

Suggestions for DIGSS V1.1 Revisions

Gord Harris – Christie Digital - Jan 15/2015

Introduction & Disclaimer

The intended audience for this document is the GSCA Technical Committee and website forum for the DIGSS1.1 standard. I am new to the DIGSS task force but very supportive of the GSCA goal of setting reasonable specifications for viewer experiences “as good as or better than the film-based GS theatres now in place in museums and science centers”. I take that goal seriously and base these recommendations on 24 years direct experience growing IMAX, four years of freelance R&D consulting and ten years of digital experience at Christie. I disclose that I am employed by Christie and in my R&D capacity fairly aware of future capabilities of digital projection, but not expert in our current digital cinema product line or the DCI standards. *Please note I do not speak formally for all of Christie, but informally from my own experience in the GS industry and Simulation/Visualization industries.*

The goal of this document is to make some suggestions for changes to the excellent DIGSS V1.1 document so that it more accurately reflects current and future capabilities. I will focus more on the “Aspirational” specifications so as to not exclude current pioneering GS digital theatres. In general, I feel some of the “acceptable” and “recommended” figures are perhaps a little too lenient to achieve the stated goal from the Introduction section A paragraph 2 (see above). I trust we will discuss these lower limits more in the review process.

I feel we should leverage existing standards such as SMPTE and ANSI/ISO, INFOCOMM etc. as much as possible to save time and energy and to get a broader perspective from industry and academia. One 100,000-foot-level question is whether we should separate the standard for digital capture from that of digital projection, just as SMPTE wrote different standards for camera film vs. projected film. Another example of the idea of separating capture from playback is the 44.1 KHz sampling frequency for CDs even though we cannot hear much beyond 20 KHz at best with young, fresh ears. I feel the industry has been caught up in confusing CGI footage with live-action footage. The industry has also oversimplified the resolution in “K” and fundamentally ignored Nyquist sampling theory that we know is true for both audio AND video (i.e. you have to capture live action in camera at double the highest frequency you are projecting at to avoid sampling artifacts). By and large, digital cameras are behind projector technology.

Another 100,000-foot-level question is whether we should have a separate standard for domes vs. flat screens I think an organization like SMPTE would prefer two shorter standards to one giant one like DIGSS. Here are my suggested initial discussion points for the early “Flat Displays” pages of the spec V1.1: (I will comment on domes and audio separately later):

Feedback on page 1

- Section A - The Introduction looks good and I agree with the goal in paragraph 2.
- I trust we will update the boilerplate intro paragraph 1 when the new version is issued to add to the history.

- Perhaps it's worth adding a further goal along the lines of "to clearly differentiate GS theatres from typical commercial digital cinemas and home cinema experiences." If we get too similar to premium typical "movie theatres" we are in danger of losing the brand of giant screen.
- We must aspire to better than UltraHD (four times HD resolution) TVs now available at home!
- Section B background – we might add note that aspect ratio is not exactly 4:3 but SMPTE standard 419M-2005 projected Aspect Ratio is 1.433:1 (not 1.33:1)
- Not every theatre screen masks identically and at least in IMAX® theatres we established a MIN IMAX (safe action area for titles) and MAX IMAX image area for camera viewfinders so we should note there is a tolerance here.

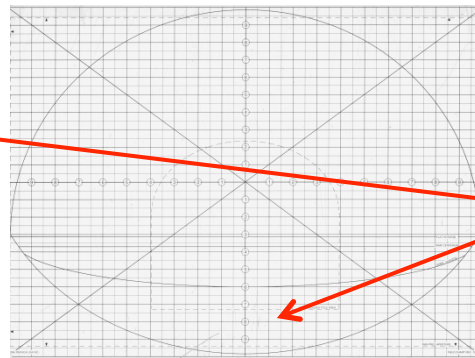
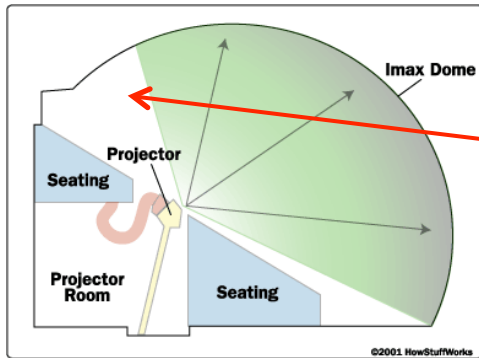
Feedback on page 2

