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Application scenarios and usability for modern 360-degree video projection rooms in the MICE industry

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Abstract

360-degree image and movie content has gained popularity in the media and the MICE (Meeting, Incentive, Conventions, and Exhibitions) industry in the last few years. There are three main reasons for this development. On the one hand, it is the immersive character of this media form; on the other hand, recording and presentation technology development has made significant progress in resolution and quality. Third, after a decade of dynamic rising, the MICE Industry focuses on a disruptive change for more digital-based solutions. 360-degree panoramas are particularly widespread in VR and AR technology. However, despite the high immersive potential, these forms of presentation have the disadvantage that the users are isolated and have no social contact during the performance.

Therefore, efforts have been made to project 360-degree content in specially equipped rooms or planetariums to enable a shared experience for the audience. One application area for 360-degree panoramas and films is conference rooms in hotels, conference centers, and other venues that create an immersive environment for their clients to stimulate creativity. This work aims to overview the various application scenarios and usability possibilities for such conference rooms. In particular, we consider applications in construction, control, tourism, medicine, art exhibition, architecture, music performance, education, partying, organizing and carrying out events, and video conferencing. These applications and use scenarios were successfully tested, implemented, and evaluated in the 360-degree conference room "Dortmund" in the Hotel Park Soltau in Soltau, Germany [1]. Finally, the advantages, challenges, and limitations of the proposed method are described.

1. Introduction

1.1. The situation

With the accompanying ban on a large number of event formats, the event industry has received a further sustained boost from digitization, which is also leading to changes in the stakeholder structure and increasing demands for value-added technological solutions. This particularly affects the MICE industry (Meetings, Incentives, Conventions, Exhibitions), which, with its business and economy-oriented event formats, is increasingly under pressure to change and compete. Although many digital tools and digital possibilities such as apps, streaming services or platforms for video conferencing etc. have been available for several years, the Covid crisis has now led to an enormous increase in virtual conferences, meetings or business events - summarized here as MICE Industry. This means that technological uses are also becoming more commonplace within this industry, just as meeting hotels and conference centers, as significant stakeholders, have to adapt to new demands and conditions.

With the development of usage scenarios of a 360-degree conference room in the conference hotel "Hotel Park Soltau" (Germany), which is experimentally enhanced by visual effects (VFX) in particular, value-added technology solutions are to be worked out. Especially in the segment of relatively small and medium-sized meetings with less than 100 participants, which represent the large mass of MICE events, such investments must be able to secure usability and value creation simultaneously. In the context of this work, the heterogeneous event industry will first be briefly outlined, focusing on the "MICE Industry," followed by the technological conditions for video technology and VFX applications, which have been developed for the usage scenarios developed here.

1.2. Events: An overview

Here, only a simple overview of the phenomenon "event" can be offered, which should only provide a first orientation. There is a thoroughly broad spectrum of single-authored literature on the most diverse forms of events or the various scientific perspectives, including economic, sociological, ecological, and geographical perspectives [2]. While defining events as an overarching description is not uniform, they can be understood as planned, purposeful, one-time gatherings with a clearly limited time frame. The emphasis on experiential orientation can be seen as a core element, i.e., a multisensory approach with features such as staging and anesthetizations that are linked to positivist goals. An overview of the heterogeneous structure of event types is given by Donald Getz and Stephan J. Page. They arrange these "planned" events in different pillars, such as "business and trade" [2, p.59].

