Why Multiple Displays are (much) Better than VR Headsets

There is increasing interest in using "Virtual Reality" (VR) Headsets such as Meta's "Quest" for video gaming [1] and simulator-based training.

The idea is simple: when you turn your head, movement is detected by "head-tracking" electronics in the VR headset, and then what you see on the two small displays in front of your eyes (inside the VR Headset) changes accordingly.

But a recent review of the scientific research about using VR Headsets for education and training [4] concluded that when it comes to developing the psycho-motor skills required for operating heavy equipment, VR Headsets have "... no advantage [compared to multiple displays] and in some cases even proved counter-productive because of widespread cyber-sickness, technological challenges, or because the VR experience distracted from the learning task."

The most obvious symptom of "cyber-sickness" is nausea, but other symptoms include disorientation, eye strain (blurred vision), vertigo, dizziness, fatigue and headache, even hours later [6].

One automotive manufacturer told us that he had to "mothball" his VR Headset simulator because 80% of trainees experienced such symptoms. And that's why he concluded by telling me this: "If I can't use the VR Headset with everyone, then I have to use it with no one."

And the "susceptibility" to cyber-sickness will vary with age, health status, and even gender [6].

Practically, cyber-sickness is due to two problems [2], [3].

About Field of View

Consider this: more of your brain is devoted to processing what you see, than the combination of what you hear and touch and smell.

Our visual field of view is about 200 degrees left/right, and about 160 degrees up/down [5]. "Central" vision is what's right in front of you, i.e. a viewing angle of about 5 degrees, so everything else is "peripheral" vision. And that peripheral vision is especially important for performing psycho-motor tasks [5].

Consider learning how to operate an excavator to load a truck. In the real world, you rely on your central vision to "watch" the excavator's bucket, but you rely on your peripheral vision to guide the directional movement of that bucket from the trench to the truck box. So that's what should also happen in the simulated world.

But with a VR Headset, your field of view is mostly limited to seeing what's directly in front of you, much like the "blinders" that prevent thoroughbred horses from seeing side-to-side. For that reason, with a VR Headset, you must turn your head to "see" left /right and up/down. This, of course, makes it difficult, in the simulated world, to rely on peripheral vision to guide the bucket of the simulated excavator from the (simulated) trench to the (simulated) truck box.

Of course operating heavy equipment more often involves more than just a single object e.g. the excavator's bucket, moving at some distance in front of you e.g. at the end of a long, articulated, boom.

Consider now a simulated forklift at work in a "crowded" simulated warehouse. As you drive down the aisle in the simulated cab, the loads on either side seem to move backwards (as you drive forwards, past them).

Now because the VR Headset's field of view is so limited, all that "motion" fills up your viewing angle, and "tells" your brain that your body should be mov-

ing too (but it's not). It is this "mis-match" that "triggers" the cyber-sickness previously described. Moreover, the effect becomes more pronounced as you drive faster, making objects "move" faster.

About Training Simulation and Real-Time Interactivity

The second problem with using VR Headsets is the time delay between turning your head and "seeing" in the new direction (also called "lag" or "latency"), because "ordinary" computers can't "keep up" with typical head movements [6]. Even a very small lag will be noticed, and contribute to the "cyber-sickness" problem.

Here are the technical details: "frame rate" refers to the number of times, per second, that the head-tracking "notices" movement, the computational elements "decide" what to change now that you are looking in a new direction, performs lots of calculations associated with those changes, and finally "re-draw" what you see inside the VR Headset. To avoid cyber-sickness, the frame rate must be very high (at least 90 Hz, often 120 Hz), and that requires lots of computing horsepower.

For that reason, even a "stand-alone" VR Headset with an onboard computer that works well enough when playing a video game (e.g. to shoot a simulated weapon at a simulated target) still needs the "help" of an external computer via a cable or "tether" (wireless connections are too slow) for optimal performance [1]. For example, Meta's "Quest" increases its frame rate from 72Hz to 90Hz when an external computer is "helping".

(Of course you can reduce the computing "load" to use just the onboard computer (so no "tether") by making the simulation graphics and physics "cartoon-ish", but doing that will greatly reduce the training help provided.)

Practically, you can mitigate the time delay problem in two ways: first, by learning to turn your head s-l-o-w-l-y, and second, by training for just a few minutes at a time, and not every day [6]. Clearly, both "solutions" greatly impact simulator-based training.

Why Multiple Displays are (much) Better for Training Simulation

In the real world, you can turn your head as quickly as you want and you always see something new, i.e. there is no "time delay".

More importantly, when you look forwards, you see not just forwards but also left/right and up/down. And as previously indicated, because that peripheral vision is key to operating heavy equipment, preserving that "natural" field of view is vital for real world work and therefore for simulator-based training.

With Simlog, you can set up three "big screen" displays in front of the simulator controls to provide a panoramic field of view of 180 degrees. (When it's important to turn your head to look backwards when moving backwards, just add another "big screen" display set up behind the simulator controls.)

Fortunately, the growing popularity of home entertainment systems has brought the price of off-the-shelf HD (UHD, and now 4K) "flat screen" TVs within the reach of every training budget, even as the size of popular models continues to increase from 42" to 55" to 65" to even 75" or more. Indeed, bigger displays "fill up" more of your field of view, making the simulation experience more "immersive".

And you'll find that the price of four such displays can often be less than the price of a single VR Headset.

Six More Reasons Why Multiple Displays are (much) Better

We can identify six additional limitations associated with VR Headsets.

1. Wearing a VR Headset limits what you see to just the simulated world. For this reason, it can be difficult, for example, to reach for a forklift lever with your right hand (in the real world) because you cannot "see" the lever or your hand. More expensive VR Headsets overcome this problem by adding cameras to "superimpose" what the cameras "see" on top of the simulated world to create "augmented reality", at added cost. Of course, this also means that you will "notice" everything the cameras "see", so not just the lever you want to move, but everything around the lever too, and that will necessarily reduce the sense of "immersion" in the simulated world.
2. If you wear glasses, you may have problems "fitting" the VR Headset on top of them, because some models are too narrow to accommodate the wider frame designs that have become very popular [1].
3. The weight on your head, and the display fitting tightly over your eyes (to block out the real world around you), can make VR Headsets uncomfortable to wear for the extended periods of time required for simulator-based training.

4. As previously indicated, even "stand-alone" VR Headsets must be typically connected to an external computer for optimal performance, and that cable can "get in the way" when you move your head.
5. When wearing a VR Headset, only you can "see" what's going on. So, if you want a second trainee to learn by watching the first trainee, or if you want your instructor to monitor the simulated work, you will need to add a conventional display at additional cost.
6. When sharing a single simulator "station" among many trainees, the VR Headset must be adjusted each time (everyone's head is different), and that means extra wear-and-tear that can quickly lead to damage, not to mention problems associated with personal hygiene. (This is especially problematic, since COVID-19 is still with us.)

Clearly, using multiple displays has none of these limitations.

The Bottom Line

Because what you see is so important, multiple "big screen" displays will always deliver superior support for hour-after-hour simulator-based training.

The fact is, today's VR Headsets are simply too "primitive", too fragile, and present too many visual limitations for "industrial strength" simulator-based training. And although that technology is improving (slowly), off-the-shelf "flat screen" TVs are increasing in size much faster, and at prices that continue to fall (even as the price of high-end VR Headsets continues to rise). Practically, this means that "filling up" your field of view with multiple displays has never been so affordable.

References

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