

# Integrating XR for Live Broadcasting Workflows: An Industry Perspective

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## Abstract

This paper presents the results of an expert evaluation of how extended-reality (XR) head-mounted displays (HMD) may be integrated into live broadcasting workflows. To date, the adoption of HMD in live broadcasting remains limited despite the growing use of XR within virtual production. As part of the International Broadcasting Convention (IBC) 2024, industry professionals engaged with a technical XR demo that showcased a virtual control room and virtual studio. The application was experienced with the Quest 3 HMD. After the demonstrations, broadcast professionals provided feedback with respect to opportunities for XR within the control as part of live broadcasting workflows. Analysis of the results showed interest in XR solutions being integrated with existing progressive and accepted systems. The industry professionals highlighted potential cost savings via improved collaboration and efficiency. They also highlighted concerns in terms of potential technical limitations and the impact on adoption management. Interest levels and sentiment suggest that such positive XR experiences should lead to increased adoption. Further exploration with respect to XR’s role in broadcasting with respect to scalability and long-term impact.

## Keywords

XR, HMD, broadcasting industry, spatial control room virtual studio

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## 1 Introduction

Broadcasting involves the transmission, relaying, or distribution of various media elements and signals over a network for direct public reception. The broadcasting industry is made up of organisations that provide broadcast services to the public [3]. Broadcasts are typically managed from a central control room. Control rooms are equipped with various equipment including processors, monitor banks and control desks. Such static systems are challenging to reconfigure and costly to maintain.

Extended Reality (XR) represents a spectrum of immersive experiences reflecting how much content is presented to the user via virtual reality (VR), augmented reality (AR), and mixed reality (MR) [8]. Today, XR technologies have been incorporated within virtual production (VP) techniques in the broadcasting industry [13]. However, the use of XR head-mounted displays (HMDs) in live broadcasting workflows has not gained traction. This research considered opportunities of HMD-based XR workflows. Two proof-of-concept (PoC) solutions were demonstrated at the IBC 2024 (see Figure 1). These applications facilitate the configuration of live and pre-recorded virtual monitor streams, running order editing with AI generated prompter scripts and control desk automation. After the industry professionals experienced the demonstrations, they completed questionnaires. The feedback was used to realise insights into the use of such HMD-based solutions as part of broadcast workflows.

## 2 Background of XR in Broadcasting

In the broadcast industry, XR technologies have started to gain traction within VP [3]. VP combines physical and virtual components with studios having real-time graphics, camera tracking



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**Figure 1: Industry professionals interacting with the virtual control room and virtual studio using Quest 2 & 3 HMDs.**

solutions, game engines and LED walls [5],[7]. Such studios can bring utility in remote interviews hosting, with the interviewee appearing on a virtual screen displayed on the LED wall [2], or are represented as volumetric video feeds, allowing them to be virtually transported into the studio and visible to the presenter in the virtual environment [6]. It is also possible to present data-driven graphics in easy-to-understand and interactable ways [7]. While overlaid AR content is now a core element of live broadcast [1], more recent content in the form of 3D model, volumetric video, virtual set pieces, and spatial audio are now gaining interest [4]. The motivation for including such elements is more immersive and engaging experiences for the audience.

However, the use of HMDs in production workflows remains largely unexplored. This study aims to introduce HMD-based solutions into live broadcast workflows by gathering industry feedback on the potential impacts of adopting these technologies.

### 3 The XR POCs

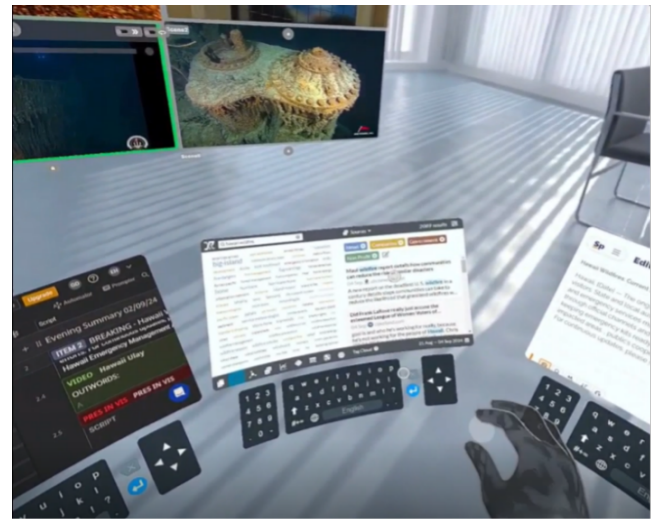
The IBC Accelerator program [3] unites industry partners to collaboratively and quickly create innovative solutions to industry

