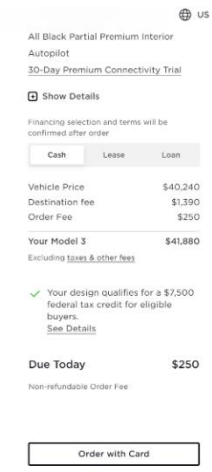
Virtual reality for vehicle inspection and configuration

Report based survey and project done by Łukasz Kur (CS, UJ) with help of Maria Starowicz (FAIS, UJ)

Introduction

With the rapid adaptation of virtual- and augmented reality technology into the mainstream, it is not only becoming another way to experience media, but also things that may be directly utilitarian. From digital workspaces, to navigation assistance, VR/AR technology is very much the so-called "next big thing". Thus, many industries have already adapted this technology in ways that assist in the workspace. One such is the automotive industry, where VR/AR is used in the design evaluation process, as well as an assistant to a car mechanic's workflow. As this technology is very much already in use and being practically proven as viable for enterprise use, there is no reason to further emphasize its importance. As mentioned in the beginning however, it is much in the realm of "cutting-edge" for casual use, unlike computers or smartphones. The casual users may find themselves using the beforementioned technology to view a vehicle via configurator, look at its specifications or (only in recent years) purchase a vehicle much in the same sense one purchases something on Amazon (*as seen in the Tesla configurator on the right*).

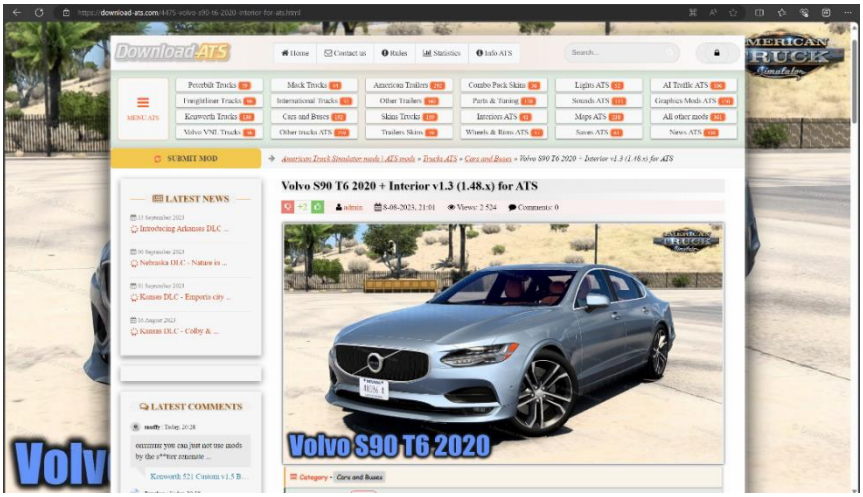


We are thus looking for the potential of virtual reality technology in the purchasing experience of a vehicle, where many ideas arise - is VR better in showing the vehicle, its details, proportions? Or maybe could it replace the whole need of car showrooms? To answer a few of such questions, we have prepared a full-scale model of a Volvo S90 in Unity[1], where users can freely look around the vehicle in virtual reality and compare that experience to the one it could potentially replace – a

[1] https://youtu.be/KzaC5hQxjDQ

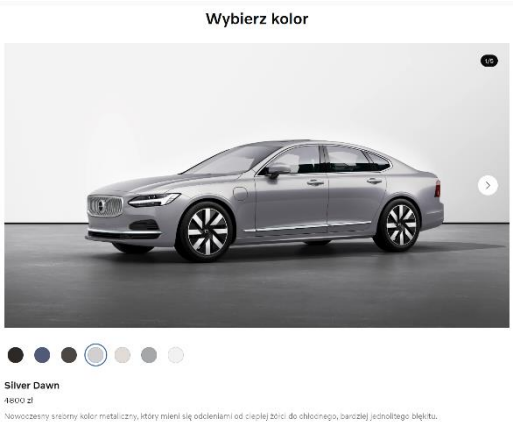
browser based car configurator of the same make and model[2]. The VR headset in question was a Meta Quest 2 connected via Link to a Windows PC running the Unity game engine. The users had no controllers in hand, as hand tracking was sufficient. Users could view the whole car inside out and choose an exterior colour by telling the moderator. The same PC was used to access the official polish Volvo website car configurator. After both viewings, there was a short interview on the users' experience. 16 volunteers have attempted such vehicle configuration through the aforementioned methods, with 6 falling in the age range of 22-26, another 6 in the 30-40 age group, and the final 4 being 55+.

