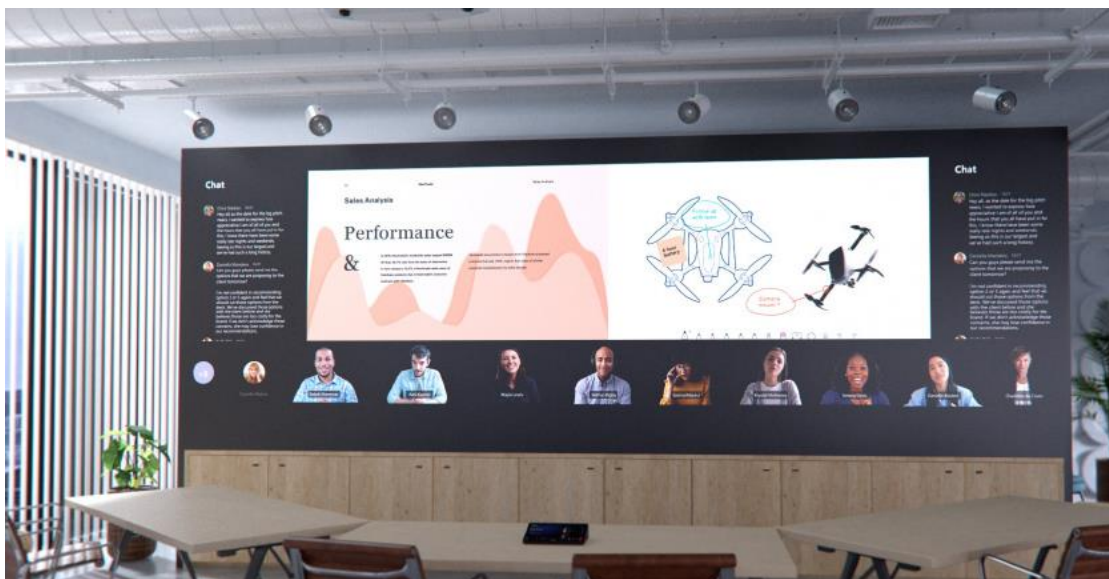# VISUAL DISPLAYS

Microsoft Teams Rooms – Displays, Projection and the bigger picture.

A White Paper by

Greg Jeffreys, Visual Displays Ltd

19 June 2022 (V2.4)

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1   Executive summary

➢ A White Paper concerned at high level with the design and deployment of Microsoft Teams Rooms (MTRs) into physical three-dimensional workspaces. How can Microsoft's vision for MTRs can be delivered, measurably and consistently, at the level of quality that the Microsoft brand demands?

➢ It distinguishes between the functions and features of MTR software and hardware ecosystem – and their deployment in the creation of optimal in-person and remote user participation experiences

➢ A detailed examination of the use of projection in creating MTR displays, with particular reference to:

   o Front Row layouts
   o Aspect ratios

➢ An analysis of displays using illustrations from *Bringing Microsoft Teams to your meetings rooms* and other published collateral for Front Row

➢ Visual Displays' development of MTR displays for medium and large meeting and teaching spaces

➢ New and in-development design tools and IP for design and specification of MTR displays

➢ The use of existing standards, and their development, for use in MTR rooms and displays

   o Related environmental standards

➢ Certification of projection hardware and installing practitioners

➢ Conclusions drawn

2   Introduction

At a time of mass creation of, and conversion to, hybrid meeting and teaching spaces, the global adoption of 'Teams Rooms' as a catch-all term for hybrid workspaces provides testimony to the substance and impact of Microsoft's campfire. The MTR campfire sits in a pioneer landscape with a geography yet to be fully explored. Sectors of the map remain uncharted because pandemic-forced changes to organisational structures and workflows remain work-in-progress.

During 2021, Microsoft released *Bringing Microsoft Teams to your meetings rooms*, a significant workpiece authored by Jimmy Vaughan and Joe Sarrasin. It includes photo-realistic renderings of several room configurations. These contain significant innovations, particularly with regard to displays and VC camera positioning.

But these are visualisations. Although many significant features and details can be inferred and unpacked from them – which we do in detail here – the practical question remains how these can be delivered to the quality associated with the Microsoft brand. They represent an ambition, bearing testimony to ambitious performance and experiential benchmarks.

The route to achieving these exemplars is, as yet, the road less travelled.

Moving into the 'real world', in recent months Microsoft has released images and videos on installed systems in The Hive featuring:

- Early iterations of Front Row:
    - 32:9 twin projectors with 'hard edge' blend and two different colour schemes (or colour temperatures?);
    - 21:9 single projection;
- Another, apparently projected image, with a camera embedded in the screen.

Perhaps as a result of the photography, and despite these spaces having closely controlled lighting, the quality of the displays bear witness to the practical issues faced.

From an outsider's perspective there are three significant contextual themes:

1. This marks a bold and definitive step by Microsoft into the physical free space of hybrid meeting and teaching spaces. (With regards to Higher Education and application to its various – and developing – pedagogies, I use 'hybrid teaching' as an umbrella term to include blended teaching/learning and associated teaching modes.) Although this White Paper is primarily concerned with MTR projected displays, the context of the physical workspace and the need for a holistic approach is also covered here. As yet Microsoft's ambitions as to the extent of this move remain unclear. What are the end stops of their scope and reach? Which elements will be proscriptive and subject to future certification? Which elements will be advisory and how detailed will (or can) this advice be?

2. This step is timely. Testimony from all parts of the AV food chain, from tech managers in the user community, to consultants and integrators' pre-sales designers, through to integrators, all reported a pandemic-driven rush to create or convert hybrid meeting spaces – but before the user needs and workflows had been properly identified and mapped out.

3. This trend has been coupled with the tendency to ignore even the most basic tenets of AV and associated environmental standards. Critical use – and development – of existing AV and environmental standards is an essential tool in the continuous improvement of MTRs, and in their consistent and certifiable deployment.

I have been engaged with these issues for some time: professionally through my business Visual Displays; through R&D and development of IP in immersive displays (some of which is directly applicable to Teams Rooms); through my leadership of AVIXA's ANSI-accredited standards management body; through co-writing of standards (some of which are mentioned here); through teaching and writing; and most recently through regular LinkedIn posts, which have garnered global engagement – including within Microsoft.

This White Paper has been written to capture and express some relevant parts of our work and findings, but also to engage better with the Microsoft ecosystem and to elicit feedback to help channel my and my team's resources – and capitalise on significant opportunities at what I believe to be a pivotal moment in organisational practice and behaviours – and thus for business.

This is an edited version of the original, which was for circulation within Microsoft. This version is still appropriate for internal MS circulation, but also for wider circulation – please share as you feel appropriate!

2.1   Projection and its revitalised place in the displays continuum
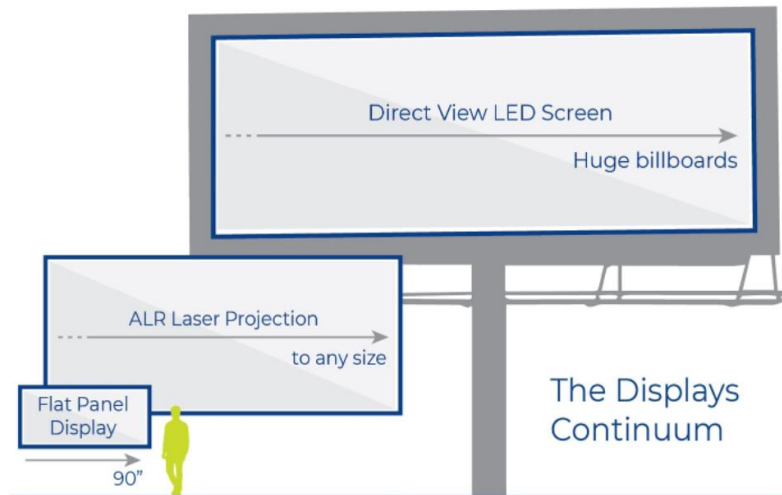
Before any display technology specification is considered, one overarching fact stands out: the next generation of Teams Rooms requires a step change upwards in display size relative to previous practice and expectations. (Display and image size is addressed in detail in this section below.)