challenges. The POCs consisted of an XR Control Room and an XR Studio, as described in the following subsections.

#### 3.1 XR Control Room PoC

The Spatial Control Room was adapted from an online repository [12] by IBC Accelerator champions TRANSMIXR. This involved incorporation of Cuez™, webLyzard™, and Storypact™ partner functionality for running order creation and controller automation. This was achieved using 3D WebViews [11] to incorporate web interfaces. This was demoed on the Meta™ Quest 3™ using a combination of hand or controller inputs depending on user preference. The XR Control Room therefore allowed the following functionality:

- The Cuez™ Tinkerlist™ application allowed for creation and editing of running orders.
- Cuez™ Automater™ could be configured for the automation of a comprehensive set of compatible control equipment per the running order.
- The webLyzard™ application facilitated the creation of the running order using a suite of current affairs analysis tools as per Figure 2.
- The Storypact™ application aided the creation and editing of the running order with AI content generated from current affairs.
- A monitor bank of up to 10 virtual monitors that could be positioned and sized according to user preferences. These monitors could be used to display and cue live and pre-recorded OBS NDI streams [10].



**Figure 2: A look inside the Spatial Control Room with cloud APIs to aid running order creation.**

#### 3.2 XR Studio Control PoC

The XR Studio developed as part of the TRANSMIXR project. It allows news broadcast professionals within a fully immersive studio environment viewed using an HMD as per Figure 3, to manage and

control the broadcast production. The control interface application, running on a separate HMD, allows a broadcast professional to control features of the virtual studio through a mixed reality interface (Figure 4). The professional user can perform the following tasks:

- Panel colour and lighting intensity adjustment.
- Multiple virtual cameras spawning and positioning.
- Output NDI video feeds from virtual cameras to a server.
- Adapt video sources.
- Launch interactive audience polls.
- Import and manipulate 3D models in the virtual studio.
- Adapt the studio configurations (e.g. surroundings) from a virtual studio to a dome that displays a live 360 video feed.

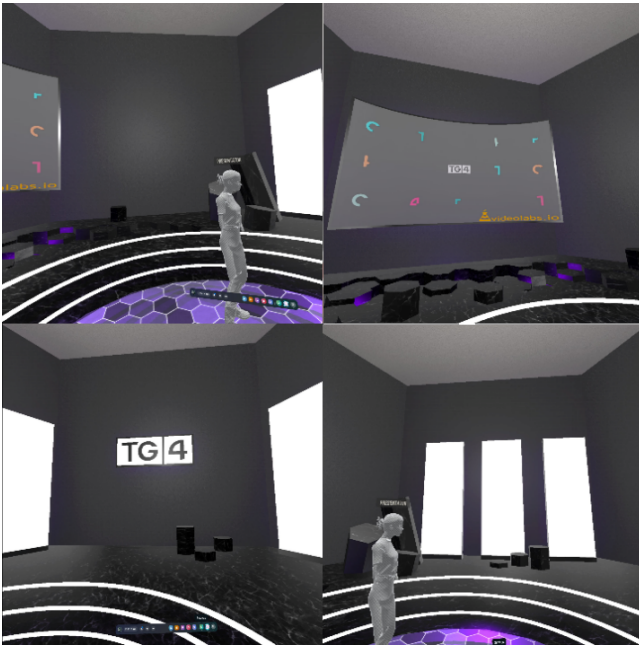


Figure 3: A view of the XR studio.

The 3D model of the virtual studio supports changes in real-time allowing for immediate visual feedback. The audience member, experiencing the virtual studio in VR through their own HMD, also sees all updates in real-time. It was also possible to interact and reposition with different control panels.

