage-goes-global-with-younite-partnership.html ↩
3. Online evidence does not suggest that the FNO's XR Stage tool was released to the public at any point. It does not appear in the public Unreal Engine plugin library. A Github or other public release may have, in theory, seen uptake by more intrepid theatre technologists around the world. ↩
4. Notably Mark Zuckerberg of Meta, Palmer Luckey of Meta, now Anduril, John Carmack, senior leadership of Google (abandoned Stadia), to name but a few ↩
5. Deloitte Tech Trends 2025 outlines how once certainly did not replace the other, spatial computing capability will lean on and benefit hugely from AI development ↩
6. Amazon Web Services ↩
7. (Universal Scene Description) ↩
8. NVIDIA Omniverse is a cloud platform designed specifically for building and connecting 3D tools and applications, facilitating real-time collaboration, physically accurate simulation, and high-fidelity rendering. ↩
9. Godot and CryEngine are players in this space though not as dominant at present. ↩
10. See more: William Faucher's photorealism techniques, criticisms of Unreal's overuse of DLSS technology ↩

11. OpenUSD is an open source library which supports many realtime, pre-rendering, and CAD platforms at present. Many theatre specific CAD and previs software do not support the standard yet, but a movement towards interoperability could encourage adoption to accelerate.

    Supported OpenUSD Platforms: Autodesk Maya, Autodesk 3ds Max, Autodesk Fusion 360, Autodesk Revit, Blender, Cinema 4D, Shapr3D, Rhinoceros 3D, Vectorworks

    Non-Supported Platforms: Capture, wysiwyg, GrandMA 3D, Depence R3, AutoCAD, Vision (ETC), Soundvision (L-Acoustics), d&b ArrayCalc, Disguise d3.

    Read more in our File Format Compatibility with Major Platforms appendix. ↩

2025-02 - XR Network+ - Theatre Virtually Everywhere

Announcements were posted on the websites of XR Network and Royal Central School of Speech and Drama, about a new collaborative projec aimed at hosting virtual rehearsals.

Read more on the XR Network+ website..

Contents

Summary

> "The projects are bringing together experts from academia and the creative industries to explore new techniques that combine traditional stagecraft with virtual production technologies such as performance capture, game engine software and virtual reality."
>
> - Press Release, cssd.ac.uk

Remarks on this will be brief, as the project does not directly concern previsualisation, but it does shed light on the many institutions concerned spatial technology, beyond just stage design and lighting, and towards performance capture of actors, and immersive audio- by the look of the institutions involved.

XR Network+ also boasts a background of virtual production R&D grants with RSC.

Key players in project

XR Network+

- "provides funding and support to researchers working in virtual production technologies"
- Sister project of XR Stories, an R&D initiative into immersive/interactive storytelling
- Funded by EPSRC, administered by University of York

CAMERA Centre

- Based at University of Bath
- Recent research into 2D motion analysis

- Volumetric Capture project
- Digital Twin production (Egg Theatre)

University of York

- Virtual reality and spatial audio labs >
- Involvement in CoSTAR LiveLab
- Their AudioLab linked with IAMF - open standards for immersive audio >
- AudioLab Spatial Audio Library >

Sam Crane

- Established actor, academic and creative
- Theatre, film and television

Agile Lens

- New York based VR/XR developer
- Background in
  - game design,
  - architecture previz
  - arts, virtual theatre
  - corporate

PTEQ - Centre for Performance, Technology and Equity

- Based at Royal Central School of Speech & Drama
- Tech / culture hub
- Motion Capture Studio
- Sonic arts lab

Threshold Acoustics

- Architecture and space design
- Focus on acoustic design of built spaces

What we can see happening

This project shows a recent, large cooperation effort of major institutions into XR research. This particular project is concerned with hybrid digital/physical theatre performances, and rehearsing/spectating these using performance capture. FNO's XR Stage has also evidenced research into performance capture[1].

Institutions involved are connected particularly to advancements in acoustics and immersive, spatial audio.

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1. Video: XR Stage - MoCap testing https://www.youtube.com/watch?v=bYw4pR-grmc ↩

Concluding Summary of Case Studies

That was quite the tour through the last 15 years of previsualisation in theatre- to the point where we have original software solutions on the horizon.

We will use all of the information we have learned to bring it all together, and look at scenarios and timelines for the next decade of the industry in the next section.

Here is a summary of what we have learned from the Case Studies.

Contents

Key Themes

Immersive Tools

- VR has enabled teams to "walk" virtual stages, testing sightlines, layouts, and designs, to positive feedback.
- The nature of VR lends itself to infrequent but valued use, when in-person referencing is difficult. (Bremen, Lapland, FNO, Preevue, Younite).
- Future advancements in this technology promise to make VR indistinguishable from reality: a trajectory towards a reliable digital reference for stage.

Digital Twins

- Virtual staging replicas can centralise planning, providing a common reference for departments and flag issues pre-build (Lapland, Preevue, FNO, Younite).
- They can ease speculative pressures and enable clearer decision making, as with many other industries - but must be imbued with essential data by all departments to leverage this value.
- Currently high cost and labour intensive, but used frequently by high-end productions.
- Future success will rely on progress in software, standardisation and asset generation

Early Conflict Detection

- Tools can catch sightline clashes, set collisions, or lighting misplacement before tech week, saving time and budget (FNO, Preevue, Lapland, Younite, Metcalfe study).

Diverse 3D Engines for Digital Twins

- Realtime game engines like Unreal Engine (FNO, Lapland), Unity (Agile Lens) are utilised for VR simulation at present
- Autodesk ecosystem (AutoCAD, 3ds Max) is effective for high fidelity video previs
- Emerging platforms like OpenUSD/NVIDIA Omniverse (Younite) are powering interactive, dynamic previews for other industries
- More recent web-only tools promise to remove deployment/device barriers to spatial content (three.js, AutoDesk Flow)
- Focus for digital twins is currently on set design and partial lighting, with potential to go further with simulation of other aspects of the stage, like spatial audio and performance capture.

Digital Must Support Reality

- Digital tools enhance, not replace, physical models, site visits, or hands-on work, honouring theatre's spirit (Lapland, National Theatre, Metcalfe, Bremen).

Pain Points addressed

Our earlier analysis 2. Identifying pain points pinpointed communication breakdowns, late-stage integration chaos, resource scarcity, complexity overload, and burnout as theatre's big hurdles. How do the case studies measure up?

What's Being Solved Now

Communication & Coordination:

- Every study delivers here. Bremen's VR prototypes facilitated VR previews for creatives. Preevue's digital twins synced transatlantic crews on *Harry Potter and the Cursed Child*.
- FNO's XR Stage enabled Helsinki-Malmö collaboration, saving travel costs.
- Lapland's virtual stage aligned a small team's vision.
- Younite's Virtual Stage, with OpenUSD, promises progression and fidelity.
- Metcalfe's vision for the Production Visualiser role aims to streamline comms.

Late-Stage Integration

- Wins in this area proven at large scales of production.
- FNO's *Turandot* used XR Stage to test lighting and sets months early, saving €75,000 and 1,500 hours.

- Preevue's digital twins caught sightline issues for West End shows. Lapland's digital twin spotted staging flaws pre-build.
- Bremen and National Theatre enabled early spatial checks via VR and 3ds Max respectively.
- Younite's platform promises to iterate designs faster.