In economic geography, MICE events or trade fairs or the like are understood as "temporary clusters" [3]. Such events then represent an accumulation of actors from industry, services, associations, politics or science, where knowledge is conveyed and exchanged [4] but are also resource-intensive and associated with high CO2 production due to intensive travel [5]. Crucial here are personal contacts that come about at such meetings and represent an

important reason for participation. The associated networking or network formation between the various actors shows an overall potential for innovative and production-promoting developments [6] [7]. With technological developments or digitalization, however, many business models of stakeholders such as conference hotels are now undergoing change or are under competitive pressure [8] [9]

For this paper, the focus is on the so-called MICE industry (Meetings, Incentives, Conventions & Exhibitions). This can be understood as business or economy-oriented event forms [10]. Ultimately, however, this describes only one part of the industry, but the economically dominant one. In Germany, it can be observed that more than 50% of all events can be assigned to such business-oriented event forms [11] with a turnover of 114 billion euros in 2019 [12]). For an international overview, the annual report of the International Congress and Convention Association (ICCA), among others, can be consulted. It can be seen here that it is primarily prospering economies with the USA at the top, followed by Europe (with Germany at the top) and then, however, China already follows [13]. Worldwide, such "business events" - until the COVID 9 crisis - were associated with around one billion dollars in sales and millions of employees. E.g. in Germany, the growth in participants of all event forms is developing more and more dynamically until 2019 and is estimated to exceed 423 million, with thousands of venues, convention centers or conference hotels, the latter as the most important location form of all [11]. With a turnover of around 129 billion euros (2019) in Germany, the event industry represents the sixth largest industry in Germany overall [12].

1.3. Usage scenarios for the MICE industry: 360-degree video technologies

The available digital transformation has led to a surge in innovation in the event and MICE industry. Spurred on by the pandemic crisis, there is an increasing shift away from physical meetings toward purely online meetings, also known as virtual meetings. On the other hand, hybrid events are characterized by the fact that a physical meeting still takes place, at least in part. For example, in hybrid meeting forms, parts of the keynotes and guests are present in a venue such as a conference hotel, while other speakers or guests are then added online.

The basis for the use of numerous digital tools and applications is the technological or digital advancement of recent years, from which the applications in the event industry are derived [14]. Digital tools or applications such as virtual reality (VR), augmented reality (AR), or mixed reality (MR). However, also 360-degree applications or visual effects (VFX) are then linked to the goal of offering immersive uses, i.e., an "immersion" that emphasizes an increased experience orientation or the "specialness" of an event [15]. However, especially the business-oriented MICE events, which are of dominant importance for conference hotels or the most diverse manifestations of venues, require value-added solutions, which must also be offered through such 360-degree video technologies. Thus, the following usage scenarios were developed in the context of experimental applications or technologies for the Hotel Park Soltau, Germany respectively, for one conference room ("Dortmund"):

- Poster session presentations (in the context of, e.g., company workshops, competitions)

  Poster sessions represent a comprehensive form of application, as they are a visual form of presentation for many businesses event formats, but also corporate business events as partial or final results of discussions, workshops, etc. These can be improved in the course or as a result of such a meeting by 360-degree video technology qualitatively, but also quantitatively as well as in their application clearly added value.

- Presentation of work processes requiring explanation/complexity (e.g., engineering or architectural fields).

  Complex, difficult to grasp visually, works in need of explanation, which are to be made accessible in the context of such business events, especially in smaller formats, can generate a clear benefit through the application of 360-degree video technology. The size of the visual representation, but much more the "immersion", the immersive supports such application orientations or resulting solutions.

- Team-building measures (e.g. as part of corporate or incentive events)

  Corporate events, company meetings, departmental gatherings such as sales or marketing often have the goal of achieving added value for the company through improved team building. The 360-degree video technology is able to develop targeted images or a complete program through the high immersive potential, like creating panoramas or relaxing working environment which goes far beyond previous offers. In essence, the perversive character of such 360-degree video technology rooms can be fully exploited here.

In the next section, technical conditions and requirements for the above-mentioned and experimental applications are explained.

2. Full panorama creation and immersion

2.1. Introduction

The investments required for the 360° room are significant for a medium-sized company. For example, the sum of the installed technology in the Dortmund room of the Hotel Park Soltau amounts to approx. 100 000 €. For these costs to be profitable, customers must take advantage of this offer. This is only possible if the content of the projection can also be determined by the customer. Thus, supplementation of the pre-produced offers must take place.