## 4 Evaluation Methodology

The evaluation was performed over 3 days (Sept. 13th-16th) at IBC2024 [9]. Two demos were set up at the EBU and IBC Accelerator stands. The experiences were available on the Quest™ 2 and Quest™ 3 HMDs. Participants were free to explore with the environments and considered features such as: positioning; sizing virtual monitor banks; control panels; virtual cameras; studio lighting; and editing the programme running order with AI generated content. Then they completed the questionnaire as shown in Appendix A.



Figure 4: An illustration of the XR Studio Control Interface; 3D model of the virtual studio surrounded by control panels.

### 4.1 Questionnaire

The questionnaire was designed to prompt discussion with respect to around the impact of VR technology within industry. The responses to the questions were recorded with a laptop and mobile phone. 31 interviews were conducted in total. The responses were in the form scaled and open ended responses and underwent statistical, sentiment and thematic analysis.

### 4.2 Sampling and Ethics

The 31 participants were professionals from various aspects of the broadcast industry, with varied experience and specialisations. Participants were selected by convenience sampling. Ethical approval was obtained from the Technological University of the Shannon research ethics committee.

## 5 Results

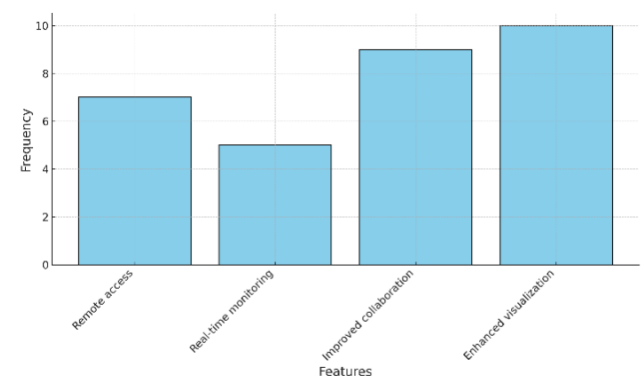
This section reports the statistical, thematic, sentiment and correlation results emanating from analysis of the questionnaire responses.

### 5.1 Question 1: What features of an XR control room solution are most appealing to you?

The participants chose one from four possible features: Remote access; Real-time monitoring; Improved collaboration; and Enhanced visualization. The results are presented in Figure 5. Enhanced visualization was selected as the most important aspect. The Improved collaboration (median = 3) rating suggest that enhanced methods of working together is a central concern for many participants. A Chi-Square Goodness-of-Fit test ( $\chi^2=0.97$ ,  $p=0.81$ ) showed no



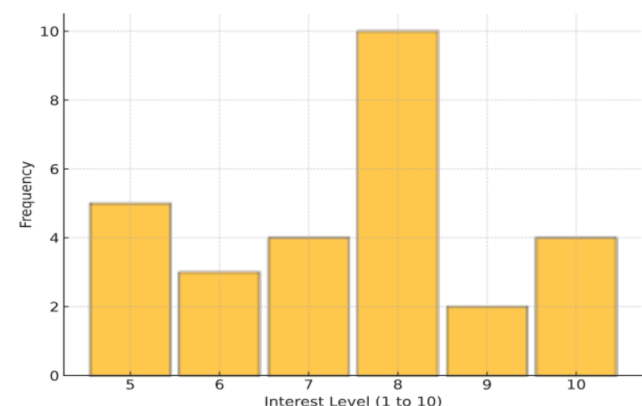
statistically significant difference between the remaining responses highlighting the general importance across the features.



**Figure 5: Bar chart showing the distribution of Q1 responses.**

**5.2 Question 2: On a scale of 1 to 10, how interested are you in integrating an XR control room solution into your operations?**

Figure 6 shows the distribution of interest levels concerning the integration of XR based control room solutions within their existing workflows. The mean score of 7.46 indicates high level of optimism, however some responders raised concerns. AWilcoxon Signed-Rank Test confirmed that the median interest level (8.0) was statistically significantly ( $p=.00002$ ), indicating that respondents generally show a strong interest in adopting XR control room technologies.