Additionally, some users will need to adopt new widescreen formats from 21 : 9 to 32 : 9. (The new Front Row screen aspect ratios and screen layouts are addressed in detail below.)

So, what practical and technological issues arise?

1. Existing large format displays (LFDs or 'flat panel displays') up to 98" are only appropriate for much smaller rooms than previously assumed, the reasons for which we dive into here.
2. The typical ±138" 1.5mm current standard dvLED offerings, have low resolution, closest viewer restrictions and high luminance ('brightness') levels designed for digital signage rather than 'serious content' delivery. Plus, closest viewer metrics make them problematic in many room designs. This serves to make their entry level point into Teams Rooms and their applicability a problematic call.

In this context it's therefore unsurprising to see that the use of projection is one standout feature of current Microsoft collateral.

But how can MTR practitioners benefit from the potential that projection offers in the use, flexibility and effectiveness of displays?

Projection is a practice. The procurement of high-quality projectors and screen materials in themselves do not guarantee good results. There are specific challenges in the certification of both the hardware and the practitioners, which this White Paper addresses.

Recent advances in projection technology and practice have by-passed the attention of much of the AV industry, particularly those involved in MTRs and other hybrid workspaces. Recent industry trends have seen focus on up-skilling in low voltage, AV over IP etc – and have tended to treat MTR display options as being limited to the 98" upper limit of large format displays (LFDs).

Projection is different to the other display technologies in that it's reflective rather than emissive. The environment, in the form of ambient light, has a profound impact on the quality of the delivered image quality. For 'quality' read 'contrast', for 'contrast' read 'ambient light control'. Projected image contrast and quality is a function of ambient light and how it is managed.

And in properly-lit Teams Rooms and teaching spaces this algebra solidifies: projected image contrast is 100% a function of ambient light.

Poor projection user experience. *Standard white screen under normal room lighting. Low contrast, low black levels. Unprocessed/unretouched image.*

Good projection user experience. *ALR (ambient light rejecting) projection screens [dnp Supernova] under high room lighting and natural light. High contrast due to enhanced (low) black levels. Unprocessed/unretouched image.*

2.2   Flat panel / large format displays (LFDs)

Absolutely ubiquitous, LFDs are the centrepiece in most rooms, yet somehow remain critically unnoticed.

The visualisations within *Bringing Microsoft Teams to your meetings rooms*, can also be regarded as an opportunity to take a critical look at the performance requirements for this display technology. For example, the simplest application of environmental standards suggest they often are too bright.

Flat panel displays form an essential part of the MTR ecosystem, but the critical application of the relevant standards would helpful for MTR practitioners to provide better user experiences.

The following sections are written with the focus on projection, but the principles covered here are agnostic as to the technologies they apply to. The approach in this White Paper is to drill down on the visual attributes of Microsoft's renderings in order to identify the specific attributes and requirements needed to deliver exceptional MTR user experiences.

2.3   Application of simulation and immersive displays IP and experience

This is a short mention of a massive topic. However, the learnings from simulation are directly applicable to MTRs and the creation of exceptional user experiences for in-person and remote participants alike.

It's helpful to think of hybrid spaces as simulators.

In simulation we think in terms of 'cues', the sensory inputs and stimulants that, in the right combination, cause users to suspend their disbelief and to fully engage with the prescribed activity or process – to engage with the experience fully and uncritically.

In my work designing immersive displays, the simulator needs to provide the cues that leads the user to suspend their disbelief, for their heart to beat faster when they crash the plane or vehicle, for example. Hopefully there are no plane crashes in hybrid spaces but the same objectives stand. We seek to help users suspend their disbelief, to 'break the fourth wall' and to dislodge the logjam of distractions, freeing in-person users to engage fluently with remote colleagues.

Cues can be positive and negative. Distraction cues, such as reflections on the display can provide conscious and subconscious cause for participants' failure to fully engage within

the hybrid workspace.

Thinking in terms of cues is also helpful in addressing UX as it's also an approach that breaks the subject into granular elements. If the hybrid workspace sensory experience is broken down into such elements, and individual projects are created to make incremental and iterative improvements for each, this is fertile ground for continuous improvement in MTR experiences.

3   Unpacking the Microsoft Teams Room displays vision

This may just be a rendered image, but there's much to unpack in this here and in associated released imagery. Here are the elements of our structured approach.
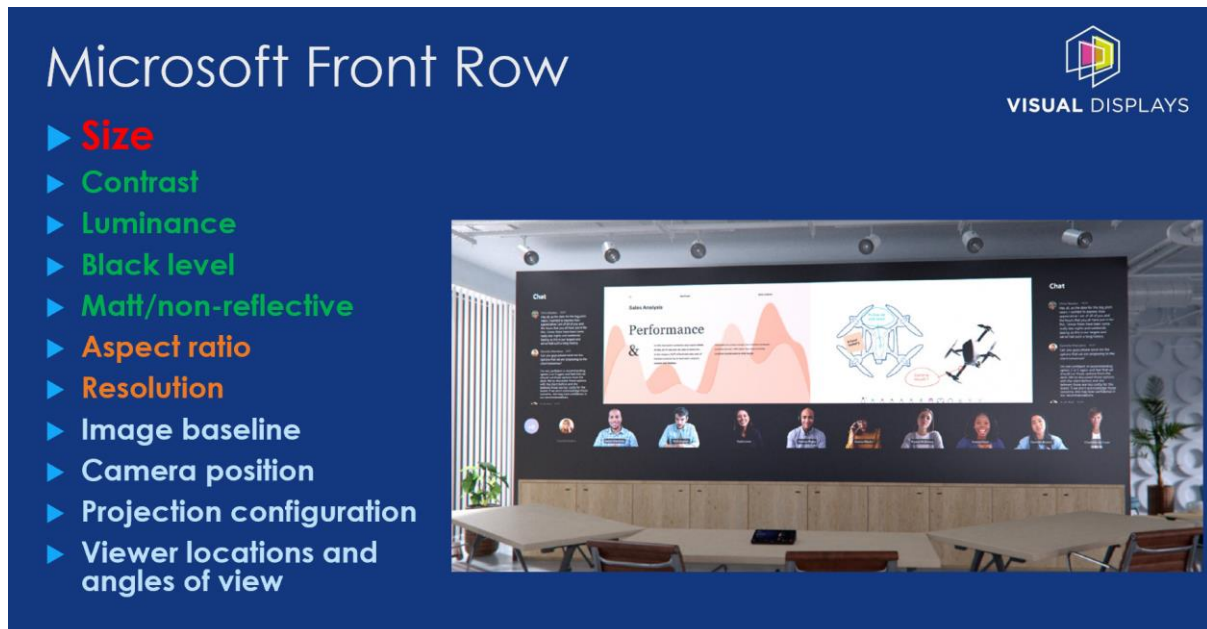
3.1   Size

MTR design 101 means getting the display size right.