Managing Complexity

- FNO's XR Stage tamed the logistics of large-scale modern opera.
- Preevue are brought in to handle venue quirks for tours and transfers, like *Moulin Rouge!*.
- Younite's OpenUSD-based Virtual Stage targets intricate shows with scalable 3D workflows.
- National Theatre's AutoCAD/3ds Max plans its signature sets.
- Lapland's VR aided an interactive show's layout.
- Insight: Metcalfe outlines two parallel twin models (visual and digital) as ideal, to organize complex data.

Resource Scarcity - **Partial**

- Efficiency gains are seen
- FNO cut labor and materials cost
- Preevue reduced travel
- Lapland saved on mock-ups
- National Theatre's previs avoided costly late fixes
- Younite's platform claims waste reduction via virtual testing, building on XR Stage's material savings
- Metcalfe's framework curbs duplicated work- but upfront costs to Previs/Digital Twin services remain a hurdle.
- Solutions remain isolated to high end productions.

What's Still Tricky

Budgeting

- Most studies involve industry heavyweights
- Preevue serves high-end clients
- Younite's commercial model, while scalable, targets bigger houses initially
- Metcalfe's research solutions call for dedicated roles, tough for mid size shows
- Smaller theatres lack resources to adopt, leaving accessibility gap.

Skill Gaps

- Digital twins, VR, and OpenUSD demand expertise: 3D modeling, game engines, etc
- FNO built in-house capacity, National Theatre leans on specialists like Radley-Bennett, and Preevue outsources.
- Lapland and Bremen's academic work relied on technicians working alongside creatives.
- Younite's polished UI (and possibile dedicated software solution) may ease use, but training for OpenUSD and Omniverse remains a hurdle especially if this is not a universally adopted standard.
- Metcalfe's paper highlights a shortage of tech-artist hybrids.

Burnout

- No study directly addresses this pain point we outlined in our Proposal, though efficiencies hint at relief.

- FNO’s time savings and Younite’s streamlined iterations could lighten loads, but long-hours will doubtless persist unless directly addressed.
- Learning curve (Lapland, Bremen) or complex software (National Theatre) risks adding stress without accessible onboarding.
- Metcalfe’s E-Tech is untested and theoretical at this stage, but the many standards and practices that would need to come together to make this happen would be in service of eliminating duplicated work and crunch, come tech rehearsal.

Physical Irreplaceability

- Lapland’s team valued tactile models and site visits for safety and intangible, tactile information (and discussion) for creatives.
- National Theatre pairs digital sets with physical.
- Bremen noted VR’s sensory limits (currently).
- FNO’s XR Stage and Younite’s Virtual Stage still rely on and celebrate real rehearsals, as they should. Theatre’s live essence demands hybrid workflows. Digital can’t fully replace the stage. The question will be, what can be built peripherally to support this process.

Interoperability and Standards

- Younite’s OpenUSD shift, likely backed by NVIDIA Omniverse, tackles this head-on.
- Preevue bridges formats as a service, and Bremen’s prototypes weren’t cross-platform.
- Siloed tools persist, slowing adoption outside integrated pipelines.

Cross-Industry Reflections

Drawing from film, gaming, architecture, and live events, theatre’s path is unique, but borrows where possible.

Unreal Engine powers FNO and Lapland's work, and shows no inclination to cater itself directly to theatre and live events more broadly, despite increasing adoption.

Live events’ AV integration (disguise) shows a great example of a product serving a specific need, but is siloed.

Opportunities and Challenges

Opportunities

These tools clearly have the potential to enable earlier decisions, clearer visions, and global collaboration.

Challenges

Cost and skill floors need to come down, through risky investment into new tools and standards.

Section 4

1. Bringing it all together

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1. A Vignette

It's 2035.

A Winter's Tale is opening in the round in 4 weeks.

A calendar alarm goes off for the 2nd e-tech meeting, ahead of the venue being clear. There's a festival showcase that's been in there for a month - we've been able to take a peek, but there are so many shows on it really can't be for long.

Rehearsals have gone well on the other side of town, actors off-book, with daily capture on-site being successful, receiving signoff for general movement and pacing. There's a poetry that's beginning to emerge.

The vast ceiling of the venue echoes above. As the last lighting cues get tweaked - a follow-spot and a blind to end Act 1 - a mixture of blank avatars and flat video-panes begin to pop in and potter around the 500-seater venue. The SM is joining via audio, muting every once in a while to greet actors who are warming up in the vicinity, which feels like it should be confusing.

The Voice of God echoes through the venue; "Right, we're in a great place so I will have to leave you to it, but just thought we should play back a few of those last scene, as we'll be rehearsing them here soon".

A junior AV designer, not long out of training, is late - but it's alright, they had dropped in their final cues out of hours, and with a bit of realignment- they're ready to go.

The team, some working from home, some borrowing desk controllers from their home venue - are in their rhythm, carefully placing cues, synchronising moments between sound, lighting, and the actors on stage - their spatial playback giving enough of an impression to be properly lit and tracked throughout the scenes. The LD is very proud of their new headset, more like a pair of sunglasses, really - and they have been able to sketch out cues in between tweaking the musical in Dubai for the new lead.

This is a big show, so it will be 2 weeks of full tech when we land in the venue proper. But we work 8 hours usually- and the time is most valuably spent tweaking what we already have. Most of the prop work we can see through spatial, so there's a bit of readjustment there When a scene needs to get get replaced in-person, but there's usually an option that we have pre-built that serves as a basis. There were even a few auto-suggestions for scenes that worked straight away.

The director leaves early, the vision of the venue fresh in their mind. The buzz of the company swells in their voice channel just before it cuts off- but a little blue light indicates an iPad feed is still in their room somewhere, in case anyone fancies a peek.

We step through Act 2 that day. An uneasy peace is comes over the team - we are living and breathing this show, but that usually goes into working on variations, or refining what we already have - not fixing tech issues like back in the day.

Feels good to be ahead of schedule. But we earned it!

2. What's Ahead

Ambitious as it might sound, e-tech of 2035 is not that far-fetched. And this calm, yet focused atmosphere described is achieved, not as a product of reckless experimentation, but by more of a careful sculpting of **process**, to allow the technology of the coming days to best help the practitioners of our art form.

The future doesn't need to be dizzying- it can be more like a **relief**.[1]

Contents

The Driver's Seat of Craft

Spatial computing and XR are likely to transform previsualisation across all industries over the next decade - this really just being a great way of digitally planning large projects, like we do today.

Like recent years, we will probably see many tools we use grow and develop- as new players and platforms emerge and compete for our custom. Software development, and crucially, interoperability between different platforms, is becoming easier.

The tech that is being pushed to revolutionise production is really in its early stages, enjoyed by enthusiasts and utilised by specialists. Looking at a Meta Quest 2 today is like seeing a second-generation Palm Pilot in 1997- with more drawbacks of use. This will improve.

The demonstrations you see of 3D previs and early VR, we will look back and wonder how we got by using tools that produced images so limited compared to real life.

From 2025 to 2035, advancements in software, tools for pros, real-time rendering, networking, data infrastructure, and communications, seem poised to make spatial computing more accessible and powerful.

Using trend reports and statistics as our guide, let's project forwards in time to see what's ahead for spatial technology.

The timeline in brief

2028

Basic VR and AR tools have improved. So light you forget they're there, much better apps, and greater instances across industry of remote collaboration.

2030

'Mixed reality' will blend digital and physical spaces for global teams, from broadcasting, to manufacturing, to entertainment, with incredible visuals

2035

Fully immersive ways of working will become common, helped by advanced AI agents and next-gen tools.[1-1]

Developing Guidelines

Above is a fairly accurate prediction of how technology will advance in the next decade. We have some say over how that will affect us as professionals, and as an industry at large. The question is how to do we correctly anticipate and prepare for the change that is to come? Here are some positive suggestions:

- Continue studying early test cases of how this technology affects process
- Establish rules, conventions and practices: and ways of working that make the most of the new tools that are on their way
- Make sure these practices optimising for the quality-of-life and freedom of practitioners

Designers, creatives, management and artists must benefit and be empowered by these changes- and early adoption and awareness makes this more likely. Let us make sure that optimised workflows do not lead to improper corners being cut at the expense of great work and positive environment.