In the following sections, the different creation scenarios are described. Also, their implemented respective immersion is discussed. Finally, referring to the three usage scenarios: poster session presentations, presentation of complex work, and team-building measures, the corresponding value for customers through such an experience is presented.

Figure 1. *Still Image Panorama*

2.2. Full panorama scenarios

The complete panorama in the Dortmund room is a closed image of 12000 x 768 pixels. The image aspect ratio is solely determined by the geometry of the room. The critical resolution of 786 pixels results from the mosaic configuration of the four NVIDIA graphics cards.

The projected panorama is a so-called single-line panorama, where the rotation is only perpendicular to the image plane. That means the camera does not need to tilt up and down to fill the remaining areas of the spherical panorama [16].

2.2.1 Still panorama

This is the simplest form of the full panorama and offers the least immersion experience. Here it is possible to show landscapes (see Fig. 1), a panoramic view of the company premises, or a large factory hall. Small indoor spaces are less suitable than outdoor scenarios. Although the immersion is lower than with a full video panorama (see 3.3), it is much higher than using pure color walls.

FC Bayern Munich's soccer club has set up a so-called *SkillsLab*, where young soccer players can demonstrate their techniques in a large hall. Animated players projected onto the screens of the hall walls support this purpose. The players can then interact with them and, for example, pass them the ball. In the default setting, the interior of the stadium is shown (Fig. 2).

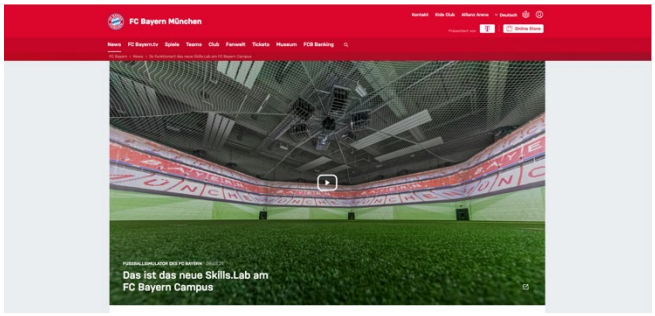

Figure 2. *Website of FC Bayern Skills.Lab [17]*

Creating such still panoramas is not easy, and one has to consider some points to get a satisfying result. Widely used panorama functions of mobile devices are not suitable for this purpose. Four points are essential:

1. The panorama must be closed, i.e., the left edge must fit the right and vice versa. Specialized panorama programs like PTGUI [3] can create this without problems.
2. There must be no parallax shift. Therefore, the camera's nodal point should be in the center of the main lens. Otherwise, stitching errors will occur. In Figure 3, such an error appears in the railing because two adjacent images contain a shift of the foreground to the background. By using a panorama head on the tripod, the camera can be pulled back so that the nodal point is at the correct position.
3. The plane of rotation of the exposure should be in a horizontal layer. This can be easily controlled with the help of a small spirit level built into the tripods.
4. Another problem is the linear movements of objects and people. These must not appear in multiple shots. It is also unfavorable for legal reasons to establish easily recognizable people in the shots.

Large-scale movements, such as the surf on a beach, are particularly problematic. Since it is impossible to capture the sea in two neighboring photos simultaneously, imaging techniques do not lead to satisfactory results here: the algorithm cannot find matching pixels.

Figure 3. *Stitching error due to parallax shift*

Nevertheless, to create panoramas, a different stitching strategy is used, which takes the recording geometry into account. This

technique can be done in the 3D space of The Foundry Nuke software [18]. Here 3D cards are placed in a circle. Each card is positioned at the same angle as during the recording. Then the images are projected (textured) onto the 3D card. A spherical camera then records the entire panorama. Using blending in-depth (z-axis) can lead to satisfying results because no image analysis is needed. Figure 4 shows the 3D card positions and stitching results using imaging and geometric reproduction.