**Figure 6: Distribution of interest in VR integration into current workflows.**

**5.3 Question 3: How do you think an XR control room could address the current problems or challenges you are looking to solve with your current NCRS/Automation software?**

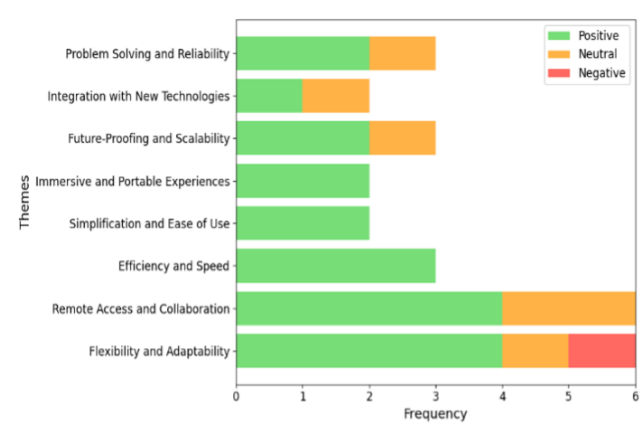
As an open-ended question, Q3 focused on the opportunities of integrating XR into current workflows. The key concerns (Figure 7)

revolved around remote access and collaboration to tackle challenges with NCRS/Automation software. The themes of flexibility and adaptability, remote collaboration, efficiency and speed, simplification and ease-of-use reflect a general desire for adaptable, easy-to-use, and forward-thinking XR solutions that can handle evolving workflows and distributed work environments. These themes are discussed in the following paragraphs.



**Figure 7: A word cloud representing the frequency of words used by the respondents in the size and hue of the words.**

In terms of flexibility and adaptability, the participants highlighted the need for reusable systems that can be flexible for use in different contexts. With respect to remote collaboration, the potential for improved cooperation between distributed team members become more important in recent years supporting enhanced “space, travel ability, [and] remote access”. Aspects such as efficiency and speed with respect to using XR for optimizing workflows particularly in terms of testing, integration and new tools were also highlighted as important. Simplicity and ease of use was another theme, with respondents seeking solutions that reduce complexity of existing production tools and workflows. Lastly, **integration with new technologies** like AI, and **problem-solving and reliability**, were seen as important features.



**Figure 8: A stacked bar chart showing theme sentiment and frequency in Question 3 responses.**

Overall sentiment was 70% positive, 26% neutral and 4% negative as shown in Figure 8, with most respondents highlighting the advantages and potential benefits of XR control rooms. Some negative sentiment was seen in flexibility and adaptability, highlighting dissatisfaction with current remote solutions. In summary, respondents viewed XR control rooms as offering flexibility, efficiency, remote collaboration, and future scalability, while also simplifying existing workflows.

#### 5.4 Question 4: What benefits do you expect from incorporating an XR control room solution with your existing software?

Question 4 respondents had a choice of four categories of benefits from incorporating an XR control room solution with their existing software. The categories were increases in efficient, cost savings, better user experience and better support for decision making. The category related to Increased efficiency accounted for almost 39% of the total responses followed by Cost savings (32%), user experience (29%). Better decision-making was not as popular as anticipated as shown in Figure 9. A Chi-Square test results of  $\chi^2=0.4$ ,  $p=0.82$  between the three chosen categories indicated even distribution with no clear preference for either one.

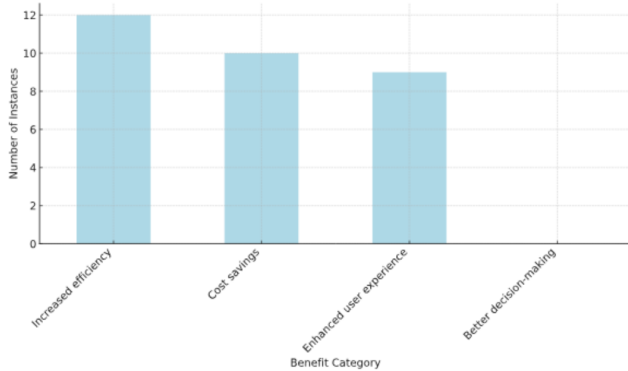


Figure 9: A bar chart showing the distribution of Question 4 responses.