If in-person participants cannot see and fully engage with the content, then there's a critical failure at the first step. Unfortunately, it's not uncommon to see 'cheap seats' effectively designed into MTR spaces by the deployment of inadequately sized displays. And there's a sting in the tail for these users if they start to use Front Row where critical content is displayed at even smaller size in a Picture in Picture (PiP) window.

This essential element of MTR design is set out in AVIXA's DISCAS standard (Display Image Size for 2D Content in Audiovisual Systems). This standard was written by a task group I led, comprising international subject matter experts. It addresses design and assessment of:

- Image size – using a metric where the size of content is used to determine minimum image height relative to the farthest viewer in a given space. (This

metric is %ElementHeight [%EH], the height of a lower-case font character expressed as a percentage of the total image height)

- Farthest viewer – tied into the image size and content formulae to ensure the entire room can see and engage with the displayed content
- Closest viewer – effectively the vertical viewing angle limit. The proximity limited by the angle between the closest eye position and the angle to the top of the screen. This is effectively an ergonomic metric to prevent viewer discomfort by having to angle back one's head to view the top of the image. The Front Row approach of presenting remote participants at eye-to-eye level and placing content windows above, identifies a need to develop some further rubric than DISCAS currently provides.
- Horizontal viewing angles. DISCAS broke with previous guidance as our task group decided the required criterion was for viewers to see the entire image – and not just the side closest to them. Viewers front right should be able to see and engage with the left half of the image, and vice versa.
  - Front Row stretches these principles: how do we address this?
- Image resolution. In practice this doesn't apply to MTRs as they fall within the Basic Decision Making viewer category within DISCAS.

(NB: display resolution is an example where standards for MTR could be critically applied and further developed. Human visual perception works in different ways and at enhanced levels when looking at moving objects. The rendering and perception of the human faces and figures of remote participants represent a technical challenge – and opportunity – for MTR user experiences to be distinguishable from other platforms.

Current and future generations of MTRs mark a step change upwards in display size.
Moving remote participants closer to lifesize. Critical content contained within a window – which needs to be sized so in-person participants can see at the back and there are no 'cheap seats' in MTRs.

DISCAS in practice uses a default of 3% Element Height for display content size to calculate minimum image size, which equates to the old 6 : 1 rule: the farthest viewer to be no more than 6 times the image height away from the screen.

Farthest viewer should be no further than 6 x image height away from display (when working with 3%ElementHeight)
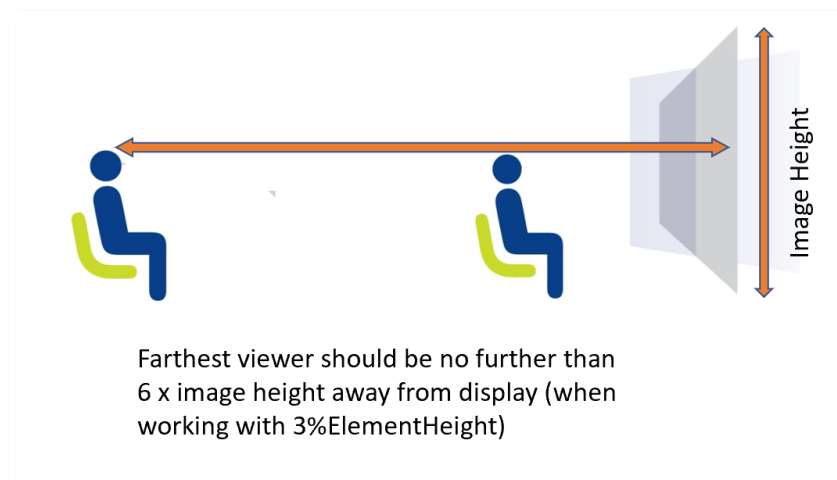
Because the Front Row screen layout places the primary meeting content in a smaller window, a PiP (Picture in Picture) inset within the overall display, we need to adjust the DISCAS calculation to apply to this content window rather than the entire display. If, say, the primary content window is 60% of the display height, then the 6 : 1 rule gets factored to 3.6 : 1.

- DISCAS %ElementHeight (%EH) default = 3%
- 3%EH = 6 : 1
  - (Farthest viewer no more than 6 x image height)
- If content window = 60% of image height
- Then ratio becomes 3.6 : 1
  - (0.6 x 6 = 3.6)

Content window e.g. 60% of image height

Full image height

This highlights two issues:

1. The move to significantly larger display sizes is an essential step in MTR development. Failure to adopt proper display sizes will risk impaired user experiences.
2. AV standards must be used critically to be fit for purpose in the design and delivery of MTRs.

So, what practical and technological issues arise?

For starters this means that existing flat panel displays up to 98" are only appropriate for much smaller rooms than previously assumed. Also, the typical ±138" 1.5mm current standard dvLED offerings, with low resolution, closest viewer restrictions and with luminance ('brightness') levels designed for digital signage rather than 'serious content' delivery serves to make their entry level into Teams Rooms environments a problematic call.

Closest viewer positions using dvLED are problematic until smaller pitch (e.g. 0.9mm) becomes affordable. An example metric for closest viewing of dvLED screens is to take the millimetre pixel pitch, double it and express that number as metres. So a 1.5mm dvLED display's closest viewer should be at least 3m / 10 feet back…

In this context it's therefore unsurprising to see that the use of projection is one standout feature of current Microsoft MTR materials.

3.2 Contrast

This is full contrast

This is not full contrast!

Low contrast even damages perceived resolution.
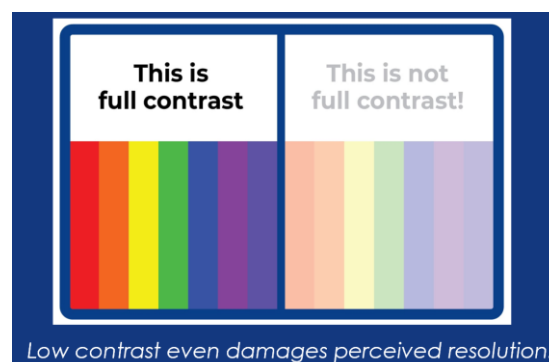
For 'contrast' read 'image quality'. The AVIXA PISCR and ISCR standards, which provide metrics for minimum contrast requirements for good image quality, mandate a minimum 15:1 contrast ratio. (This sounds really low, but only because there are two variants of this metric.) Under normal room lighting it's impossible to achieve this without ALR (ambient light rejecting) screen technology.

In practice, good image contrast is a function of its black levels. Not obvious to the untrained eye, the black levels in images such as the below, represent the pivotal metric – and issue – for the translation of these images into real-life MTR installations
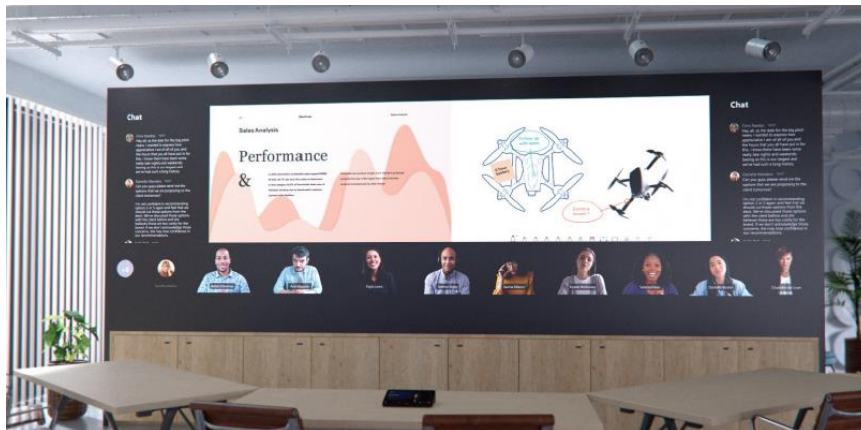
Standard projection screens are white and they remain white under normal room lighting. ALR (ambient light rejecting) screen materials, which appear black or near black until projected light hits them, are essential for delivery of good large screen MTR experiences.