Moving to Conclude the Study

The focus of our concluding articles will be firstly on actions recommendations for each industry stakeholder group. i.e.:

- What specific departments should look out for, make their voice heard about, and repurpose
- Suggested directions for organisational leads in terms of foundational work, key connections, monetisation, and early R&D allocation
- Important engagements for technical leadership and enthusiast practitioners
- Key industry consensus needed e.g. on standards sharing
- Run-through of appropriacy of different configurations of previs responsibility at different scales of production
- Goals and needs that intrepid vendors might engage with
- Best practices for collaborative creative teams to integrate emerging technology into the creative process

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References

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1. 2035 Tech projections show an increase in network speeds, miniaturization, reduced cost, and crucially, interoperability of the different advanced platforms that are being developed today. Read more in our Spatial Tech Forecast appendix. ↩ ↩

3. Actions and Recommendations

Below we will discuss critical context and suggestions for all activities and all parties.

Contents

General points of context

Standards

Existing service providers are beginning to do very well. Mass adoption and a technological leap is only possible with significant progress in interchange standards - the invention of Bluetooth and its effects is a great benchmark here.

There is possibility of a 'standards war' along the road here.

Assets

Significant ground is to be made in digital asset library management. Profit may be possible in short term but ultimately the industry will be made stronger with less gatekeeping to 'kitbash' resources, this requires big players to bet significantly on their users - great example here is Epic's acquisition and sharing and Quixel Megascans.

Who doesn't charge for their bottom rung will dictate future market leaders.

Practices

From all parties, attention should be paid to cross-comparison of best practices from other industries. Research and academia should pay particular mind here, due to a potential advantage of access and objectivity.

Quality of Life

If managed properly, interoperability and automation will clear the slate of busy work for genuine creative decisions. Esteemed creatives who become early adopters of next-gen tools will win.

Accelerated Digital Work

MCP and AI co-piloting tools are not detailed in this study- but have the potential to accelerate learning of CAD and other technical tools by non-technical creatives. We will see an acceleration of learning and accessibility, of software and ecosystem development, and competition for main players out of left field.

AI-generated imagery will see a surge of novelty uptake and inappropriate use in professional settings. That surge - caused by a bad-faith search for where human ingenuity can be replaced - will ultimately run out of steam, and those who are firmly rooted in their creative professions will be more in-demand than ever before: talent and competence is the signal in the noise.

Nevertheless, current methods of production - even digital production - are enormously labour intensive. There is a lot less of an interest for our own industry to optimise efficiencies- but it will help cost saving in a time of uncertainty.

Actions for different production areas

Audio

General awareness

- Some of the organisations we referred to in our Case Studies have seen to be working on open standards for Spatial Audio, which is wonderful.
- Standardisation for Spatial or Object Based audio would be a key step towards democratisation, as Dolby Atmos and d&b soundscape are great but they are locked to specific circumstances.
- Keep an eye on research and tools surrounding Ambisonics, Object-based Mixing, Room Convolution, Remote Mixing Solutions.
- While commercial standards exists, common standards are the only way of achieving large, more all-encompassing tools moving forward, unless a vendor takes the entire stack upon themselves to develop and deliver.

Recommendations

For Professionals

- Familiarity with spatial audio if possible, whether binaural mixing, live Spatial Audio solutions.
- Familiarise yourself with research from institutions like University of York, IAMF, keep an eye and see if any industry players are building interoperability tools or standards
- Experiment with using Ambisonic Convolution to build a library of binaural convolution impulses for your favourite spaces, practice, and make notes of what is reflected well and what isn't
- Experiment with headphone calibration, in combination - take notes on accuracy, share your results with your community

For Audio Vendors and Developers

- Utilise open standards to direct R&D towards an integrated, virtualised virtual space mixing tool. Collect feedback from live audio professionals.
- Explore compatibility or endpoint plug & play with Dante

For Researchers/Institutions

- Developing of virtualisation or compatibility layers between industry standard tools, combined convolution and speaker measurement simulation tools
- Virtualisation of existing licensed vendor standards e.g. using licensed Dante network in a fully virtual, spatial set of speakers using proprietary network protocol and software

Design for Stage

General Awareness

- Creative designers must continue to be catered for with deep, user friendly software that manifests accurate visual ideas without technical barriers.
- Large, online libraries of real stored props and set pieces benefit designers as termed 'kitbash', or 'digital building blocks' in coming years.
- We want to remove barriers and enable easier cross-conversion behind-the-scenes of tool use, including between physical and digital, between technical and creative, low and high resolution rendering, realtime vs cinematic, and different specialised software packages, offline and cloud.
- AI **conversion** tools, rather than creation tools, will enhance creative workflows rather than producing undesirable results. Ex: enhancing paper sketches into 3D assets, using diffusion models or MCP.
- Open standards promise to unify Spline and Polygon-based modelling
- Goal is to have technology outpace physical craft and allow designers shorter paths to expressing their work

Recommendations

For Professionals

- Explore user-friendly 3D tools beyond SketchUp, explore emerging AI cross-conversion between sketch and render, 2D and 3D.
- Share and document what works and doesn't work for you - what methods give you joy, traditional vs modern.
- Engage with Maker communities for news in fabricating miniatures, 3D printing.
- Keep an eye out for AI co-piloting of more complex CAD and 3D tools

Costume:

- Experiment with image diffusion models like Gemini 2.0 Flash for virtual try-ons.

For Organizations

- Virtual, scanned asset libraries of set pieces, props, and costumes could help to monetise through accessible hiring, and enrich designers' source material while working remote.
- Very large theatrical institutions or partnerships: consider joining the OpenUSD Alliance. Large bets are being placed on this standard now - become part of the discussion. This will help optimise the standard for building for theatre and live in the long term, and vendors will respond, too.

Props & Costume:

- Start digitizing your physical asset libraries with photogrammetry or LiDAR scans to support designers.[1]
- Invest in accessible scanning tools to make 3D costume data feasible for smaller productions.

For Vendors and Developers

- Create intuitive tools for qualified, non-technical creative professionals.
- Look to lower barrier of entry to emerging next-gen tools (like AutoDesk Flow)
- Offer affordable visualization kits for small troupes and pilot schemes, to create more evidential proof of future product launches.
- Low barriers to entry of high-end photorealism - like Lumion for archviz.
- Explore easy AR/VR/XR features for design tools - iOS/Android is a great start.
- Simplify creation and access to large asset libraries. Every industry should have a generous 'Unreal Marketplace' portal and community.
- AI-assisted LiDAR/Splatting/Photogrammetry tools could create itemised digital twins of cardboard model boxes, creating parts and layers from source photos, digitising simple models easily- perhaps matching to the source graphics used in creating them.

Prop & Costume

- Fashion Industry: potential business to open up to costume design archiving for theatre, television and film
- Create user-friendly tools for 3D prop scanning and visualization. Take advantage of new developments like AI retopology.
- Build platforms for shareable catalogues of 3D assets.