When creating even simple still panoramas, avoiding the problems described above requires good equipment, experience, and sometimes proprietary software solutions. This already presents challenges for many customers to create high-quality panoramas themselves. Nevertheless, if the criteria are respected, the clients can create such panoramas.

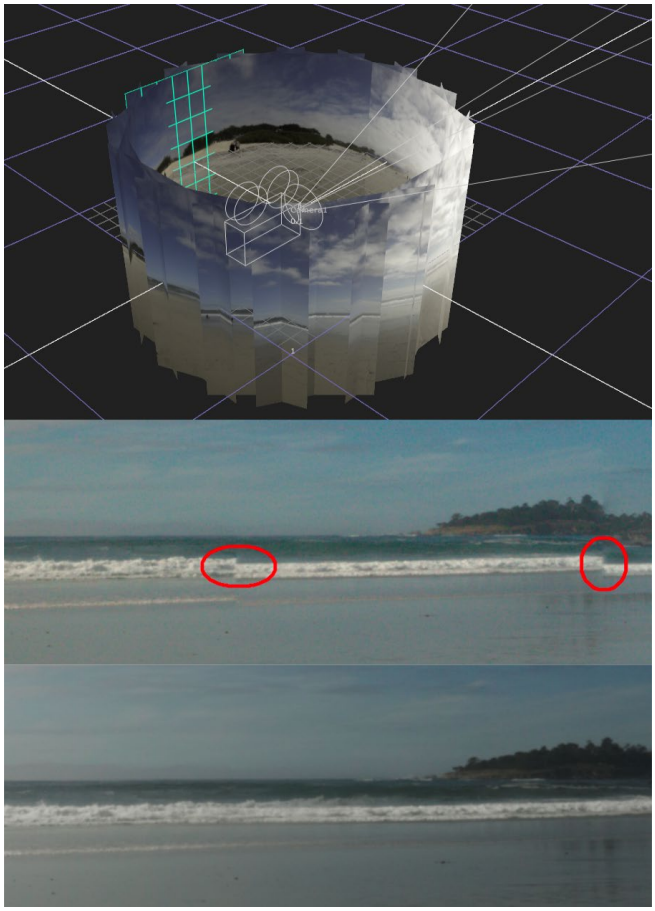

Figure 4. *Avoiding stitching errors with large-scale movement using Nuke's 3D card system*

2.2.2 Panoramas with local movement

Here, videos with localized movements of people and objects are inserted into the still panoramas. These videos are taken with the same camera settings. Depending on the sensor's crop factor, the focal length may have to be adjusted. The video is then masked out and inserted into the still panorama using methods commonly used in the visual effects industry. These movements must meet several criteria. They must not leave the frame and must be loop capable.

Figure 5 shows such movements. On the one hand, the dog moves sufficiently in a narrowly defined position - this movement can be looped without problems; on the other hand, the second dog moves between the house and the car. However, this movement is hidden by the two elements, so he appears and disappears without any problems.

To play the panorama as a video, the content must be rendered out of a compositing program at the appropriate resolution. Programs that can handle such a high resolution of 12K and larger are rare and relatively expensive. These criteria and the corresponding compositing capability present very high challenges to clients, most of which cannot be addressed. Rendering computer animation in such a resolution is slightly more manageable, but the complex 3D programs need to be mastered here.

Figure 5. *Local movement*

The immersion is much higher than a pure still panorama, primarily when the viewers' attention is specifically directed to the movements. This category also includes animations, e.g., that of a company logo, which strengthens the sense of belonging to the company.

2.2.3 Panoramas with full movement

In this category, there are movements in all parts of the panorama. Such movements occur in a natural environment when strong wind is present. Within localities with little vegetation, static objects (houses) dominate, and only road traffic moves very often. In addition, pedestrians with linear movements often pass through the frame. Nature shots are therefore more immersive and easier to capture.