3.3   Luminance ('brightness')
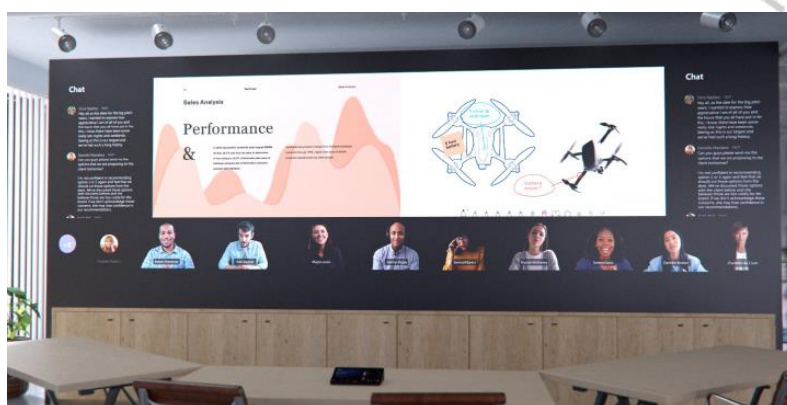
Many hybrid workspace displays are too bright and, regrettably, have eyestrain (asthenopia) inadvertently designed into the room experience. The key metric here is the Task Luminance Ratio (TLR), which provides the framework by which the luminance levels of all key objects within a room from people to surfaces to display are kept within a

defined range, such that our eyes are not constantly working to adjust to widely differing levels.

The Task Luminance Ratio is a prime example of why the holistic approach is essential for creation of exceptional MTR experiences. The display exists in the context of the overall workspace; they both impact upon each other.

However, this Front Row display illustration has low luminance and we could imagine working here all day without fatigue.

The useful benchmark here is the printed page, the attributes of which are low luminance, high contrast (see Black Levels below) and high resolution

Projection is almost infinitely scalable in both size and luminance. With the right standards-curated design tools, displays can be designed to be optimal for every workspace.

3.4   Black level

The Front Row display visual shows deep black levels. Counterintuitively, the black levels are the driver for contrast. 'Contrast' is a comparative metric; it specifies neither the white nor black luminance levels – it simply puts a number on the difference between the two. So good black levels 'ground' a display and drive good contrast levels – avoiding the need to create them by too-bright white levels.

Defining optimal image luminance (brightness) relative to the space within which it operated allows us to 'fix' the display's peak white level – and the black level is then the specified multiple below this (typically fifteen times darker, according to AVIXA's ISCR and PISCR standards).

3.5   Colorimetry

This represents a marker for the future. What shall be the metrics and best practices for best rendering of remote participants' faces and features.

3.6   Matt – non-reflective surface

This will not be immediately obvious to the untrained eye, but a display's matt finish can be a critical element for exceptional MTR user experiences. This MTR Front Room display visualisation includes this quiet revolution.

Our MTR in-person colleagues are not shiny, nor do we look at them through a sheet of

glass. A matt finish removes a significant barrier, a negative cue, to natural interaction with remote participants.

3.7 Aspect ratio

The Pandora's Box of display possibilities, unlocked by Front Row (see the [Front Row section](#) below for a deeper dive).

From an outside perspective this looks like the beginning of a major journey, combining further future options with greater user choices. Again, the flexibility of projection will be helpful for MTR practitioners and users whilst aspect ratios develop – and users work out what works best for them.

3.8 Resolution

According to DISCAS, resolution does not come under its aegis for MTRs as they fall within the Basic Decision Making viewer category. However, this is an element where, again, DISCAS needs to be applied critically because DISCAS was produced primarily for static content such as PowerPoint and Excel.

Human visual response to moving items works at a higher level than with static images. This is why in military simulation we specify simulation displays in terms of subtended line pairs. (Visual acuity is defined in terms of the smallest object we can see relative to another, in this case the separation of black and white lines relative to the distance to the viewer's eye.)

Currently, resolution and frame rate are effectively limited by either display technology or the signal transport. MTR Front Row speaks to a future tracking technology progress here.

3.9 Image baseline (distance from floor to bottom of display)

Now the hybrid workspace experience breaks away from the meeting space's sole need to present Excel, PowerPoint, etc and adds in remote participants too, the classic rules no longer apply.

In the same way our seated in-person MTR colleagues 'disappear' below the table top, a positive, albeit subliminal cue for lifelike representation can be provided if the display is lower to the floor.

3.10 Camera position

The move to larger display sizes is a positive step, but where do we place the camera? The Holy Grail of VC is eye-to-eye contact; is this possible?

This is very much work-in-progress, but there seem to be two main possibilities:

1. Embed a camera within the screen, behind a small aperture. This is theoretically possible when using UST (ultra-short throw) projection through the acute angle of the light path. We are working on this project with a subsidiary within the Dai Nippon Printing Group, the world's largest print and optical technology company.
2. Place the sensor of a small form factor camera in free space in front of the display

It's worth pointing out here that there's a difference between actual and perceived eye-to-eye contact and this forms part of design opportunities under investigation.

The VC camera is often treated like a poor relation when it should be regarded as the VIP presence in the room. Hybrid spaces fail if the camera does not send out high quality, noise-free and well framed video. The camera can only do its best with what it's given, which means that lighting, wall colour, surface reflectance values (LRV) as well as layout are non-negotiable parts of the design mix.

3.11 Projector configuration

There are three possible configurations:

1. UST (ultra-short throw) lensed projectors mounted above the screen near or within the ceiling;
2. UST lensed projectors mounted below the screen, on or within credenza units;
3. Conventionally lensed projectors suspended from the ceiling.

The UST configurations are discussed in more detail below, but all can work in MTR rooms. (However, this writer wonders whether Option 3 has been used so widely within the Microsoft visuals so readers can more clearly see that solutions are projection-based, when all of The Hive installations that have been shared seem to be UST based?)

The downsides to Option 3 are not just aesthetic. The projector will usually be installed over the MTR table, imposing in both presence and noise. However, this can be mitigated by positioning the projector at the back of the room – and even using soundproof enclosures.

3.12 Viewer locations and angles of view

These fall within the DISCAS standard. However, it's clear that larger displays in general, and Front Row displays in particular, will stretch this envelope, driving the need for a critical application – or even adjustment – to the standard itself for MTRs.

3.13 Concluding comments on projection

In practice, going above and beyond the 98" upper limits of flat panels can mark a point of discomfort for many. I am only too aware that projection has tended to play a diminishing role in the lives of the professional AV integrators who are the mainstay creators of MTR workspaces and the temptation to 'hang a TV on the wall' can be overwhelming. A seemingly quick fix can represent long term problems in a MTR space's effectiveness.