- In paragraph one it is a bit simplistic and misleading to just use the term "4K" for projected resolution as this is just the horizontal resolution. I suggest listing vertical resolution too (e.g. 4K x 3K or 4K x 2K or whatever you actually viewed in that test (assume the latter).
- *As you know we are more often limited by the VERTICAL resolution of current digital cameras and projectors, particularly for domes; it is important*
- Paragraphs 2 and 3 – very good to note this is closer to what SMPTE calls a "recommended practice" or guidelines rather than a rule book or "hard standard" which is almost impossible to enforce.
- C. Goals look good. We could add a sentence to 3 to highlight how standards like this can help and include a caution such as "to prevent uncontrolled and undisciplined expansion of incompatible playback systems that fragment the market and make mastering of "films" more difficult, time-consuming and expensive – as we've seen happen in the full-dome market " - reference the excellent Ed Lantz article: "A survey of Large-Scale Immersive Displays" Aug 2007.
- D The GSCA Giant-Screen Specifications sentence seems reasonable.

Feedback on page 3

- E Changes in DIGSS 1.1 – looks good. I very much like the approach of Acceptable, Recommended or Aspirational.
- In my own previous, independent spec work here for R&D prototypes I used a similar scheme of "must have (can't live without), should have (important differentiators), and could have (niceties and options).
- SMPTE uses conformance language such as "shall", "should" or "may".
- What surprises me is how often when the direction of a project clearly includes those "could have" or "may" aspirational items, our project team will meet many of them with extra work and thinking. For me it seems to be the most important column – a clear vision of intended result and desired ideal goal for future R&D and products.
- We need to encourage people to aim high and not just satisfy the minimum, lowest common denominator "good enough" (Here's a little known fact: – the IMAX film area was actually 13X the area of common 1.85 format film, and 10X the old 4/3 standard, 35mm 4 performance standard, which almost no one ever projected! That's an ORDER OF MAGNITUDE better than prevailing 35 cinema format).

- F Principles – well put in first two paragraphs.
- Third paragraph “...fills the.... entire ‘ceiling’ in the case of domes” This phrase seems to rule out every Omnimax (IMAX DOME®) theatre because the image does NOT fill a full circle or hemisphere or the entire ceiling but is truncated at the back in every 4/3 format theatre like this:

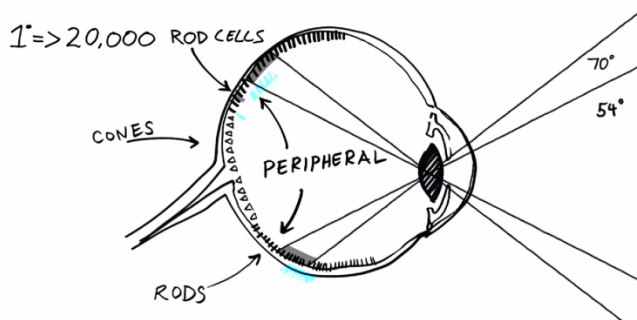
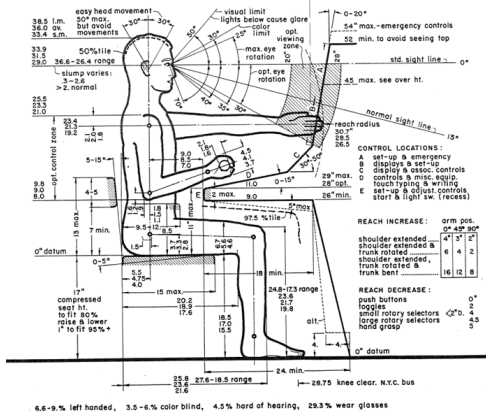