In order to create such a panorama with a lot of movements, usually every recording position for the still images must also contain a video shot. These videos are then masked using compositing techniques and placed on top of the still panorama. They also often need to be color corrected since the color spaces of the still images and the videos do not match. The masks must be chosen so that the videos are convincingly integrated into the still panorama, but the videos among themselves must also be adjusted accordingly. Figure 6 shows a panorama composed of many individual videos.

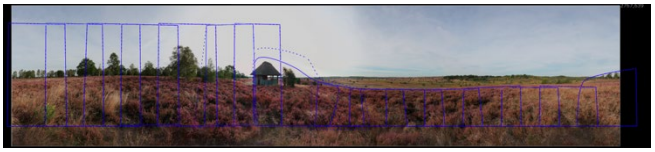

Figure 6. *Panorama with several integrated videos [16]*

The compositional skills to create such a panorama with much motion are high, and the corresponding proprietary software is

expensive, so customers can usually not execute these panoramas quickly. Therefore, these highly immersive panoramas can either be prefabricated or executed as commissioned work. The same is true for full CG shots executed in 3D programs, where no masking needs to be done, but the result still needs to be composited if the native cameras of the host program do not allow resolutions of 12k.

Figure 7. *Relaxed working environment*

The experience for this video category is high, as it effectively immerses the viewer in reality through the many visible movements. Such pre-recorded footage is well suited for a relaxed work environment and promotes the generation of creative ideas, as it has a dense and closed environment that avoids distractions (see Fig. 7)

2.2.4 Interactive Real-Time projection

A further enhancement of immersion is interactive real-time projection. This technology has come into focus as the film industry increasingly embraces projects with content from game engines (Unreal Engine) displayed onto LED walls, so-called LED volumes. Due to the high quality and resolution of the LED walls of the latest generation, actors can be captured in front of the projected background. Such footage is called an in-camera shot. The scene can then be used without the need for subsequent complex post-processing (e.g., greenscreen keying).

The rendering results from several game engines on different computers are assembled and distributed to the projection surfaces (front wall, sidewalls, ceiling) when using this technique. The individual game engines are synchronized via Ethernet or gen-lock methods [19] (see Fig. 8).

For the room *Dortmund* in the Hotel Park Soltau, such a scenario could be imagined, where renders from three Unreal Engines are synchronized and projected onto the front wall and two side walls. A complete 360° projection would also be conceivable using a fourth game engine. However, creating the corresponding content is very time-consuming, and interacting with a group of participants is difficult. Nevertheless, various scenarios can contain an extended added value compared to conventional company training courses.

The following scenario is conceivable: A 180° presentation of a labyrinth is projected from a game engine onto the front and sidewalls. The people in the room have to decide at certain intersections in which direction (left, straight ahead, right) they want to go. Labels above the paths help them to decide. At the endpoint, the subjects have thus collected several labels with their paths. These findings can help the lecturer at the beginning of training to assess the condition, thinking, and feeling of the subjects and adapt the lecture accordingly.

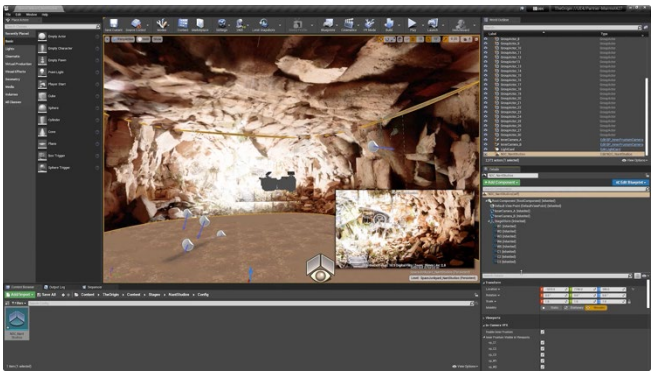

Figure 8. *180° real-time rendering in a game engine (Unreal Engine 4) [19]*

The problem of decision-making by a group of subjects could be done according to Figure 11. First, the subjects have to choose one of the areas delineated on the floor. The situation is recorded with a top camera and is stepped out using artificial intelligence. Finally, the game engine follows the path that most subjects have decided to take.