We use standards-driven design and calculation tools to design and manufacture optimal displays – with measurable outcomes. I have shared some of these at high level in the LinkedIn posts and my webinars. I'd be delighted to engage more deeply with Microsoft in their use in MTRs.

4   Front Row – new aspect ratios and screen layouts

4.1   Introduction

Front Row has created excitement – and maybe some fear – amongst MTR users and practitioners. It's an exciting vision for the future – but takes the MTR and hybrid workspace professional community out of our comfort zone. Microsoft's February 2022 release of the 21:9 aspect ratio Front Row layout caused users to rethink their display needs for all Teams Rooms and hybrid meeting/teaching rooms.

This was followed by May 2022's release of the *Meet The Hive* video which shows in particular detail two new rooms, both using projection and both using 21:9 displays (https://www.youtube.com/watch?v=eS3efXIKjpA&t=11s). Essential viewing.
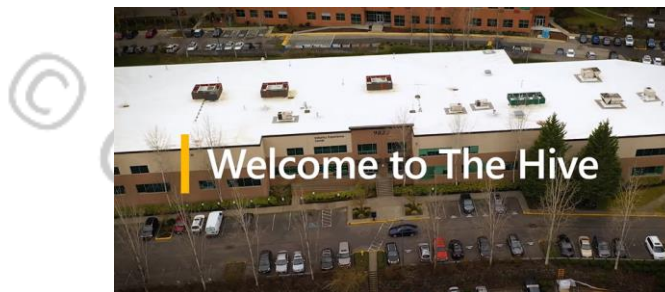
Microsoft's new main room shown at The Hive, with 21:9 Front Row projection screen, floor mounted projector with VC soundbar mounting arm.

This corroborates and underlines:

1. A 'sea change' move to significantly larger display sizes;
2. The use of 21:9 aspect ratio to accommodate simultaneous interpersonal communication with presentation of content and sidebar chats etc;
3. The use of projection as their principally-used display technology (in particular Epson EB-PU range with UST lenses).

These rooms have been apparently constructed in completely light-controlled spaces. A major issue is how to deliver such enhanced hybrid experiences under more normal and natural light, something this White Paper addresses. (See this section.)

4.1.1   The heritage attraction of Front Row

Paradoxically, the interest in Front Row is also mixed with some nostalgia for the older telepresence systems, such as this Cisco example:

[Accessed: https://www.cisco.com/c/en/us/td/docs/telepresence/ix5000/best_practices/ix5000_best_practices_fit_finish.html 21 May 2022}

Twin and triple LFD display configurations' strengths lie in the strong person to person feeling of connection between in-person and remote participants. However, the weakness of multi-display configurations is the limitations it can create in the presentation of serious content, its legibility and ability of users to fully engage.

A principal attraction and advantage of Front Row, therefore, is the ability not to throw the baby out with the bathwater: by creating a single display solution that can combine the feeling of connection and intimacy between the in-person and remote participants with the ability to show serious content. So long as the display is big enough.

4.2   What is Front Row?

What is Front Row? It is a screen layout, an iteration in the explosively fast growth and development of MTRs. The first release in February 2022 was a 21:9 aspect ratio in 2560 x

1080 pixel resolution – retaining HD pixel density, but with added width.

These were earlier installations at The Hive (now apparently superseded as per the *Meet the Hive* video):

Microsoft also released footage of 32:9 displays:
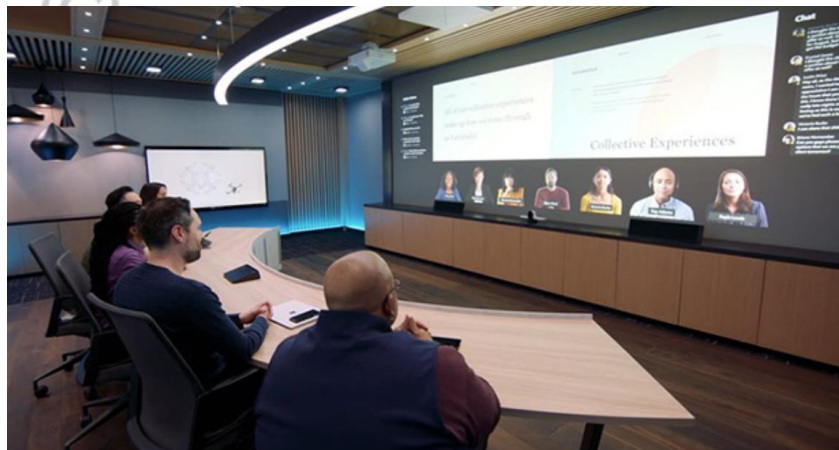
- Both use projection
- The 21:9 is apparently a blanked-down 16:9 HD or 16:10 WUXGA UST (ultra-short throw) projector
- The 32:9 uses two side-by-side hard-edge blended UST projectors

4.3 Unpacking the two new rooms in The Hive

4.3.1 Main room

Described as being built from scratch.

The visible features of note include:

- Large projection screen with minimized bezel
    - Baseline of screen relatively high, leaving top of screen in turn relatively high for the in-room participants, presumably prioritising eye level contact between the in-person and remote participants.
- Epson EB-PU series projector, fitted with X01 UST lens
- Projector floor stand with mounting bar for VC camera
- VC camera soundbar; small form factor three camera array
- Curved table, allowing eye to eye contact between in-person participants
- Wall panels with apparent polygonal acoustic panels
- Diffused strip lighting. This is somewhat surprising; one assumes this will be upgraded at some point
- Apparent small form factor camera suspended from ceiling, focused on whiteboard.

There are too many things of note to cover here but, apart from the projected display, the positioning of the VC camera in free space marks a major design breakthrough.

4.3.2 Secondary room

Described as a refit of an existing space.
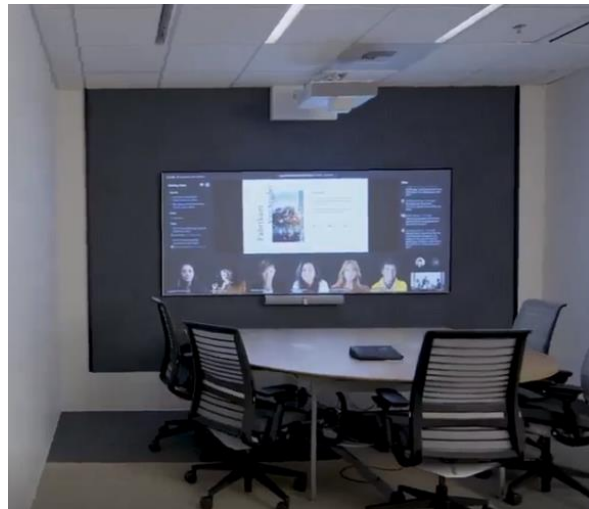
Visible features of note include:

- Projection screen with minimized bezel
- Low-cost Epson UST projector, ceiling mounted
- VC camera soundbar mounted under screen
- 'Guitar pick' shape, half-oval table
- Not seen here is the use of a raised table at the rear of space with high chairs, allowing additional participation creating better view of remote participants over the heads of those seated at table.

This design suggests that 21:9 aspect ratio will also work for conventional rectangular, 'bowling alley' rooms, so long as a tapered table shape is used.

4.4 Which displays to choose for Front Row?

There are two pathways here.

4.4.1 Workspaces exclusively used for Front Row

The first question is 'what aspect ratio do I choose'? (Second question, 'how do I avoid something that might prove to be an expensive mistake next year?')