Truncated image areas at back ceiling of “4/3” space theatre dome

- Sources: <http://entertainment.howstuffworks.com/imax1.htm>, and Andrew Oran/Chris Reyna

Feedback on page 4

- Needs a header or set-up note on “how to measure” that states that projector and lamps should be on for a minimum 20 minutes before all measurements, and the room lights turned off. The projector must be calibrated per Table A1 in SMPTE RP 431-2-2011 before the final measurements are made.
- Ideally the ambient light level on the screen should be less than 0.01 fL (aspirational).
- A1 I’m not sure why you call it 1.33:1 as the SMPTE standard 15p70 is 1.433:1.
- I personally disagree with recommending 1.85:1. A key aspect and principle of the original IMAX theatre designs was a good look down angle and wide VFOV. From ergonomics theory this look down angle and VFOV is very important – see here:



- Sources: Dreyfuss: The Measure of Man & [IMAX 101 Theatre Geometry](#).
- Also this makes it a lot harder to differentiate GS from regular cinemas or UltraHD TV. The fact some people have installed them does not necessarily make it acceptable. In the long term, an aspirational goal of full 1.433:1 aspect ratio will drive us to other solutions such as anamorphs or multiple projectors or new projector, camera or chip designs.

- A2 Horizontal image resolution - I believe it's aspirational for cameras at least and should be more like 10K to 11K based on the resolution ability of film and the eye. (ref: my SIM University course on resolution).
- A3 - I believe the aspirational vertical resolution should be more like 7k to 8k not 6k.
- A4 Frame Rate - I believe the aspirational should be 60 Hz 2D and 120 Hz 3D based on my simulation experience and Doug Trumbull's demo. Dynamic resolution is just as important as static resolution and currently strobing is a serious limitation in GS theatres running 24fps material. In simulation we RARELY run anything below 60 fps, and our high end simulations are going to 120 fps even for 2D.
- A6 Luminance Uniformity – I doubt you need 80% - many GS theatres have far worse uniformity but if it is spread out over a wider field angle, for example 90%, the eye has trouble seeing it. It is not the absolute uniformity that is important to the eye but the rate of change of luminance per degree of field angle (i.e. first derivative with regard to angle). Refer to my SIM University course on contrast and brightness)

Note from Kevin Draper: Nitpicky:

1. All through the spec. it refers to Sequential-image contrast, Checkerboard (intraframe) contrast and Luminance Uniformity as "exceeding DCI". This is both true and false. The DCI spec refers to SMPTE RP 431-2. 431-2, in turn, refers to ST 431-1. ST 431-1 defines three categories: Reference, Review Room and Theatre. It is true that the DIGSS numbers are exceeding the Theatre numbers, but they are only meeting the Review Room numbers. You might changing these "exceeds DCI" to be "exceeds DCI Theatre, meets DCI Review Room".
- A7 - For aspirational the eye can see down to a 1% change in luminance and colour over small angles. So while it's very hard to blend this well, I think we should aim for $\geq 99\%$ (ref: Howe, M. SEOS excellent proposal for Dome Standards 2004).
 - A8 - 3D ghosting 15% is totally unacceptable. The peak on axis SNR should be 180:1 or more and the average closer to 64:1 over the whole glasses field angle. I suggest aspirational is $\geq 0.5\%$ ghosting on axis and average $\geq 1.5\%$. I have studied this extensively last in the 30 years.
 - A9 - Sequential image contrast is not so important for flat screens. It is almost impossible to achieve much beyond 100 or 200:1 in real theatres due to reflected light from clothing, faces and ambient light from exit signs, stair treads etc. While it's meaningful for domes and planetarium shows, sequential contrast of projectors over 1000:1 is largely just marketing hype and not necessary. Aspirational of 10,000:1 is fine though. What does SEOS Zorro achieve?
 - A10 Checkerboard contrast – If by that you mean an ANSI checkerboard, I would be surprised if they are really achieving that 150:1 minimum in most existing giant screen theatres with projector in situ (behind ports or whatever), but I have to check my old notes. If you look at the ANSI INFOCOMM_3M-2011 Standard they recommend a minimum of 80:1 for full motion video, which seems more reasonable to me. SMPTE RP 431-2:2011 recommends 100:1 minimum for theatres. We should add a point for stray light and contrast that foot lights, exit signs and so on should not exceed 1.0 fL when directly measured from the audience area. Reflected stray light

