Collimated Visual Display – Replacing the BP Screen with Shaped LCD's

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Abstract. Technology is advancing so rapidly that it's difficult to know who is doing what and with whom. Marrying different emerging technologies to produce something tangible is sometimes difficult as those involved at the leading edge of design may not see the practical applications of their labor. Recent developments in flexible LCD design, and the ability to apply LCD's to shaped surfaces raises the question of what the possible application within the simulation field may be

This Paper is a brief window to a future possibility. As a thought exercise it presents the idea of replacing the back projection (BP) screen of a conventional collimated visual display with an LCD panel of the same shape, removing the complexity and cost of the current projection system and the overheads associated with its maintenance. It provides a brief "grass-roots" overview of the support required for current collimated display systems and how such a development could reduce the cost of ownership and improve capability.

1. INTRODUCTION

Google "flexible LCD" and you'll get almost two million hits. Samsung, Toshiba, Philips, ITRI, the list contains some impressive names. So the ability to apply an LCD to a curved surface is out there. And if we examine the performance of current generation HDTV (just check out HDTV playing BluRay™) then it seems that, if not now, then very soon we may see a generational leap forward in flight simulator visual display systems.

So what would this "giant leap forward" most likely look like, and what are the implications to the use and support of Synthetic Training Devices (STD's) should such a progression occur?

2. THE EXPENSE OF COLLIMATED VISUAL DISPLAYS

Firstly, let's do a quick re-cap of where we currently are, and which current visual methodology would most likely be impacted by the development of HD.

Simulators where the trainees are seated in tandem (one behind the other), or side by side, require quite complex and expensive arrangements of projectors and mirrors to achieve the optimum viewing angles and depth of field. These visual display types are usually referred to as being "collimated" as the arrangement of the optics allow the light reflected from the mirror to be "straightened", hence collimated. This gives the displayed image an illusion of depth to about twenty meters, or close enough to infinity as far as the human eye is concerned. These displays are generally constructed as shown in Figure 1.

To obtain the wide Field of View (FOV) required by today's modern simulators it is necessary to use multiple high power projectors to display the image. These require significant effort to seamlessly edge blend the multiple images and to ensure their geometrical accuracy. This is also compounded by issues of variance in luminosity, colour, contrast, etc.

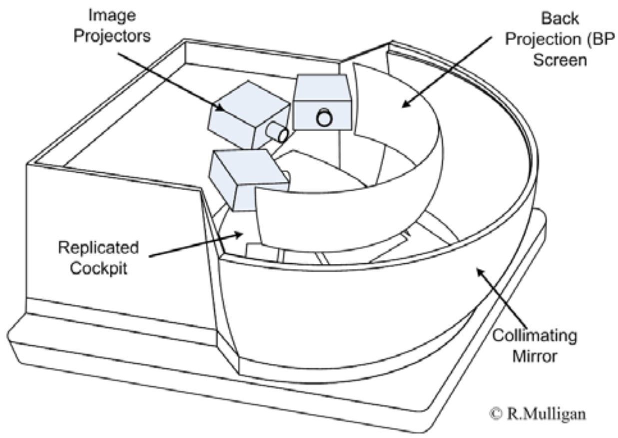

Figure 1 – Typical Collimated Display Configuration

So due to the complexity of the optical and image alignments these displays are traditionally very expensive to acquire and consume a significant portion of any support effort.

But why is this? Why are they so expensive to support? Well in a nutshell the image is created at a very fine resolution (Dots per inch or DPI). A conventional commercial flight simulator's Field of View (FOV) is in the order of 180^0 horizontal by 40^0 vertical, with later generations topping at a massive 200^0 x 60^0 or more. This FOV is nominally provided by three projectors (but can be as many as eight). Therefore in our conventional example, each projector is generating a FOV of about 60^0 Horizontal by 40^0 vertical (ignoring any edge blending). Now consider the resolution of the image being viewed from the perspective of the viewer. Imagine how big a TV would have to be to give an unpixelated image 60^0 wide and 40^0 high at a distance of approximately 20 meters, which is the binocular distance of the average collimated display cell. True, each pixel could be relatively large at that distance, but the size of the image is quite staggering. Now imagine how small each of these pixels would be when squeezed into the 40mm square projector's image generation plate. It doesn't take a rocket scientist to see that the most miniscule of distortion in the projector would produce a noticeable change to the alignment of the viewed image. With the intensity levels required to produce daylight images on the "big" screen the electronics is under considerable stress.