There is no doubt that many organisations will need Front Row workspaces and that a 21:9 display will prove of lasting value. Projection will fulfil the needs of all size spaces. But

they must be executed using standards-curated pairings of ALR (ambient light rejecting) screen technology and 3-chip (3LCD in current commercial practice).

At Visual Displays, we have additionally designed the VDL Digital Canvas large screen display solution specifically for MTR according to the principles set out in this White Paper.

VDL Digital Canvas standalone 120" display with VC camera mounted in front of unit.

4.4.2 Workspaces where Front Row will be one mode of use – or future flexibility is the required option

Here, the best option is to select the largest practicable 16:9 display and to have the 21:9 as one of the system options.

This is a current example of how we execute this (using UHD 4K pixel shifted projection to be ready for future increases in MTR display resolutions) based on a 120" 16:9 image size:

Diagram labels:
- 2.7m (105")
- 16:9 full screen for other modes of use
- 1.5m (59")
- 1646 pixels
- 21:9 – reduced height strip for Front Row (adjustable vertical position)
- 1.1m (45")
- 2160 pixels
- 16:9 full screen for other modes of use
- 3840 pixels
- Overall image upscaled resolution using external processor
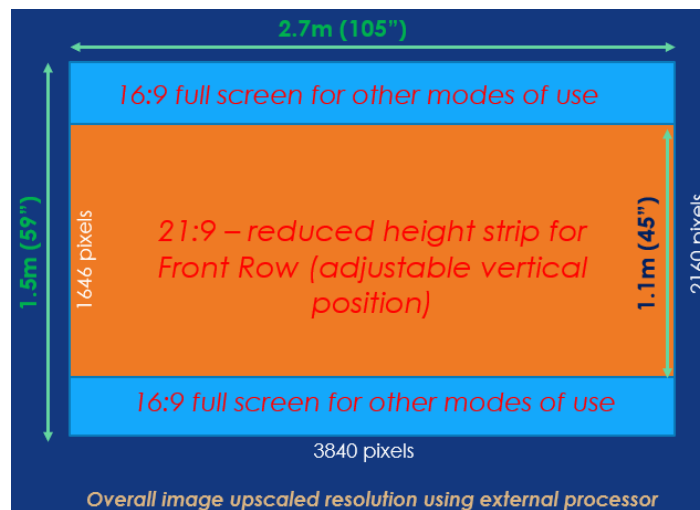
Why 120"? Because it's the maximum image size that fit within standard office heights, which are around 2.7m, 9 feet high.

Let's work backwards from the ceiling. Allowing 10cm or 4" above the image, a 120" image is 1.5m / 45" high, leaving an image baseline (floor to bottom of image) of 1.1m / 45".

4.5   Curved screens

Our analysis of Front Row's super-wide aspect ratios suggests that curved displays – and a curved table for the in-person participants – will be a preferred option in many cases:

1. It will help viewers at one end of the table to see the far edge of the display;
2. It will help in-person participants make eye contact with each other;
3. A curved Front Row room table facing a curved display promotes inclusivity – and gives a feeling of parity for all in-person participants, with no feeling of being in the 'cheap seats' for those in the outside positions.

Curved screen displays are one of the bespoke options in the VDL Digital Canvas product range. They are produced as part of our immersive and simulation display division operations.

5   Delivering projected MTR solutions

This White Paper demonstrates in detail the need to use standards-curated bundles of ALR (ambient light rejecting) screen technologies with three chip laser projection technology.

This section gives a brief overview of our current approaches to projection for hybrid workspaces.

5.1   Screen material choice

Visual Displays distributes all the principal manufacturers of ALR (ambient light rejecting) projection screens, which we also use to manufacture standard and bespoke display products and solutions.

There are over twenty surfaces we select from, mainly from three manufacturers, each on different continents. In practice, for hybrid workspaces we concentrate on two materials, both from dnp Visiosign (https://www.dnp-screens.com/), a subsidiary of Dai Nippon Printing (https://www.dnp.co.jp/eng/index.html), the world' s largest print and optical technology company:

1. dnp Supernova 08-85 for conventionally lensed projectors
2. dnp Supernova STL05 for UST projection

The dnp Supernova materials are used in our display products as they are the only true 'optical' materials in that they combine lens and nanotechnologies to control and reflect light. They are unique in the projection screens market in that the manufacturer, the Dai Nippon Printing group is a global large scale technology group.

5.2   Projector choice

For proper rendering of human faces, a three chip technology is required. The commercially appropriate choice is 3LCD. Although we work at partner level with all projector manufacturers, and other manufacturers do make good 3LCD products, we mostly work with Epson, the global leaders in both 3LCD and projection itself.

5.3 VDL Digital Canvas

VDL Digital Canvas is available in two formats, each using standards-curated combinations of dnp ALR (ambient light rejecting) screens and 3LCD laser projectors (primarily Epson).

1. Standalone credenza units with a projector fitted with UST lens mounted within the cabinet, with rack space for all equipment within. These units are modular in construction, assembled within an hour and are shipped flat-packed to export customers. They have zero structural impact in the room and can be redeployed.
    a. Options available for structure-only, to allow finish and cladding by the project's interiors contractors
    b. Options available for bespoke furniture, working to our designs or yours.
2. Wall-mounted systems. These are standard configurations comprising wall mounted ALR screen, 3LCD laser projector and ceiling mount.

- Standard sizes are 120" and 140" in 16:9 – and 2.7m x 1.5m in 21:9.
- Bespoke systems are supplied in any size or aspect ratio

VC cameras and camera bars can be mounted in various locations on these units.

5.4   VDL Digital Canvas Curved Screen

These units are designed and built to order from a standard tariff by our immersive and simulation displays division.

Units are available in any size and aspect ratio with a wide range of screen radius (curvature) options.

6 Displays in the wider context of MTR space design – the holistic approach to Teams Rooms:

In a previous project for a major technology corporation, I worked as specialist consultant on their next generation of hybrid meeting rooms, with particular sub-projects on displays, room lighting, VC lighting, plus AV and related environmental standards. At that time, I developed some tools and approaches to help teams to create successful spaces by taking a holistic approach and breaking the project into granular elements and identifying the interdependencies. These have been developed further, refined working on practical projects and assignments.

A holistic approach is, I passionately believe, essential in the creation of successful workspaces. The word 'holistic' has some association with generalised statements and lack of rigour, which is why taking a granular approach and using this to create a description of the successful outcome – in hard, measurable metrics – is a non-negotiable approach.

An example breakdown is as follows:

1. The room layout
2. Design, colour schemes and aesthetics – with special reference to backgrounds with VC camera field of view (FOV)
3. Natural light – managing and controlling it
4. Lighting design – for in-person participants and VC cameras
5. Display specification
6. Furniture
7. Temperature and ventilation

This can be further developed and versionised for MTRs.

I consult, teach and write on this subject and have extensive further materials.

6.1 It's a 'pre-technology' approach

This is a conversation taking place between technologists. Our safe and happy place is often by going straight to the selection of hardware! The outturn of taking a 'granulated holistic' approach to workspace design is that there's a pre-technology project phase whereby the technology specification selection remains an agnostic outcome, pending the development of hard performance metrics for each workspace.

There's a significant practical aspect here. Organisations above a certain size tend to

operate in silos. By looking at the above room design breakdown, we can see that building/facilities management, for example, can dictate the lighting which, in turn, can damage the performance of MTR displays and the experience of in-person and remote participants.