For Researchers/Institutions

- Investigate bridging proprietary tools and standards using conversion, copiloting and MCP.
- Test digital asset libraries for troupes to remix (kitbash) props, sets, and costumes across productions. This will enrich future, next-gen immersive tools.
- Explore volumetric video (or hi-res stereoscopic) streaming for virtual “visits” to workshops or large areas, live.
- Behavioural research on creatives and 'tech barriers' - when does the creative professional turn and reject a tool? Is it a high skill floor, poor UX, lack of familiarity, or something else?

Costumes

- Research photogrammetry tools and techniques for efficiently capturing costume textures and shapes. Consider initiating open forum discussion with fashion industry and digital costume leaders.[2]
- Test prop asset sharing previs tech in-field.
- Explore photogrammetry advancements to make 3D scanning easier for creatives.

Lighting

General Awareness

- Lighting previsualization tools, with digital twins of fixtures and materials, are advancing and becoming embedded in workflows. Vendor lock and compatibility at scale will become an unavoidable issue if trends continue. There is no likely model where a single vendor controls the entire ecosystem.
- Fixture libraries are bound to move past simple metadata, into full calibrated digital twins for all lighting products. This kind of work, and easy access to these libraries, will benefit the market as a whole. Customers should be able to experiment and trial different vendors' lights in a mix-and-match fashion, before making hiring decisions. [3]
- Advancing HDR display standards, and raytraced lighting engines, will raise the bar for lighting simulation professionals can trust.
- Lighting is, in some way, the benchmark for any previs simulation to become transformative to the industry.
- Overall goal: Reasonably accurate simulation tools, well-furnished with CRI-accurate, digital twins of vendor lights and common materials, with a long term interoperability plan for a complete picture of interdepartmental previs.

Recommendations

For Professionals

- Keep an eye out for the latest in wide-gamut and HDR.
- Check out realtime rendering occurring in UE5, other Nvidia RTX, or even cinematic engines like Blender Cycles.
- Experiment and look out for digital twin technology from lighting hardware vendors.
- Stay informed about open standards (e.g., GDTF, potential OpenUSD).
- Share needs and feedback with your community.

For Organizations

- Explore existing digital cataloguing tools.
- Strengthen relationships and dialogue with vendors.

For Vendors and Developers

- Build digital twins libraries of all on-sale fixtures.
- Experiment with high-fidelity rendering, interoperability standards, and AR/VR features, to enhance lighting preview platforms. Explore 3rd party rendering integrations for your previsualisation tools.
- Explore creating virtualised control desks, deepen app control or other cross-control protocols.
- Become familiar with modern cloud sharing capabilities. Three.js and others support fully baked lighting from a web browser. Tools in this area could be of immense value to creative teams as compute power increases.

For Researchers/Institutions

- Engage with ESTA/TSP on future of standards[4]
- Engage with Artistic License corporation on future of virtualisation and previs control[5]
- Engage with practicioner organisations e.g. ILP[6]
- Develop open cue-based formats (e.g., these exist for film editors like OpenTimelineIO) for exchanging cue stacks across vendor tools, integrating protocols like Art-Net, DMX, OSC.
- Test virtual libraries of fixtures and materials for troupes to reuse across shows.

- Explore AI for optimizing fixture placement or predicting lighting looks, ensuring human oversight.
- Align with open standard initiatives (e.g., OpenUSD) to bridge lighting tools with other departments.
- Develop AI tools to create digital twins of cardboard model boxes, identifying parts and layers from source photos.

Directing and Creative Leadership

General Awareness

- Testing tech with directors will be very valuable, but technologists bust keep in mind the director's core responsibilities, and how much they must trust their four senses.

Recommendations

For Professionals

- Experiment with immersive storytelling tools, like VR experiences or spatial video apps, and make note of what interests you.
- Observe and study how directors and creative leads in other sectors are working. The mentality needed to manage a large production is becoming more like film with lots of specialists and moving parts - big jobs can be of a completely different nature. Tech whispering directors will succeed
- Educate yourself on these trends, and make your voice heard.

For Organizations

- Involve directors deeply in testing immersive tools, ensuring they support creative vision and streamline collaboration.

For Vendors and Developers

- Develop intuitive VR/AR tools that respect directors’ sensory focus, making tech feel like a creative ally.
- Become experts in creative process - as tools become more advanced, they will serve this directly rather than through proxies.

For Researchers/Institutions

- Engage directors in research on immersive tools, ensuring tech enhances their creative process. Take particular note of negative feedback and sensory/intuition blockers.

Automation Specialists

General Awareness

- Current automation protocols are often vendor-locked or lack scale; open standards could streamline file handovers.
- Abstraction layers in pre/post-visualization could unify workflows. Businesses with leverage have the opportunity for greater market share if they lead in this direction

Recommendations

For Professionals

- Explore 3D tools to visualize automation in context, seeing the “big picture” without lengthy explanations.

- Stay informed about open standards like OpenUSD; share workflow needs at industry forums to shape tools.
- Test virtual previews of automation setups to ensure smooth integration with other departments.

For Organizations

- Invest in accessible visualization tools to support automation teams in planning and collaboration.
- Encourage participation in standards discussions to align automation with theater-wide workflows.

For Vendors and Developers

- Develop intuitive visualization tools for automation, supporting open standards like OpenUSD for interoperability.
- Create abstraction layers to simplify file handovers across proprietary systems.
- Join initiatives like the OpenUSD Alliance to influence future automation control protocols.

For Researchers/Institutions

- Explore open-standard formats for automation data exchange, integrating with protocols like DMX or OSC.
- Test visualization tools that unify automation with design and lighting previews.
- Research abstraction layers to bridge vendor-locked systems, enhancing cross-department workflows.

AV Design

General Awareness

- Next gen spatial tech and simulation will unlock a new level of preparation and simulation possible for the AV or Projection Designer; you will be able to design 'for the space' from day one.
- AV Designers are already technologically minded, and relatively isolated in production - yet their work's high visibility in the show, product engenders a high cost of failure. This all indicates a stronger proclivity and motive to embrace this technology.
- Leading platforms dominate industry standards, but high cost-of-entry leads mid-and-small-size productions to cut them out entirely (e.g. disguise, Pixera, Notch), leading to sub-optimal workflows and compromises.
- There is no serious solution catered to solo AV designers at present, that would also empower teams, forcing borrowed tech and practices from other industries which is not conducive to the workflow of theatre production.
- Solving this will be key to progressing a comprehensive previsualisation tool (or the fabled e-tech), as the same technology - realtime rendering, quick iterations - will be utilised.

Recommendations

For Professionals

- Realtime AV creation tools are likely to fit this market need.
- Experiment with cutting edge realtime rendering design tools like UE5 Avalanche.

Production Management

General Awareness

- Autodesk Flow is a compelling example of a production management tool, that is integrated with spatial data oversight and AI insights.

- Production managers are an important voice in the conversation as spatial tech develops, as their ease will be the benchmark of the tools' efficiency. 'It's nice, but does it get the job done?

Specialists/SMs/Movement

General Awareness

- Rehearsal rooms are sacred; tech like VR headsets may disrupt the director’s and actors’ creative flow.
- Volumetric video and markerless, non-invasive motion tracking could capture rehearsals non-intrusively, like a Zoom feed would today.
- Simple, unobtrusive tools are key to respecting the rehearsal process while enhancing visibility.

Technical Rehearsal Specialists/Technicians

General Awareness

- Interoperability standards (e.g., OpenUSD) could prevent duplicated work and streamline cross-department tech integration.
- E-tech hopes to enables early testing (e.g., sound, AV, lighting interactions) in virtual setups, saving time before tech rehearsals, but is many years away from being a reality.
- Unified platforms could let technicians preview projector output or light interactions weeks in advance, boosting efficiency.