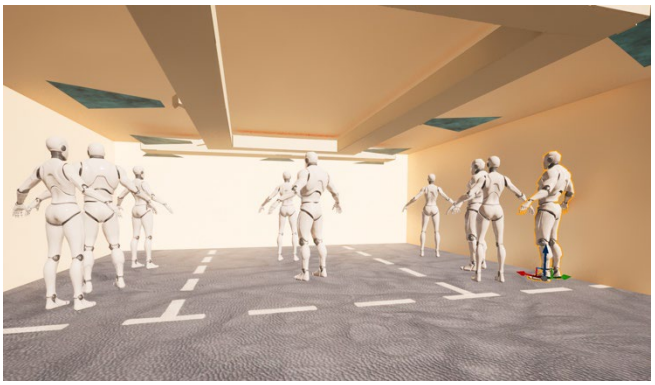

Figure 9. *Automated decision making*

Such creative approaches are pretty standard. Some of the most interesting are described in the book Game Storming by Dave Gray, Sunni Brown, and James Macanufo [20]. They can lighten the atmosphere, increase concentration, provide relaxation and increase attention and creativity. Of course, the cost of such a scenario is high, but it can be profitable if used widely and for a long time.

2.2.5 Conclusion

The stronger the immersion, the more complex the creation of the content of the projections (see Fig. 10). For most of the content in this category, images or videos from customers are unlikely to be considered. However, several pre-produced panoramas with intense immersion are available for the clients. Panoramas with high motion

density are particularly suitable here. These can be used as work backgrounds for relaxation or team building. Inserting client content into the system requires a different approach, which will be explained in the next section.

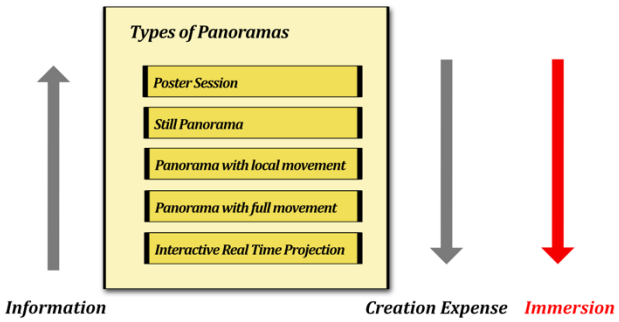

Figure 10. *Types of panoramas according to information, creation expense, and immersion*

3. Poster Sessions and conveying complex content

3.1. Introduction

Poster sessions are known from conferences and the university environment. Here, the contents of conference papers or final theses are exhibited. These are individual, self-contained elements. Such posters are well suited for projecting customer-made content in 360° space. Although they reduce immersion, they increase the information content, an important consideration, especially for conferences and training. The posters can be created relatively quickly by the customers themselves using templates and standard software. Photos, videos, graphics, and even animations can be created; in other words, all the common elements in company presentations.

Because the posters are displayed in a room, people can walk around and get known to other participants. In the Book *Game Storming* the authors point out the advantages of physically walking along with the projected posters:

> *Part of the exercise was a "gallery walk" where all the participants walked around the room to look at each other's posters. This meant the posters could not be simply visual aids for a presenter, like a PowerPoint slide. Rather, each poster needed to be standalone and self-explanatory, like an information graphic in a newspaper.*
>
> *...*
>
> *Although not a formal game, whether it's a walk in the park or an informal lunch, unstructured time allows any team to gel as a unit so that all the players can get to know each other. After the poster session concluded and everyone had loosely tied themselves to one of live "project teams," the teams were invited to take a walk, get to know each other, and begin to frame out the work they wanted to do.*
>
> *"The walk gave me a chance to meet the other people who had shown an interest, explore ideas with them, and think about how we wanted to take the concept forward," says Toby. [21]*

The most important technical aspect is that the posters do not have to cover the entire panorama and can be distributed over the walls. They are arranged in the *Resolume Arena* [22] playback software columns, as shown in Figure 11. The still or moving posters are then played and projected simultaneously. At the push of a button, the entire room can then be rearranged.

