The Future Fusion of Virtuality and Reality

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THE YEAR is *2000 PLUS 84* in a time where man has successfully blurred the difference between what is real with what is virtual. While technologists say they have triumphed, others are not so sure.

Man has been attempting to capture, preserve and replay experiences for tens of thousands of years beginning with crude but artful cave drawings. These early sketches could only convey a simple "reality", perhaps an animal, or even the action of a hunt. Initially absent, were color and the 3rd dimension. After countless millennia, color, motion and sound were added using ever-advancing technology. While statues and carvings had three dimensions, they were static figures with few exceptions such as mechanical contrivances, that while clever, were limited imitations of real life.

Motion pictures became the mainstream virtual reality as they advanced with color, audio, odor and eventually 3D. Many recognized that adding the 3rd dimension was essential, but technically challenging during the 20th century. Simple gimmicks, like color filter eyeglasses, and even polarizing lenses, could only hint of what might come. But by 2010, more realistic 3D had become the rage based on the elegantly simple principle of right-left eye synchronized *active shutter* eyewear. Each eye alternately received a complete but slightly different image at a high data rate that was enabled by MOEMS (MicroOptoElectroMechanical Systems) devices for cinema projectors and some HDTVs. But by 2011, most TV makers were able to obtain a suitably rapid image-switching rate from LCDs so that the 3D revolution could tap into existing technology with only minor modifications rather than use a true breakthrough. 3D was widely embraced to become the *de facto* standard by 2015. And while building a MOEMS chip with over a million individually addressable movable mirrors, or boosting LCD rates to 240Hz and beyond was impressive back then, future advancements would move far beyond inorganic "workhorse" silicon technology as we'll see later.

So what about personal products like ubiquitous smart phones and the myriad of wearable wonders? The same shutter glasses could be applied here and by 2020, these products standardized on 3D. But since glasses were required, wireless 3D video display eyewear won out. These glasses provided right and left eye images through a wireless interface that was as realistic as a 70-inch 3D-HDTV. The obvious next level was to invent "naked eye" 3D. By 2025, PB-3D (parallax barrier) technology allowed the viewer to see the 3D images without special glasses. The popular OLED displays applied nanotechnology to subdivide the image into complex repeating segments appearing as 3D when viewed and integrated by human binocular vision; the left and right eyes received different images. As we approached the halfway point of the century, virtual reality had come far, but still had a long way to go.

A major complaint was the small screen for naked eye handheld products and the need to wear active shutter glasses for big screens. But a breakthrough was made around 2040 in contact display products. The idea was at least 30-years old, but the multiple challenges of transparent electronics, invisible power supplies and extremely small pixels had delayed commercialization. Organic electronics, still the dominant technology today,

transparent batteries, or inductive through-space powering, and nanoscale optics, were cleverly combined to provide this next level or virtuality. The thin compliant contacts provided near-perfect 3D images using high-speed data transmission from the wearable product. Early models required that hardware be worn as a necklace to reduce the range for the low-power high-bandwidth requirement of the gigapixel contacts. While most were satisfied with wireless contact 3D, the "realists" wanted *total virtuality*.

A brain-computer-interface, or direct neural interface (DNI), would be the "killer app", and perhaps the final breakthrough. DNI would be the holy grail of total virtuality. The two competing DNI approaches throughout the 2050's, were implant vs. non-invasive. Device implantation had long been considered the best way to bring the customer real virtuality. The idea of placing an electronic chip within a live body, while controversial, had been around for nearly a century. RFID chips had been implanted in animals and even humans but no interface was required. But add the task of interfacing such dissimilar systems and the idea of implanting a device that can bring video, audio and other sensations directly to the brain, and the challenge increases by orders of magnitude.

Advances in hybrid neuron-semiconductor devices afforded sufficient biocompatibility making direct-connect to the brain possible, but completely impractical from a commercial point of view. Other work that used noninvasive brain-wave read-write also held promise but required careful placement of external electrodes. Finally, biotech nano-engineering provided an unexpected solution. Totally organic biofilm circuits were developed that could be grafted to the skin. The body-powered biocircuits served as electrodes but also provided a wireless interface to electronic hardware. Once a biocircuit was crafted using molecular nano-manipulation, replicates could be economically produced by the millions. While skin patch films were successful, a biosphere version that could be injected under the scalp became the standard. Although the DNI biosphere installation required medical specialists, it was a onetime event akin to getting a tattoo. Upgrades were at the hardware level and a wide assortment of DNI-compatible products was offered throughout the 70's. By 2084, every sense could be recorded, edited, synthesized and played into the brains of individuals with the DNI interface. Brainware programmers could create a new life, a parallel virtuality. Since actual sense organs were bypassed, the sightless could see and the deaf could hear. All that remained was to deal with the lengthening list of unintended consequences brought on by *Total Virtuality*.

"Now I do not know whether I was then a man dreaming I was a butterfly, or whether I am now a butterfly, dreaming I am a man." Zhuang Zhou.