Recommendations

For Professionals

- Understand previs long-term goals, make your voice heard as to benefits and drawback of current approach, to shape future practices and tools

For Organizations

- Adopt a forward-thinking, data-driven approach to technical production. Listen and record opinions of current practices.

For Vendors and Developers

- Move forward to develop integrated platforms for virtual tech rehearsals, being mindful of current moves in industry.

For Researchers/Institutions

- Gather detailed systems, ops and cultural data on current tech practices.

Production Visualisation

General Awareness

- Professional production visualisers exist as a rarity in the industry today, but their sharing and communication of their skills in production environments will be very valuable to develop best practices moving forward.
- It is the current thesis that previs ultimately sits as a **communications** focused role - rather than tech focused, or arts focused. The job of the previsualiser is to communicate creative visions through imagery

and simulation, to facilitate earlier decision making.

Recommendations

For Professionals

- Deepen expertise in interoperability standards, simulation, tools and standards from other industries.
- Create communities for theatre & live previsualisation to establish a network of peers
- Share your work and methods to shed light on best practices and raise awareness of this new skillset, to evidence and drive momentum for new studies and products

Further data and guidance is shared in the body of this study, and in our conclusion ahead.

Associates and Consistency

General Awareness

- Non-intrusive data collection (e.g., video, motion tracking) will be able to help associates monitor performance consistency.
- Deep learning technology could offer insights (e.g., variations in cue timing) without disrupting the show. This could be monitored remotely, or enable data gathering between associate visits.
- Virtualization and interoperability layers could log cues or hardware issues, simplifying maintenance tasks.

Remounting and Transfers

- huge value has been shown for this being used for transfers. metcalfe/preevue are run off their feet and are finally seeing the fruition of their project. this will only expand as technology gets easier to operate.

General Awareness

- Virtual tools (e.g., 3D simulations, e-tech) are proving valuable for remounting and transferring shows, saving time.
- Interoperability standards (e.g., OpenUSD) could streamline data sharing across venues and productions.
- Simplified tech (e.g., user-friendly platforms) will expand access to these tools for transfers.

Final message to sectors

Vendors

- Cutting edge organisations and groups would be open to startups pitching custom portals for asset sharing and cataloguing. This is straightforward to achieve MVP using lovable or v0.
- Practitioners are sold on utility, and audiences are sold on story.

Practitioners and working professionals in general

- It may seem like this is all going on over your head - but there are definite signs where if you are passionate about this future arriving, that simply sharing your cooperation, willingness to learn and observe how it can help, this can make a huge difference.

All parties

- Cooperation from all parties at all levels will result in the best possible scenario for our industry.
- Two scenarios we do not want to happen:
  - AI being pushed to make key creative decisions, e.g. scripts
  - Tools evolving in such a way outside of our industry that our practicioners end up with compounded complexity and duplication. This is happening right now.
- Innovation is not just a luxury: this is ultimately for resilience of our industry - as has been evidenced to be essential in recent years. By increasing process efficiency we can expand creative potential per show, increasing quality and decreasing turnaround time.
- Real theatre, the core offering, must maintain priority. Practicioners must be mindful of technology increasing distance to the subject of work, rather than decreasing it. This is critical information which must be shared, as it could affect output quality in the long term. The medium is the message, but the method can influence the message, unwittingly, as well - which might not be the intended one.

We now move to explore different scenarios of process integration for previs.

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1. This process can range from incredibly simple (iphone lidar scan) to complicated (using polarised light to capture normal maps.), to immense detaiil (1:1 artist modelling of cloth fibres) ↩
2. Solidwords, CLO ↩
3. https://open-fixture-library.org ↩
4. "The **ESTA Technical Standards Program** is the only ANSI-accredited standards program dedicated to the needs of the entertainment technology industry." https://tsp.esta.org/tsp/index.html ↩
5. Artistic License owns the Art-Net protocol https://artisticlicence.com ↩
6. the Institution for Lighting Design in the UK and Ireland https://theilp.org.uk ↩

4. Roles, Impact on Process

The theatre industry's current state of vendor lock and fragmented tools hinders the adoption of emerging technologies. However, awareness of the future, and its potential benefits, can drive positive change.

In this section, we'll explore the impact of production visualisation on process, considering various role scenarios and their implications.

Contents

Dedicated Visualiser (Solo or Small Team)

Recommended by Metcalfe. A dedicated production visualizer can serve as a crucial communications role, working closely with the stage management team, designers, and other stakeholders.

Their primary responsibility, logically, would be to reflect the creative vision of the designers, rather than imposing their own. This role requires transparency and collaboration to avoid consolidating decision-making power.

In-House

Integrate seamlessly with existing CAD systems and workflows. Allows for tighter control and data management, and in-house teams can work alongside draughtsmen, as they are, across multiple productions at once.

This could have a huge impact on organisational efficiency, especially as technology and platforms develop. In-house is likely the most cost-effective solution overall.

Venues would need to ensure their in-house practitioners stay well on top of industry best practices, as tech and execution methods will be rapidly evolving. Their strength will be to see the wood for the trees, though - they may have their own particular valid approach or preferred platform.

Freelance

Freelance production visualisers, like those working with major institutions like National Theatre at present, can bring specialised expertise to specific productions, offering flexibility and specificity.

Busy freelancers will have job access to a wide variety of shows and applications, like many in their position - but may be more likely to stick to tried-and-tested methods, and will be mindful of expenses of extremely high-end platforms.

Further thoughts

Dedicated visualisers, as have existed in other sectors for many years, represent a good first step for our industry

This capability will be accelerated with in-house asset libraries being shared with either venue teams or freelancers, for accurate 'kitbashing' by artist, and even designer, in a similar process to creating a virtual model box. Building these 3D asset libraries, will represent a significant increase in capacity, even at this early stage.

As we are late adopters of this technology, we will be subject to future technology evolutions inaccessible to other industries. This could be termed 'leapfrogging' in an economic sense, or 'second mover advantage' for vendors.

Shared visualisation duties represent this technological capability that will be available and utilised in the coming years, for existing creative teams to build their digital twin without the support of a dedicated person.

Shared Visualization Duties Across Show's Production Team

As the industry moves towards a more integrated ecosystem, shared visualization duties across teams may become increasingly feasible. However, the current model is unsustainable without further standards adoption, and adding complexity without addressing underlying issues will only exacerbate problems. The following segment outlines hoe creatives can be empowered to operate digital twins with enhanced standardisation and interoperability - or risk falling behind.

Standardisation must occur to empower creative teams

Vendors will continue to develop quality-of-life tools for individual creative professionals, who will undoubtedly make use, but this approach won't unlock the full potential of production visualisation we have outlined.[1] This just has not been necessary before, but will become increasingly so.

At the rate of development of startups like Preevue and Younite, the risk of outsourced teams outperforming traditional creative teams, due to platform disparity, is very real.

Service providers have optimized workflows that enable them to build entire shows from the ground up, potentially leaving traditional production teams behind. This disparity will highlight the need for better-integrated tools and more efficient workflows, moving forward.

Production teams for shows are, unfortunately, subject to greater forces beyond their control. A theatre production team comprised of creatives and technicians, with an advanced spatial platform at their disposal, would be greatly empowered in leveraging this technology, as they represent the fastest point, closest to the genesis of ideas and execution of any theatre production.

Outsourcing / Service Model

The outsourcing and service model is already showing success. Direct profit motive drives innovation, and more companies are likely to emerge in this area, especially if software solutions from top players are released or licensed. Larger tech firms, such as Autodesk or Disguise, may also enter the market with software solutions.