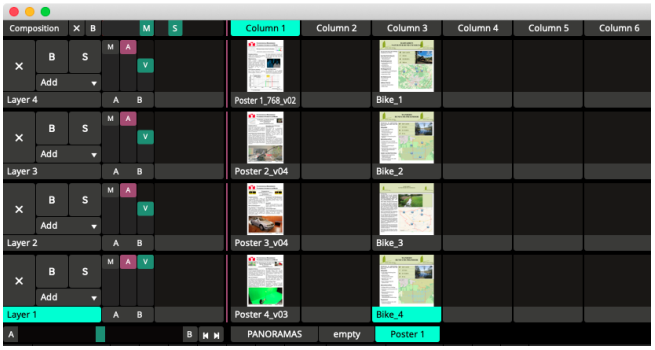

Figure 11. *Poster templates in Arena software*

To ensure user-friendly handling, it makes sense to use a mobile device (tablet) to interactively control the arrangement of the posters (see 3.4). Video editing programs can be used in addition to the usual image editing and graphics programs to generate moving or animated content (see Fig. 12).

3.2. Still poster creation

Creating a still poster is reasonably straightforward. However, some circumstances of the projection must be taken into account. The number of lines of the poster is only 768, so the content is severely limited, and a shortage of content is necessary. However, this has the advantage that only the essentials are shown, giving the viewer easy access. Furthermore, the width of the poster element in pixels is freely selectable. The following two formats proved efficient in our tests: 810x768, and 543x768 pixels.

Figure 12. *Poster session*

It should also be noted that due to the somewhat blurry projection, the display of fonts should be larger than on the relatively sharp computer screen. This is also true for text in figures, images and charts. Figure 11 shows a poster with different font sizes, where the poster on the left has a 30-point title, a 20-point text heading, and a 14-point body text. The poster on the right has a title of 30, a

text heading of 26, and a body text of 18 points. The poster on the right is better readable with the same amount of occupied space.

Figure 13. *Posters with different font sizes*

A poster element can also cover a complete wall. However, over-corner projections are not recommended; they can distort the content and be avoided by projecting the walls individually and choosing a white background. For the Dortmund room, the side walls require images or videos with 3233 pixels, and the end walls require image content with 2766 pixels. These numbers show the flexibility and ease of use, as most DCC (digital content creation) programs can render an output resolution of 4K (4096 pixels).

File formats that can be considered for the image side are png, jpg, tiff, and OpenEXR. Video content can be converted to DXV video in Resolume Alley. This program can also convert image sequences to DXV video [23].

3.3. Creation of posters with video content

Posters with moving image content can be easily created in video editing programs (see Fig. 14). A graphic base is recommended, into which photos, logos, videos, and animations can then be inserted. Posters with video content can add considerable value over printed paper posters, as movements can be displayed and explanations are often easier to convey. The same templates used for still posters can be applied to videos, but pure videos would also be possible. For example, a 16:9 video would have a resolution of 1366 x 768 pixels in Raum Dortmund.