#### 5.5 Question 5: What extra percentage would you be willing to pay for the XR control room solution?

#### 5.6 Question 6: Would you be interested in a demo or trial period for an XR control room solution?

With an eye on business and exploitation, Figure 10 shows the distribution of cost brackets. 48.1% of participants indicated that they were comfortable with a 5-10% price increase in current expenditure to be allocated towards XR control room solutions. Figure 5 show that smaller proportions of respondents were willing to pay either less than 5%, 10-15% or more than 15%. This suggests a general openness to moderate price increases for XR technology. Figure 11 shows the distribution of question 6 responses. Chi-Square Test

result of  $\chi^2=8.58$ ,  $p=0.014$  showed a statistically significant difference from a uniform distribution. Pairwise analysis with Bonferroni correction revealed statistically significant differences of  $p=0.001$  between no (10%) and maybe (55%), and  $p=0.023$  between no and yes (35%). This shows that a significant minority of respondents were not interested in a demo trial period of the XR control room.

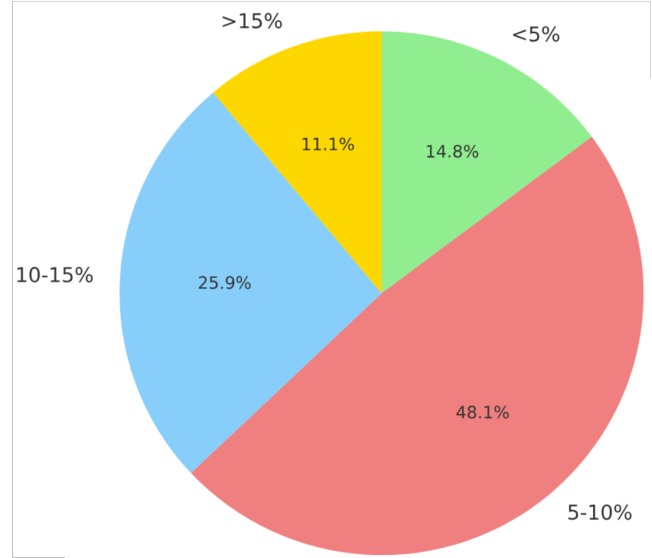


Figure 10: A Pie chart of preferences for the four brackets of XR integration costs as a percentage of current expenditure.

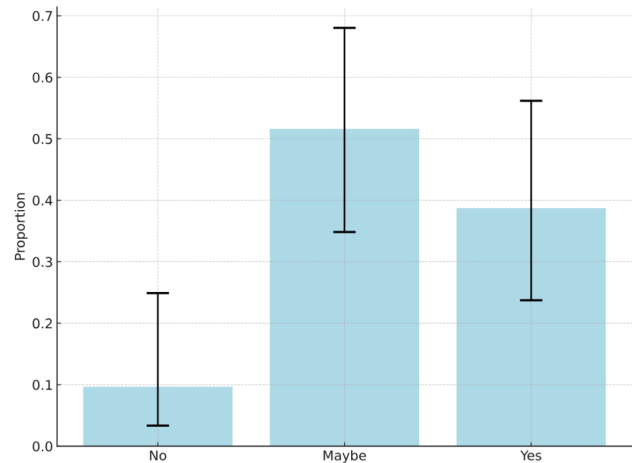
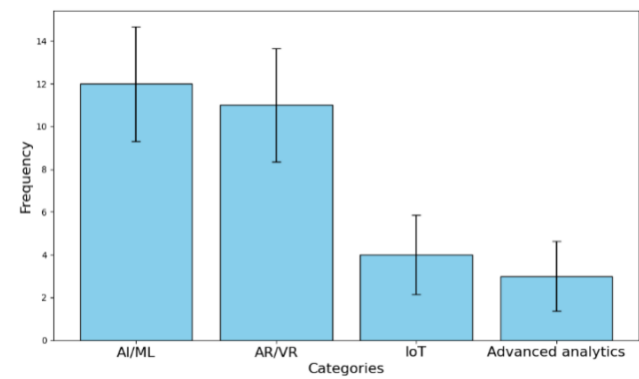


Figure 11: A bar chart showing the distribution of the three categories of question 6 responses with 95% confidence.