By taking this approach – and by use of the latest environmental and UX standards – it is possible for MTR practitioners to help their customers to help themselves to better outcomes and budget deployment. These project approaches also help MTR practitioners to get involved much earlier in the overall project process.

6.2 The need for test, development and R&D spaces – the UX piece

MTRs and teaching spaces, bundled together in the 'hybrid workspace' generalisation, are technology enhanced rooms.

The term 'hybrid' is annoying to many. If we accept that its definition includes a sound and video connection to people in other physical locations and, as we can and do make these remote connections at virtually any waking moment, perhaps the term itself will become redundant?

For education technologists, pedagogies' complexities in manifold teaching modes, the finer details – and definitions – of blended learning, were certainly matters of fierce debate and engagement at the recent LTSMG conference in the UK in April '22.

Which brings us to UX.

Within AV, many think that UX design is concerned with control panel or GUI design. But true UX design is a radical and holistic approach which takes its lead from phenomenology, a starting point for which holds that objectivity is effectively a myth.

In AV, the radical and scary thing about UX design is that you have to talk to users. And there's an art here about how to talk to users, how to avoid asking leading questions. It's based around Human Centred Design and User Centred Design. Ten seconds of Googling will find you some wonderful books and resources.

The last question to ask a user is what s/he wants. If Henry Ford had asked that question, the reply would have been 'faster horses' not the Model T. And so it was with the iPhone.

In AVIXA, we're producing a new standard: User Experience Design for AV. Keep your eyes

open for it. Engage with it when it goes to public review. I'm privileged to be working with some real experts in this task group. In the US there's [Lisa Perrine](#) and in the UK there's [Adam Banks](#), to name but two.

It's quite possible for organisations to 'get it' about UX, which is transformative. But it's virtually impossible to keep on the path of righteousness without getting back into the self-polluting dangers of dogfooding.

In the long term, organisations with a true understanding of UX will have ongoing engagements with third party UX specialists, such as those mentioned above, to keep them on track and to maximise their investment.

The enablement and facilitation that MTR and hybrid workspace provide are pivotal to organisations' present and future operation and success. Organisations and campuses which lack dedicated test and development space are at a severe disadvantage relative to those have them (and actually use them!).

7 Standards: their essential role

7.1 Standards are key

Although future iterations of Teams Room screen layouts and Front Row present complex issues and dependencies, the use of standards is surely a non-negotiable. They may need to be versionised, they may need to be used in hierarchical form where one metric takes priority over another – but they are necessary in order to tease out the principles and priorities that will drive successful outcomes within both meanings of 'standard', namely the quality of the entity and the ability to replicate it consistently.

However, there's a tactical issue here. Users need MTR solutions right now. Although it might be optimal to spend one or two years developing new standards, there are AV and environmental standards that can be used or adapted right now.

Standards can be problematic. There can be lack of clarity as to their specific meaning relative to the organisation and its needs. There can be inconsistency of use between departments and other organisational silos. There can be confusion in distinction between a standard and a best practice.

Best practices are useful. If a standard doesn't exist, a best practice can be the least worst alternative – but they lack the precision and rigour needed in the case of needing consistency with a global reach. They tend more to soft ambitions rather than hard outcomes.

My firm personal belief is that proper standards are a perfect example of where 'front-ending' a workpiece – making a judicious investment at the front end of a project – creates efficiencies, cost savings and consistently better outcomes.

7.2 The taxonomy of standards

Every profession or industry sector tends to have its own culture, reflected in their approach to standards.

The word 'standard' itself starts with two meanings:

1. Relating to a level of quality;
2. Relating to a norm or a model, in this context meaning, for example, a room specification that can be replicated globally. In this second category, this is often reduced to the minimum viable content, a Bill of Materials (BOM).

Both apply in this workpiece, but there's a hierarchy to be observed: the quality part

needs to be defined before any standardised entity is rolled out. Will the standardised room be good enough? Will it cope with all the workflows and modes of use during its programmed lifecycle?

7.3 Start with the end in mind

My standard working practice relating to standards at a macro level is effectively reverse engineering, namely to define excellent user experiences in measurable and certifiable outcomes. Each element affecting the overall user experience in the workspace has to be both identified and the required performance metrics defined. (This is why the AVIXA standards are mostly 'performance' standards, as they address this need.)

7.4 AVIXA standards

Having been involved with AVIXA (formerly InfoComm) standards and best practices for over twenty years, been a founding member of the original InfoComm Standards Management Committee, I now lead AVIXA's standards as Chair of the Standards Steering Committee. Leading the group throughout the pandemic we have had to pivot and make strategic reviews in fast order – partly driven by the major expansion of hybrid meeting and teaching.

I'm not exactly unbiased, but the role of AVIXA's standards can play in creating outstanding user experiences in Teams Rooms cannot be exaggerated.

There is a wide range of standards in existence and in production. I'm going to focus on those relating to the displays and lighting – and are essential references for Teams Rooms. All the AVIXA standards referenced here have achieved global recognition and adoption.

7.4.1 Display Size – DISCAS (Display Image Size for 2D Content in Audiovisual Systems)

This standard not only covers setting image size, but also viewing angles, closest/farthest viewing positions – and resolution. I led the task group that wrote this. Under ANSI time protocols to keep standards current, we are assembling a new task group to revise it, including how to address the 'picture in picture' (PiP) issues thrown up by the Front Row screen layouts.

7.4.2 Image Contrast – **PISCR** and **ISCR** **(Image System Contrast Ratio)**

The original PISCR standard was based upon a best practice work I wrote as part of an academic assignment to write a post-graduate MSc degree module for the University of Manchester in 2003.

Originally applying to projection, the new version, planned for publication Q2 2022 applies to all display technologies, meaning all display types can be specified and certified on a completely level playing field. This will prove of great significance for future Teams Rooms deployments.

7.5   Lighting and VC Lighting Standards

7.5.1   **CIBSE** **(Chartered Institute of Building Services Engineers) /** **SLL** **(Society of Light and Lighting) –** **Lighting Guide 7**

The SLL is a subset of CIBSE and is the professional body for my lighting practice. LG7 relates to offices and relates directly to Teams Rooms. This is a UK body and the US equivalent is the IES (Illuminating Engineering Society) and their Lighting Library.

7.5.2   AVIXA - **Recommended Practice for Lighting Performance for Small to Medium Sized Videoconferencing Rooms**

Unusually for AVIXA, this is a guide. I was originally involved in this workpiece as a best practice but it transitioned into this. It contains much that can boost MTR lighting performance and I have adopted much from this in my professional practice.

7.6   Standards relating to the built environment

My focus here is on light: balancing the display luminance to the room lighting and avoiding eye strain (asthenopia), but the new WELL V2 standard offers Microsoft the opportunity to enhance their presence and leadership in successful workspace design – especially as the work is mostly already done!

7.6.1   WELL Building Standard V2

A holistic and encyclopaedic standard for building design and certification, with particular focus on wellness for building users (https://v2.wellcertified.com/en/wellv2/overview).

This newly updated standard is a game changer as it ties the lighting to display performance.

I have been working with WELL to explore the overlaps between AVIXA and WELL

standards.

There is a wealth of opportunity here for Microsoft, not least in the possibilities it affords for engagement with building owners and architects in more fundamental ways in building projects.

7.7 UX (User Experience) and standards

Within some tech environments, the term UX is often applied, for example, to the design of GUIs and room control, whereas it is actually a complete design approach and philosophy.