As we continually attempt to squeeze more and more from these devices they are constantly operating at the limits of their design. The outcome of this is "drift" or changes to the image intensity, geometry, colour, etc. even across the image contained in the one projector. Now imagine trying to match these aspects between projectors. Especially if one fails and is replaced with by one significantly newer. These are the issues facing support personnel every day.

3. THE AUTO ALIGNMENT BAND-AID

To alleviate the problems and to simplify the support liability, expensive and complex "auto alignment" tools have been devised, often involving a static method (such as slide projectors) for displaying a grid comprising a series of light points. These are registered by cameras fitted to the inside of the display cell. These cameras then provide input to a computer system which adjusts light points projected by the image projectors across a matching gird, providing geometrical convergence. Similar toolins are also available for setting and matching colour luminosity etc.. And all of these tools themselves need to be calibrated.

How much simpler then if you could dispense with all of this. And this is where the future of curved high definition LCD screens may take us.

4. A JOURNEY OF THE MIND

Join me on an imaginary journey where the projectors and all their associated power supplies and complex alignment equipment are removed… And where the BP screen has been replaced by a curved LCD panel of the same shape, as shown in Figure 2, providing not only a new generation of display cells but fueling a veritable "blitz of retro fits".

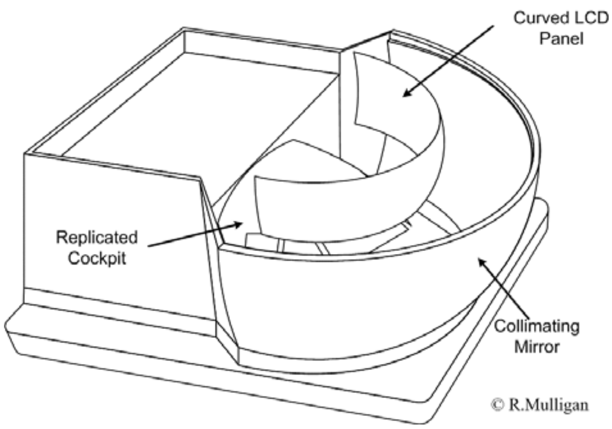

Figure 2 –Collimated Display With Curved LCD

It is immediately obvious that we have increased the size of each pixel where it is generated. No longer is the generating area 40mm square it is now (for a 3 projector system) 1/3 of the BP screen!! And of greater significance, the geometry of the image is now physically fixed and cannot drift!! We have replaced 3 plus individual image projectors with one image generating curved screen. No more edge blending, geometrical alignments, or colour matching.

The retro fit aspect is of singular simplicity as the original BP screen shape and matching collimated mirror are all retained. Leaving only the issue of a change to the center of gravity (CoG) and what to do with all those excess support hours and dollars.

5. SO WHAT'S THE CATCH?

So what's the catch? Well, there's always a catch.

For starters the screen would be big. And the number of pixels for the full screen would be huge. A far greater number than on anything commercially available today. Also the intensity levels may not be sufficient to generate realistic daylight scenery.

And we'd need an Image Generator (IG) capable of generating the whole image in one bang. Even with current leading edge IG technologies we are struggling with the density and complexity of the current databases. This is primarily because the more "grunt" out IG's can produce, the more complex we make our visual scenes.

A special LCD display, with seamless joins between the images would solve the problem, but again it's a matter of physical design, and of course the will to produce it.

6. SUMMARY

This paper is a thought exercise, and depending on the level of interest generated, the beginning of a more detailed study. It has been authored to highlight that the technology is out there. Perhaps not at the level to make this a reality just yet, but certainly heading in the direction to make the current projection technology "old hat".

7. CONCLUSION

I'd like to believe that given the right incentive an LCD such as this could be produced, even if initially only for very limited FOV. With lightweight mylar mirrors, it might bring collimated single IG display cells into the realm of affordability for quite rudimentary simulations and trainers. Certainly extending into applications other than flight.