External services will doubtless scale past and beyond theatre, towards top-level live events and productions, and will do very well.

The centralised, totalised nature of previsualisation will give tomorrow's previs firms an advantage with client pitching: eventually delivering entire conceptions of all kinds of events and productions- effectively rubbing shoulders with high level creative agencies and production companies. They will have the advantage also, of licensing or remaining sole proprietors of their own tools.

With this happening in the high end, smaller productions will be left completely unaffected by this success story, except to look up in wonder. Existing disparities therefore risk being exacerbated in the industry.

It would be beneficial for large and successful previs vendors to remedy this- seeding the next generation of industry innovators as they do so - by encouraging, outreach, favourable software licensing, collaboration with education institutions - accessibility by any means necessary.

Further Thoughts

In any practical scenario, a comprehensive previs effort may involve collaboration with multiple asynchronous departments, which may cause scoping issues if revisions and deliverables are not properly defined to the respective parties. The infrastructure and expectations need to be set for this participation ahead of time: key lighting, cuing or design decisions need to have taken place, or have the capacity to take place digitally, to be reflected in previsualisation of any kind.

In a more general sense, 'accessibility by any means necessary', really applies across the board in all areas of this rapidly developing field. Sharing of technology, creation of open standards, and building innovative cloud platforms will ensure that Spatial Previsualisation technology serves its practitioners, industry, and audiences properly in the long term.

Digital-first approaches, live links, and freely shared assets will enable creatives to explore and provide feedback in-sync and in parallel.

Footnotes

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1. This involves further standardisation in:
    - Fixture definition
    - Rigging definition
    - Lighting animation i.e. moving heads
    - Cueing
    - Human-representative animation e.g. manual scene changes
    - Automation protocols
    - High-quality assets and textures
    - Digital speaker mapping, mixing and spatial audio codecs
    - HID control for digital twins across multiple vendors
    ↩

5. Conclusion

As we conclude this report, it's clear that the adoption of production visualization in theatre has the potential to revolutionize the creative process. By systematically exploring existing technologies, adjacent projects, and forward-thinking organizations, we've identified opportunities for growth and innovation.

Contents

What we can do

The core ways of integrating and innovating production visualisation in our industry involve:

- identifying areas that can be improved in our process
- developing plans, standards and practices that directly affect these areas positively

This involves an effort which connects:

- Academic institutions
- Major and minor players in industry: venues, production companies
- Relevant trusts and foundations
- Research projects and funds
- Commercial software vendors
- Existing previsualisation service vendors
- Standardisatoin Bodies [1]
- Technology alliances[2]

To move forward, we need to:

- Establish relationships between forward-thinking organisations, researchers and vendors to facilitate further coordination of standards and practices, and to calibrate market need.
- This could take the form of informal dialogue, partnerships, or wider consortium or conferencing
- Research, development and trialling can take place to integrate and innovate production visualisation practices across all areas of theatre production

The industry's task is to express a clear need, and the first vendor or product to step up may face risks. However, with heavy investment and next-generation technology, the possibilities for production visualization are vast.

However, the technology must show a clear benefit to current workflows before any production use, to ensure a positive track record.

Signing off

As we navigate this new era, we must balance the risks and opportunities. In the past year to date, strikes have taken place in the entertainment industry due to improper handling of emerging technology. By working together to establish standards and alliances, we can create a better future for theatre production.

This report aims to serve as a living repository of knowledge for the next decade of learning and documenting production visualisation technology. By sharing best practices, case studies, and industry insights, we hope to empower emerging creatives with the tools and expertise they need, to succeed in this rapidly evolving field.

We invite industry professionals, vendors, and organisations to contribute to this ongoing conversation and help shape the future of production visualisation. If you would like to submit your story or get in touch, please contact hi@viz.academy.

Thank you for reading, and we look forward to updates and future collaborations.

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1. In the UK, these include UK Theatre and ABTT. Read more in the Standardisation in Theatre appendix ↩
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Glossary

Glossary of Key Terms (Expanded)

Actors

Performers who embody characters on stage, including singers and dancers in musical theatre.

AD (Assistant Director)

Supports the Director creatively and logistically, often acting as a liaison between the director, actors, and other departments.

Adobe Suite

A collection of creative software from Adobe Inc., often used in film/TV post-production and design (e.g., Photoshop, After Effects, Premiere Pro).

AI Visualization

The use of Artificial Intelligence algorithms to generate or modify visual representations, such as predicting how a costume might look on a specific actor's digital model.

Alpha / Beta Testing

Phases in software and game development where nearly complete versions are tested internally (Alpha) or by a wider external audience (Beta) to find bugs and gather feedback before launch.

Animatic

A preliminary version of a film or animation sequence, created by editing storyboard images together with a soundtrack, used to plan timing and pacing. A key step in film/animation previs.

API (Application Programming Interface)

A set of rules and protocols that allows different software applications to communicate and exchange data with each other. Relevant for integrating visualization tools with other production software.

AR (Augmented Reality)

Technology that overlays digital information or virtual objects onto the real world, typically viewed through a smartphone, tablet, or specialized glasses.

ArchViz (Architectural Visualisation)

The art and technology of creating digital representations of architectural designs. Using 3D modeling, rendering, and animation, it helps architects, designers, and clients visualize spaces, materials, and lighting before construction, enhancing communication and decision-making.

ASM (Assistant Stage Manager)

Part of the Stage Management team, typically responsible for specific backstage tracks, prop management, and assisting the DSM and SM during rehearsals and performances.

AutoCAD

A widely used commercial Computer-Aided Design (CAD) software application.

Automation (Stage Machinery)

The use of computer-controlled mechanical systems to move scenery, fly bars, revolves, or other stage elements during a performance.

Baked Lighting

A technique in 3D graphics where complex lighting calculations are pre-computed ("baked") into textures for efficient real-time rendering.

BECTU / Equity

Major UK trade unions representing workers in the media, entertainment, and arts sectors, including theatre.

BIM (Building Information Modeling)

A process involving the generation and management of digital representations of physical and functional characteristics of places. BIM models are data-rich 3D models used extensively in architecture, engineering, and construction (AEC) for planning, design, construction, and operation.

Blender

A free and open-source 3D computer graphics software toolset used across various creative industries.

Blocking

The process during rehearsal where the director and actors determine the specific movements and positioning of actors on stage.

Budget Tiers (Scale)

Productions categorized by budget, influencing resources and timelines (e.g., Small Scale: ~£50k-£100k, Mid Scale: ~£250k-£1M, Large Scale: £1M+ in UK theatre context).

Burnout

A state of physical, emotional, and mental exhaustion caused by prolonged stress, a documented issue in creative and production industries.

CAD (Computer-Aided Design)

Software used to create precise 2D drawings and 3D models (e.g., AutoCAD, Vectorworks).

Capture

Specialist lighting previsualization software known for accurate photometrics simulation.

Casting Director

Specialist role organising and overseeing actor auditions.

Choreographer

Designs and directs dance or stylized movement sequences.

Clash Detection

A process, often using BIM models in architecture/construction, to identify where different building systems (e.g., plumbing, electrical, structural) interfere with each other in the design phase, preventing on-site problems.

Cloud Computing

Delivery of computing services (storage, processing) over the internet.

Cloud-Hosted Assets

Digital files stored on remote servers for shared access.

Co-production

A production funded and produced jointly by two or more different companies or organizations.

Combat Director / Fight Director

Specialist who choreographs and rehearses staged violence safely.

Commercial Theatre

Theatre funded primarily through private investment aiming for profit.

Commissioning

Hiring an artist to create a new work for a specific production.