I am working on a task group producing a new AVIXA standard, User Experience Design for Audiovisual Systems (https://www.avixa.org/standards/user-experience-design-for-audiovisual).

This standard could have great positive impact upon MTR design and development.

8   Concluding remarks

This paper has not been written as a proscriptive piece, but more to explore and set out the issues that stand between the vision and delivery of MTRs.

Although the centrepiece of this document is the projected element, addressing projection within its context and working towards standards and use of measurable performance metrics are directly linked with achieving exceptional user experiences and engagement with the display – as well as the overall hybrid workspace.

Further, I have written and shared this White Paper because excited as I am for the possibilities of what can be achieved with MTRs.

So, I offer this document respectfully to my Microsoft colleagues and the wider MTR and hybrid meeting and teaching space practitioner and user communities, with the hope that your feedback can help me better focus my and my team's resources and energies. From here the intention is to develop it into discrete pieces, focusing on single subjects or more limited scope.

I welcome your feedback!

Greg Jeffreys

23 May 2022

greg@VisualDisplaysLtd.com

9   Visual Displays design tools, IP and current R&D

Visual Displays' capabilities and experience have direct application and relevance to both MTR displays and the room design itself.

## 9.1   Design consultants and Parametric 3D CAD design

We are design consultants and we use the latest 3D parametric design systems to create designs and visuals.

9.2   Rear projection mirror system design and manufacture

Our background is in the design of rear projection mirror systems, using parametric 3D CAD models we developed to design light paths and to build complex mirror and mechanical structures (https://visualdisplaysltd.com/rear-projection-mirror-rigs-gobos-floor-projection).

9.3   Design and manufacture of simulation and immersive displays

We have decades long experience in consulting, designing and building immersive and simulation displays.

(https://visualdisplaysltd.com/solutions/technology/immersive-displays).
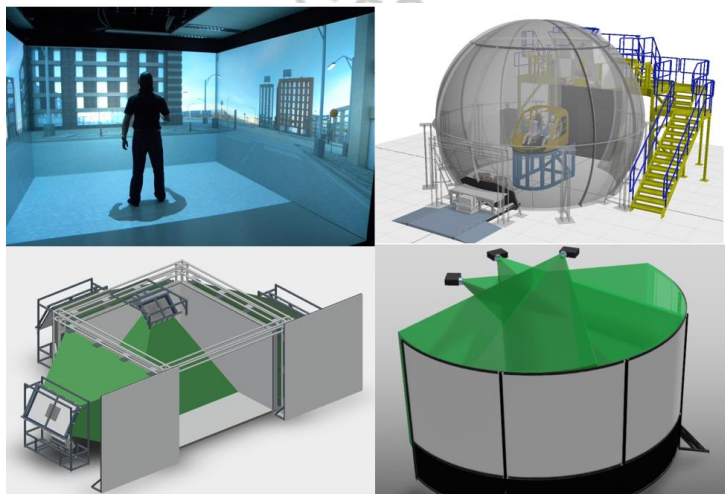
## 9.4 Laser app and tools for precise installations

With our technology partners, Portal Devices, we have the Stellar family of apps and associated Leica 3D DIsto heads to facilitate the entire process of taking complex designs into millimetre perfect installed structures.

(https://visualdisplaysltd.com/solutions/technology/immersive-displays/advanced-laser-measuring-tools-software-and-services).

9.5 Real time design tools for projected displays

With our technology partners, Portal Devices, we have the DPX range of real time design tools. We use these to help clients design projected displays, from simple curved screens to the most complex dome and toroidal displays.

(https://visualdisplaysltd.com/solutions/technology/immersive-displays/design).
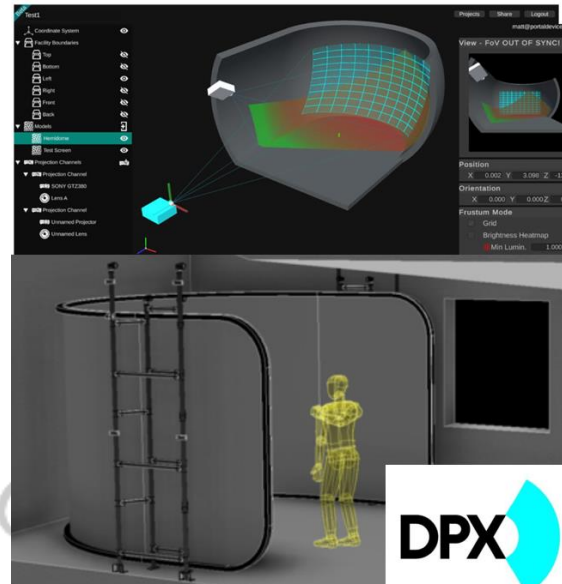
9.6 Roadmap for developing our tools for MTR

Our real-time tools for designing immersive displays will be repurposed and developed into real time 2D and 3D hybrid meeting and teaching room design tools.

A high-level presentation of these systems can be shared under NDA.

10 About Greg Jeffreys

I am a consultant, business owner, writer and teacher.

Apropos this White Paper, I offer short duration consultancy packages. Typically, these comprise:

1. One day looking at or auditing existing spaces, and/or discussion of future needs;
2. One day producing a detailed report;
3. Detailed debrief session and follow-up summary.

Please contact me for further details.

Relevant professional experience:

- 2002. Visiting Lecturer at UMIST (now University of Manchester) writing module on projected images for MSc course Sustainable Electronic Building Design.
- 2007. Founder member of InfoComm Internationals Standards Committee, leading to InfoComm's appointment as ANSI Standards Development Organisation (SDO). I served a full term of four years.
- 2008. Appointed as Director at Large to the board of InfoComm, the global AV association, now AVIXA (https://www.avixa.org/en).
- 2009. Appointed as officer to the board of InfoComm (fixed four year term).
- 2009 – 2011. Task group member co-writer of PISCR (Projected Image System Contrast Ratio) standard
- 2012. President of InfoComm, first non-US person to hold this position. Chaired committee to appoint InfoComm's new CEO, Dave Labuskes, following the retirement of Randy Lemke.
- 2015. Lifetime Achievement Award. Install Awards. https://www.installation-international.com/business/installawards-lifetime-achievement-award-jeffreys , https://www.youtube.com/watch?v=jXIT9wQJFVo
- 2011-2016. Moderator and co-writer of ANSI/INFOCOMM V202.01:2016, Display Image Size for 2D Content in Audiovisual Systems.
- 2016-xxx Current task group member for the new ANSI/InfoComm ISCR Standard
- 2015 -2017. Board member of INFOCOMMASIA Pte Ltd (IAPL), the company that runs InfoComm/AVIXA's Asia-Pacific trade shows and education program.
- 2016- onwards. Specialist consulting projects with Google, UK Government Cabinet Office, Fidelity etc.

- 2018-xxxx. Current task group member on new AVIXA/ANSI Standard on UX (User Experience) in AV Design - https://www.avixa.org/standards/user-experience-design-for-audiovisual .
- 2019. Outstanding Contribution Award at the AV Technology Awards 2020 - https://www.installation-international.com/business/outstanding-contribution-in-depth-with-greg-jeffreys
- 2020-xxxx. Current chair of AVIXA Standards Steering Committee, running and overseeing AVIXA's standards program - https://www.avixa.org/about-avixa/membership/committees-councils/standards-steering-committee .

I write, teach, present and consult, as part of which I travel internationally to support international development of the AV industry, education and standards.