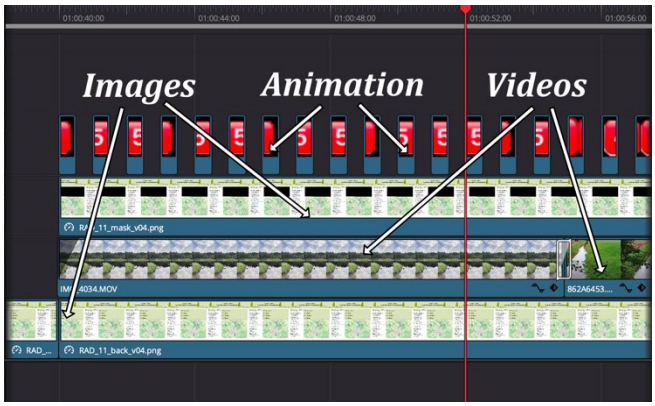

Figure 14. *Video creation in Resolve DaVinci*

3.4. Interactive placement

A mobile device with an appropriate graphical user interface (GUI) is required to place and control the posters interactively across the walls, preferably a tablet. The interface is then linked to the playback software through a bridge software and contains the functionality of the host software.

Figure 15 shows an interface with only the most basic functions for each poster slot. These consist of a list of uploaded videos and an on/off switch, a slider for horizontal placement, and a control element that positions the video exactly above the one below to compare possible versions (see 3.5.) quickly.

The upload can be done in advance of the event or on location. The GUI can possibly be offered via a web browser remotely, where a 3D simulation can help visualize the distribution of the posters across the walls. The data can then be transferred to the bridge software. Of course, this leads to an additional effort, but it is worth it when used by the clients. It would also be desirable to save the poster session and switch to another one at the push of a button.

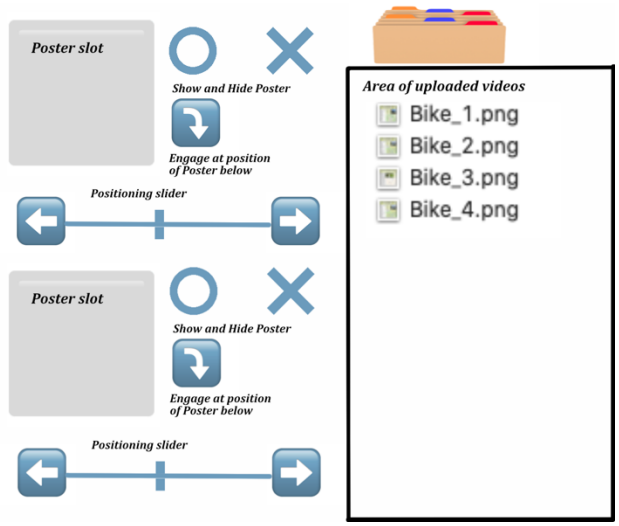

Figure 15. *GUI Template for interactive video placement*

3.5. Conveying complex content

Complex content can be something like Flowcharts of complex systems (like color workflow in film production) that can not be conveyed with simple slides. Due to the large projection, participants can physically walk to another part of the presentation to better understand relationships.

The same is true for technical drawings of complex systems (see. Fig 16). One drawing can encompass all four walls of the projection. It is also possible to have different versions of a drawing. With the help of the GUI on the control tablet, they can interactively be changed on location when standing close to the drawing. This version tracking can be done by placing the different versions on top of each other using the GUI functionality (see 3.4).

Figure 16. *Complex drawing projected onto all four walls*

4. Conclusion

The heterogeneous event industry continues to be dominated by the MICE industry in terms of quantity and global significance, primarily due to the business-related formats. The technological tools are in constant flux due to ever-increasing demands. At the same time, stakeholders such as conference hotels, in particular, must be able to offer value-added solutions due to changing requirements and significantly increased competitive pressure. With technological advancements, e.g., visual effects (VFX) and the accompanying 360-degree video conference rooms, attractive usage options emerge. Application orientations, illustrated here based on three different scenarios, must also meet visual, immersive requirements. Because of the relatively smallish MICE formats, such technology tools remain a challenge with regard to investments, profitability, and efficiency and are under constant pressure to develop further. With increasing profitability and value-added capabilities, such 360-degree video technologies will play an even more significant role in the MICE industry.

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