Company Manager

Manages logistics and pastoral care for the acting company and sometimes crew.

Composer

Writes original music for a production.

Concept Art

Illustrations created early in development to visualize the look, feel, style, and atmosphere of characters, environments, or key moments. Crucial in film, games, and theatre design.

Corporate Event

Live events produced for businesses, such as product launches, conferences, or award ceremonies, often requiring high technical reliability and clear messaging.

Costume Designer

Responsible for the visual appearance of actors through clothing and accessories.

Cover / Understudy / Swing

Performers hired to learn roles to cover for absent primary actors.

Cues / Cue-to-Cue

Specific points for technical actions. A "Cue-to-Cue" is a rehearsal focusing on these transitions.

Dark (Theatre)

A theatre closed to the public between productions or on specific days.

Data Exchange

Transferring digital information between different software or departments, often a technical challenge.

Depence²

Lighting visualization software noted for advanced features like VR.

Development Deal

Agreement providing resources for developing a new script over time.

Digital Asset Management

Systems for storing, organizing, and sharing digital files.

Digital Twin

An accurate, often data-rich, virtual replica of a physical object, space, or system. Used differently across industries (e.g., lifecycle management in architecture vs. production planning in theatre).

disguise (Media Server)

A prominent hardware and software platform used extensively in live events (concerts, corporate, theatre) for integrated video playback, projection mapping, real-time effects, and show control.

Dramaturg

Specialist focusing on research, development, and structure of scripts.

Dress Rehearsal

A full run-through shortly before opening, incorporating all elements including costumes.

DSM (Deputy Stage Manager)

Usually "calls the show" during performances from the prompt book.

Environmental Storytelling

Using the design of a game level or environment to convey narrative information or atmosphere implicitly, without explicit text or dialogue.

E-Tech

A forward-looking term for integrated, next-generation technology solutions (often involving spatial computing, VR/AR, and real-time rendering) designed to streamline theatre production processes, particularly previsualization and technical rehearsals.

ETC's Augment3d

A lighting visualization tool integrated into ETC's Eos lighting consoles.

Executive Producer

Oversees funding, strategy, and high-level aspects, particularly in commercial productions.

Extended Reality (xR)

Often used in live events/virtual production to describe techniques blending camera footage with real-time rendered virtual backgrounds and foregrounds, often using LED screens and camera tracking. Also an umbrella term for VR/AR/MR.

Facility Management

The maintenance and operational management of buildings and infrastructure, increasingly aided by data from digital twins in architecture.

File Formats (3D)

Standard ways of storing 3D model data (e.g., .obj, .fbx, .gltf for meshes; .dwg, .vwx for CAD).

Fly System / Flys

System of ropes, pulleys, counterweights/motors to hoist scenery/lights. Operated by a Flyman/Fly Crew.

Followspot Operator

Technician operating a spotlight to manually follow a performer.

Fourth Wall

Imaginary "wall" between stage and audience.

Frame Rate

Frequency of images displayed per second (FPS). Crucial for smooth VR/real-time visuals.

Freelancer

Independent worker hired project-by-project; majority of theatre workforce.

Funding (Models)

How theatre is paid for (public subsidy vs. private investment/commercial).

Game Engine / Real-time Engine

Software framework for creating interactive experiences (e.g., Unreal Engine, Unity).

Game Mechanics

The rules, systems, and interactions governing gameplay in a video game. Prototyping these is key in game development.

General Manager

Oversees business and administrative operations of a theatre company/production.

Get-in / Load-in

Period when equipment is brought into and installed in the venue.

Global Illumination

Advanced lighting calculation simulating indirect light bounces for realism.

Green/Blue Screen

Screens used in filmmaking to allow the background to be digitally replaced in post-production (chroma keying). Also used in some virtual production setups.

Ground Plan

Technical drawing showing a top-down view of the stage set.

Haptics

Technology simulating touch via force feedback or vibrations, used in some VR controllers.

Head of Department (HOD)

Senior manager overseeing a specific technical department.

Health & Safety (H&S) / Risk Assessment

Identifying hazards and implementing controls for safety.

Immersive Installation / Experience

Events or artworks designed to surround the audience, often using multiple sensory inputs and sometimes interactivity, blurring the line between observer and participant.

Immersive Theatre

Theatre where the audience is situated within the performance environment.

Intimacy Director / Coordinator

Specialist choreographing intimate scenes ensuring performer safety/consent.

Iterative Development

A development process common in gaming where features are built, tested, and refined repeatedly based on feedback (e.g., playtesting).

Kitbashing

The practice of assembling or modifying pre-existing digital assets (e.g., 3D models, textures) to quickly create new designs or virtual environments, commonly used in theatre design to build virtual model boxes or stage setups.

Latency

Time delay between action and system response. Low latency is crucial for VR comfort.

Leapfrogging

The phenomenon where late adopters of technology (e.g., theatre industry) bypass intermediate stages of development and adopt advanced solutions.

LED Volume / Wall

Large screens composed of LED panels used in virtual production to display background environments in real-time, captured directly by the camera.

Level Design

The process in game development of creating the environments, stages, or "levels" that players navigate, involving layout, pacing, challenge, and environmental storytelling.

Librettist

Writer of the text (libretto) for an opera or musical.

LiDAR (Light Detection and Ranging)

Remote sensing method using lasers to create precise 3D maps/models.

Lifecycle Management

Managing all phases of an asset's life (design, construction, operation, maintenance, disposal), often facilitated by digital twins in architecture.

Lighting Designer

Responsible for the artistic design of the lighting.

Lighting Previsualization Software

Specialized software (e.g., Capture, WYSIWYG, Depence², Augment3d, MA3D) for simulating and programming lighting virtually.

Lighting Programmer

Works with the LD to program cues into the lighting console.

Load-out / Get-out

Synonym for Strike; dismantling and removing the production.

Location Scouting

Searching for and evaluating real-world locations for filming or inspiration.

Look Development (LookDev) / Visual Development (VizDev)

Process, originating in animation/VFX, defining the final visual appearance of assets or shots, considering textures, lighting, rendering, and compositing.

Lumen

Unreal Engine 5's dynamic global illumination and reflections system.

MA3D

3D visualization tool for MA Lighting control consoles.

Markerless Tracking

Performance capture using cameras/AI without physical markers.

Marketing Lead / Execs / Social Media Mgr.

Team responsible for promoting the show and managing audience engagement.

Maya

Professional 3D graphics software often standard in film/VFX/animation.

Media Server

Specialized hardware/software (e.g., disguise) used in live events to store, manage, process, and play back video content across multiple displays or projectors, often synchronizing with lighting and sound.

MEP (Mechanical, Electrical, Plumbing)

Building systems often coordinated using BIM models in architecture.

MIDI Show Control (MSC) / OSC (Open Sound Control)

Protocols allowing different entertainment technologies to communicate.

Modular Design

Designing systems or environments using interchangeable components or modules, common in game level design for efficiency and scalability.

Mood Board

Visual collection of images, materials, etc., communicating style or atmosphere.

MotionBuilder

Autodesk software often used in film/games for character animation and motion capture editing.

Movement Director

Works with actors on physical movement and characterization.

Musical Director (MD)

Responsible for musical elements, conducting, coaching.

Musicians (Band / Orchestra)

Perform live music.

Nanite

Unreal Engine 5's virtualized geometry system for highly detailed models.

Narrative-Driven Design

Game design approach where the primary focus is on telling a story and guiding the player through a predefined narrative arc.

Nuke

Node-based digital compositing software from Foundry, widely used in film/TV post-production.

Optimization (3D Models)

Reducing complexity for efficient real-time rendering.

