The Future of Helmet-mounted Displays for Hypersonic Aircraft (from a technological and logistical standpoint)

The Blackbird SR-71 was an aircraft developed by Lockheed for the United States Air Force during the Cold War, flying over Russia at speeds of Mach 3 (supersonic) and beyond to survey and gather intel from the skies.

It's speed gave it even greater stealth so Russian systems were unable to detect it. Imagine this plane but with modern AR technology and an even greater top speed.

What is an HMD? A Helmet Mounted Display is an augmented reality screen attached to a helmet which overlays data and information on a real-world environment to provide the user with data and information.

Helmet-mounted displays have been used for some time in the military sector, whether it be by a tank or APC driver to help analyse terrain; on a fighter pilot to help locate targets and keep track of the aircraft's orientation or worn by infantrymen to help spot enemy forces and monitor injuries and weapon information. Today, the military and companies such as Boeing and Virgin are developing hypersonic aircraft for surveillance and cross-continent flights. This case study will focus on how I believe the HMD can be further developed and improved to suit the new, faster aircraft.

One of the new features would be the ability to look around and 'see through' the cockpit walls so that the pilot can keep track of objects at all times. I would adapt the design by fitting cameras on the exterior of the aircraft and, upon a button toggle, all the camera feeds would be merged into an augmented world where the outline of the cockpit walls were still visible. This would allow the pilot to effectively 'see through' them while also knowing where they are, creating a 360 degree field of vision and the ability to keep track of where they are going and the direction they are facing.

Technology like this would come at immense cost however. The plane would require hundreds of high-resolution, damping proof cameras with a near real-time response rate because at 3800mph (Mach 5), a millisecond could be the difference between life and death. The feed would be transmitted through a wired connection to the pilot's helmet and be overlaid on the real world.

Although it could limit mobility inside the cockpit, a wired connection is the only possible solution as wireless transmission times are nowhere near yet fast enough to cope with the required load. The testing of this technology would also be very expensive because the only accurate way to simulate hypersonic speeds is to conduct real time testing. This incurs huge costs such as fuel, coolant, oxidant, maintenance and pilot training.

Another issue during development is the data retrieval. When testing this hardware, there will need to be some sort of temporary black box to keep a record of the transmission speeds, transmitted data and current aircraft and atmospheric conditions. It would be impossible for the box to store what amounts to multiple streams of real-time data, so it needs to have some form of advanced algorithm to enable repeated data results to be deleted and ensure data is retrieved under different conditions and loads.

Because this algorithm needs to decide what to keep, it needs to be somewhat intelligent, an artificially intelligent compression algorithm, if you will. To develop and deploy this would come at huge expense.

It is important to note that this technology needs to be Optical see-through as opposed to Video see-through. The main reason for this being that a Video see-through AR display is subject to parallax. Because, the plane would be flying at 5 times the speed of sound, parallax can become a real issue as it can act as 'real life lag' and the pilot's surroundings may not be exactly as he or she sees it. Although Optical see-through displays are the more expensive option, they will display the world in real resolution, free from parallax.

Another new feature of the HMDs would be the ability to overlay an abstracted world map onto the pilot's lap, Google Maps style. This is beneficial for pilot surveillance. Technology like this already exsists in the form of Land Rover's Head-Up Display. This technolgy is fitted to the latest Land Rovers and enables the driver to 'see-through' the bonnet so they can see the terrain directly underneath it.[1] Although this is similar, it would not be fit for hypersonic aircraft because the cameras would not have a quick enough refresh rate.

Because these planes will be flying at hypersonic speeds, their design will have to overcome additional challenges, such as air flow, heat resistance and engine performance.

However, the issue I want to focus on is differing atmospheric levels. From an engineering perspective, it is important that a hypersonic aircraft does not fly higher than the stratosphere as this can lead to many problems occuring, amongst which is the fact that the air becomes too thin, meaning that the engine can't take in enough, causing it to stall. To ensure the pilot does not fly higher than 50km (roughly 160000ft) the HMDs can be equipped with another mode that will project two thin lines running from the pilot's eyes to the sky directly onto their flight path. If the aircraft is approaching its maximum altitude, the lines will turn amber and, if the pilot is at, or exceeding, the maximum altitude, the lines will turn red. This feature is similar to those used in Microsoft's Hololens. On the Hololens, visual data is augmented on the real world.[2] Because this is an exsisting piece of technology, devlopment wouldn't be financially taxing and would be easy to test.

I will link the head-mounted display to the plane's computer system so that, in this instance, the pilot will also receive an audible warning from the cockpit as well as the visual one through the HMD. This mode will not only help to keep the pilot and aircraft safe but is also financially viable. It would, however, rely on an accurate altitude reading!

The obvious risk with combining all of this functionality on a single display is it would be very crowded and likely *hinder* the pilot's sight rather than *improve* it. To solve this, I would build it in such a way that the display only shows one mode at a time and the pilot can toggle a button to circle through those modes. This allows the pilot to actually see where they're going as well as providing them with an additional aid which doesn't obsure their vision.