**5.7 Question 7: What emerging technologies are you most interested in for enhancing your control room capabilities?**

AI/ML was the most popular choice of emerging technologies having been selected by 40% of respondents. AR/VR followed closely at 37%. IoT was chosen by 13% of respondents. A Chi-Square test indicates a statistically significant difference between preferences (results of  $p=0.003$ ), with AI/ML and AR/VR being significantly more favoured than IoT or Advanced analytics as shown in Figure 12.



**Figure 12: A bar chart of category distributions with 95% confidence.**

### 5.8 Question 8: What additional features or functionalities would you like to see in an XR control room solution?

From the open-ended responses, collaboration and A/V enhancements were the most sought-after features (Figure 13). The consensus was towards the growing demand for XR technologies to realise effective teamwork and collaboration. With respect to A/V enhancements, there was particular interest in how emerging technologies such as immersive audio or better audio control could support more sensory-rich control room experiences. In this context, the respondents also mentioned "haptic feedback" and "instant 2D 360 video generation from scratch" pointing towards a desire for cutting-edge technologies. Lastly, the ability to easily integrate all these novel technologies was highlighted as an important feature.

**5.9 Question 9: How do you see the role of XR and other advanced technologies evolving in your industry over the next 3-5 years?**

Four main themes have emerged regarding broadcast professional opinions on the evolving role of XR in the coming years. They highlighted challenges the quality of user experience, specifically with respect to resolution, latency, weight, precision of interaction. This reflects a scepticism about how easily XR can be integrated into existing workflows. There was also some optimism that XR could play a key role in production environments due to its flexibility and support of remote and collaborative working as well as efficiency.



**Figure 13: Word cloud representing the frequency of question 8 terms by size and shade of.**

## 6 Conclusion and future work

As part of this work, two XR proof of concept applications to support a live broadcast workflow were showcased and evaluated at IBC2024. Industry experts at IBC were invited to provide feedback via questionnaires and open-ended questions on the current perception of XR HMD-based workflows in the broadcasting sector. The industry experts highlighted the need for enhanced collaboration, integration with existing systems, and user-friendliness. A key element was that XR solutions should align and compliment current workflows while brining key benefits to support distributed collaboration, added flexibility, cost savings and an enhanced user experience.

There were some concerns about implementation challenges such as the quality of experience and adoption management were noted, reflecting a cautious but hopeful outlook. These results highlight a generally positive attitude towards XR technologies, underpinned by an understanding of potential benefits, concerns about implementation, and a willingness to embrace innovative solutions. This research serves as a foundation for further development of the virtual control room concept.

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## A Appendix

### A.1 Compliance with ethical standards

**Conflict of interest** The authors declare no conflict of interest.

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### A.2 Spatial Control Room Solutions Questionnaire

1. What features of an XR control room solution are most appealing to you?
1. Remote access   2. Real-time monitoring   3. Improved collaboration   4. Enhanced visualization
2. On a scale of 1 to 10, how interested are you in integrating an XR control room solution into your operations?
- (1 = Not interested, 10 = Extremely interested)
3. How do you think an XR control room could address the current problems or challenges are you looking to solve with your current NCRS/Automation software?
4. What benefits do you expect from incorporating an XR control room solution with your existing software?
1. Increased efficiency   2. Cost savings   3. Enhanced user experience   4. Better decision-making
5. What extra percentage would you be willing to pay for the XR control room solution?
1. 5-10%   2. 0 <5%   3. 10-15%   4. 0 >15%
6. Would you be interested in a demo or trial period for an XR control room solution?
1. Yes   2. No   3. Maybe
7. What emerging technologies are you most interested in for enhancing your control room capabilities?
1. AI/ML   2. AR/VR   3. IoT   4. Advanced analytics
8. What additional features or functionalities would you like to see in an XR control room solution?
9. How do you see the role of XR and other advanced technologies evolving in your industry over the next 3-5 years?