OpenUSD (Universal Scene Description)

An open-source framework for describing, composing, and exchanging 3D scenes. See appendix 6. OpenUSD In Detail

Pain Points

Specific challenges or inefficiencies within a workflow.

Papering the House

Giving away free/discounted tickets to fill seats.

Patching (Games)

Releasing updates or fixes for a game after its initial launch to address bugs, balance gameplay, or add content.

Performance Capture (PerfCap / MoCap)

Technology recording human movement digitally.

Photogrammetry

Creating 3D models from multiple photographs.

Photometrics (Lighting)

Technical data specifying a lighting fixture's output.

Photorealism

Rendering computer graphics to be indistinguishable from photographs.

Pixel Streaming

Technology for streaming interactive 3D applications remotely.

Player Agency

The ability of a player in a game to make meaningful choices that affect the game state or narrative. A key differentiator from passive media.

Playtesting

The process of having target users play a game during development to gather feedback on gameplay, usability, bugs, and overall experience. Crucial in iterative game design.

PM (Production Manager)

Manages budget, schedule, logistics, technical elements.

Postvis (Post-visualization)

A process in filmmaking where temporary VFX elements (often derived from previs) are composited into live-action footage during editing to guide final VFX work and test cuts.

Previsualization (Previs)

Planning and visualizing complex sequences or designs before physical production, using various tools from storyboards to VR. Focus varies by industry (film: shots/sequences, theatre: staging/sightlines, games: mechanics/levels).

Preview

Public performance before official opening night for adjustments.

Projection Mapping

Projecting video onto surfaces that are not flat, like buildings or complex stage scenery, using software to warp the image to fit the geometry precisely.

Prompt Book / "The Book"

Master copy of the script with all blocking and cues, used by Stage Management.

Prompt Corner

Area, traditionally stage left, where the DSM calls the show.

Prop / Costume Makers

Craftspeople who build or source props and costumes.

Props (Properties)

Objects used on stage by actors.

Prototyping (Games)

Creating early, functional versions of game mechanics or systems to test feasibility and "find the fun" before committing to full production.

PR (Public Relations)

Manages relationship between production and media/public.

Ray Tracing

Advanced rendering simulating light paths for realism.

R&D (Research & Development)

Activities undertaken to innovate.

Real-time Effects

Visual effects generated and rendered instantly, allowing for interactivity, common in games and live event visuals managed by media servers.

Real-time Rendering

Generating images from 3D models rapidly enough for interactivity.

Reference Imagery

Collection of photos, illustrations, or other visuals used as inspiration or guidance during the design process.

Rehearsal Notes

Notes taken during rehearsal documenting changes, corrections, etc.

Rendering

The process of generating a 2D image or animation from a 3D model by means of computer programs, calculating lighting, materials, etc. Can be real-time or offline (pre-rendered).

RenderStream

A disguise technology allowing integration of real-time content from third-party engines like Unreal Engine into their media server workflow.

Revit

Autodesk software central to many BIM workflows in architecture, used for creating intelligent 3D models containing project data.

Rigging (3D Models)

Creating a digital skeleton for a 3D model for posing/animation.

Rights / Licensing

Legal permissions to perform a copyrighted work.

Risk Assessment

Identifying potential hazards and implementing controls.

Run (of a show)

Duration of public performances.

Scenic Designer (or Set Designer)

Responsible for the visual appearance and physical environment of the stage.

Section (Drawing)

Technical drawing showing a view as if cut through vertically.

Second Mover Advantage

The competitive benefit gained by industries or organizations that adopt technologies later, leveraging refined tools and lessons learned from early adopters to implement more effective solutions.

Shot List

A detailed list of camera shots planned for a film or video production, specifying framing, angle, movement, etc. Used in simpler previs or alongside storyboards.

Sightline Analysis

Checking visibility from audience seats to the stage.

Sightlines

Lines of sight from audience seats to the stage.

Sitzprobe

Rehearsal focusing on integrating singers and orchestra in musicals/opera.

SM (Stage Manager)

Head of stage management team, responsible for running the show.

SME (Small and Medium-sized Enterprises)

Businesses below certain size thresholds.

Sound Designer

Responsible for all auditory aspects.

Spatial Audio

Audio processing techniques that create the illusion of sound sources existing in three-dimensional space around the listener, crucial for VR and immersive experiences.

Spatial Computing

Technologies (VR, AR, MR) allowing interaction with digital information in 3D space.

Standing Ovation

Audience standing to applaud at the end.

Step-through / Stagger-through

Types of technical rehearsals focusing on cues.

Storyboard

Sequence of drawings representing shots or key moments, a foundational previs technique.

Stuntviz

Previsualization specifically for planning and choreographing stunt sequences in film.

Strike

Dismantling the set and clearing the theatre after closing.

Subsidised Theatre

Theatre receiving public funding.

Suspension of Disbelief

Audience willingness to accept the performance's reality.

Sustainability

Considering the environmental impact of production.

Synchronization

Ensuring different technical elements (lights, sound, video, automation) trigger and run precisely together, critical in live events and often managed by media servers or show control systems.

Systems-Driven Design

Game design approach focusing on creating robust, interacting systems and mechanics that generate emergent gameplay, rather than a strictly linear narrative (e.g., simulation games, sandbox games).

Table Work

Early rehearsals reading through and discussing the script.

TD (Technical Director)

Oversees technical departments, drawings, budgets, safety.

Technical Drawings

Precise drawings for construction (Ground Plan, Section).

Technical Rehearsal (Tech)

Period integrating all technical elements with performers.

Techvis (Technical Previsualization)

A specific form of previs, often used in film, that creates technically accurate 3D mock-ups of shots, considering real-world camera gear, lens properties, set dimensions, etc., to ensure a shot is physically achievable.

Toolkit

Set of tools, resources, or methods available.

Touring

Taking a production to perform in multiple venues.

Trello

Web-based project management application.

Twinmotion

Easy-to-use real-time visualization tool, often used with architectural models.

Unreal Engine

Powerful real-time 3D creation tool (game engine).

Usability

Ease with which users can employ a tool effectively.

Varjo

Company producing high-resolution VR/MR headsets.

Vectorworks

CAD software popular in entertainment design.

Vertical Slice

A fully-realized, short sample of a game used during development to demonstrate the core gameplay loop, visual style, and technical capabilities to stakeholders or potential publishers.

VFX (Visual Effects)

Digitally created or manipulated imagery used in film, TV, and games to create environments, characters, or phenomena that cannot be easily or safely achieved practically. Previs is essential for planning VFX-heavy sequences.

Virtual Production (VP)

Techniques using real-time rendering to combine live and virtual elements during production.

Virtual Model Box

A digital equivalent of a traditional physical model box, created using 3D modeling or visualization software to represent a stage set, allowing designers to test and refine concepts virtually.

VR (Virtual Reality)

Technology immersing a user in a computer-generated environment via a headset.

White Card Model

Simple, uncoloured scale model used in early set design stages.

Wide Colour Gamut (WCG)

Describes displays or image formats capable of showing a broader range of colours than standard RGB, leading to richer, more realistic images. Relevant for high-fidelity visualization.

Wings (Stage Area)

Offstage areas to the immediate left/right of the main performance space.

Workflow

Sequence of steps or processes to complete a task.

Workflow Optimization

Improving the efficiency and effectiveness of a workflow.

Workshop (Development Phase)

Period of practical exploration during development of a new work.

WYSIWYG (What You See Is What You Get)

Long-established lighting visualization software.

XR (Extended Reality)

Umbrella term for VR, AR, and MR.