from carpet, seats, walls, ceiling etc. should be minimized by low-gain fabrics under say 0.3 lambertian (dark gray) (ref SMPTE 431-1-12006 for D cinema). Black is even better.

- A11 - White chromaticity looks fine. We could reference SMPTE 431-1-2006. I'm not sure about corner uniformity but that sounds pretty tight. Has anyone measured it in a real GS theatre?
- A12 - Pixel structure looks fine but you could bump the minimum up to 87% if you want.
- A13 - Contouring is a little vague, and a lot depends on compression and the bit depth of the source (obviously. 8 bit images can contour) and the spacing on contours. I am not sure we can say "no contouring" under any circumstances. Maybe we could change to aspirational or define better. We need some tolerance. To say "not exhibit any" is a strong absolute.
- A14 - Colour deviation – Again, the term "not exhibit colour deviation" needs to be put into more precise language. There is always some deviation. The question is how much. SMPTE 431-1-2006 section A.5 allows theatres ± 0.015 x and ± 0.015 y of center but those are smaller theatres with smaller screens and not I'm not sure the colour constancy of screens is that good. Aspirational for review room is ± 0.008 x and ± 0.008 y of center

Feedback on page 5

- B1 - Aspect ratio: My personal opinion is we are doing GS a disservice by showing such limited height aspect ratios as 2.39:1 in GS theatres. It does not differentiate us enough from commercial cinema. Do we really need to complicate DIGGS by including these other three ARs?
- B2 - H res. I have similar comments as for A2. We need to separate camera/capture resolution from projected resolution, but our current 4K is 4096 x 2160 projected as a minimum.
- B3 - V res. Being able to see only 1716 vertical pixels on GS is going to look bad. I would not do it.
- My other comments are pretty much the same as for section A so I will not repeat them. My main 100,000-foot-level question is what do we gain by including these in the specs? What we have seems to "ratify" or "endorse" showing 2.4:1 etc. in our GS theatres making them seem just like a giant Cineplex screen. There may be a short-term gain, but does it create a long-term problem for GS theatres?
- C Dome Displays - This whole section is weak and too dependent upon repeating section A's parameters. My recommendation would be to do a totally separate spec for domes since so many factors are different and require totally different thinking and approaches.
- So that my "feedback" doesn't get longer than the spec, I will address domes separately, probably next week. This requires a much deeper discussion.

----more to come here later---

Feedback on page 7

Kevin Draper added these comments: Pg. 7 II. Digital Giant Screen Package A. Flat Displays/B. Alternative Flat Displays 18. Bit rate. 250 Mb/sec (DCI Compliant) – 250 Mb/sec should be considered an "Acceptable" value whereas 450 Mb/sec should be considered as "Recommended". If you are going to be showing high resolution images, especially at HFR frame rates (48 fps/eye) then you want a higher bandwidth. All The Hobbit HFR content was released at 450 Mb/sec.

Feedback on page 9

Kevin Draper added these comments: Pg. 9 III. Audio Specifications All Screens 26. Channels. DCI only mandates 16 channels, not 32 (See DCI DCSS 7.5.6.2). So 16 channels meets DCI and 32 channels exceeds DCI. One final comment. I'm surprised that there is no mention of Object-based Audio (aka Atmos) in this standard. It would seem to be tailor made for these large screen installations, especially domes.

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