One of the more important technicalities - the car model - was relatively easy to find, though behind a paywall. This of course is there for professional users, such as architects preparing a render of a neighbourhood. For purposes such as this, there is a way around that, without painstakingly modelling the vehicle manually in programmes such as Blender – modding forums for different car-related videogames have a plethora of real-life car models ready to download for use in said videogames. One such website forum is *ets2mods.pl* & *download-ats.com* from which we have acquired the necessary model for our basic educational needs (*as shown on the left*). The selection of the rendering engine Unity was motivated by its support of VR goggles, easy environmental modification such as lighting and user movement (unlike in Blender itself). The car model itself was not interactable due to its complexity, other than the outside colour changes.



[2] Skonfiguruj swoje S90 Recharge | Volvo Cars Polska

Virtual reality & conventional car interaction in practice



The users are first shown the official browser configurator for the Volvo S90 (*on the right)*. They were free to play around with the interface and configure their car. At least 4 of the users found themselves choosing options of the vehicle, which are not even optional, suggesting that it was a sort of role-playing experience, where if they were to be able to purchase the Volvo, they would like to specify such and such options. Some of the users also sat down behind the screen with the configurator open with some confusion visible, as to what challenge they are expected to face. After a quick explanation, that they should just play around and experience the interface fully, they then interacted with it without any issues.

After the browser experience came the VR interaction (*on the left*). All of the users were visibly at awe due to the technology's immersive properties during the first few seconds of use. As if by scripted sequence, the users firstly looked around their head. Then they tried to focus their attention to details which were not available in the web configurator, that being the Unity skybox or panoramic sunroof. Then some tried moving around by stepping around, driven by curiosity. After taking off the VR headset, most felt very positive about the experience, praising the immersion and detail. Due to the static nature of the interior, none have mentioned to experience any discomfort. Whilst moving around the exterior, controlled in-engine by the moderator at the PC, they were asked to close their eyes during movement. This was to eliminate any possible motion sickness.

The users' opinions on the experiences

The users in the 22-26 age group were all familiar with the concepts of virtual reality, having experienced it in one way or the other. Two of the six were owners of VR headsets, though they would use them rarely.

Only two out of the six users found that it was less comfortable to look around the vehicle in VR – this was in both instances blamed on the lack of freedom in movement. The rest mentioned however, that they did found more comfort in VR, as there was complete freedom in the head movement, making it possible to peek into areas not visible in pictures on the website.

Furthermore, all users found it very much comfortable to *sit down* in the car, calmly look around and take in the details, which resulted in them noticing things not visible in the browser equivalent – some of those details being the rear air vents, the charging port being on the front fender or the details in the footwells.

Another critical detail in a car's design are proportions, which need to be properly represented and scaled in VR. This detail was noticed by half of the contestants – as in the necessity of the vehicle to be properly scaled into the digital world.

To summarise the experience, users were asked how they find the VR *showroom* compared to the browser one overall. One responded indifferently. Four mentioned the necessity of having the proper hardware, but other than that, they found it much better than the browser experience. The last user was overall very positive about the VR experience.

The users in the 30-40 age group were also all familiar with the concept of virtual reality, all of them also experiencing it in one way or the other. None used a VR headset on a regular basis.

When it comes to the comfort of viewing the car in VR, only one person stated that it was less comfortable due to the Meta Quest 2's known lacking IPD configuration. Another user did not directly confirm that it was more comfortable, though she found it was more attractive, engaging and time better spent that in the web browser. The other 4 people found the VR experience more comfortable than the web browser one, due to more freedom.

Similarly to the earlier age group, users have found themselves looking into nooks and crannies of the vehicle's interior, finding details they would have not recognised in the 2D application.

When it comes to the proportions, two out of the six users mentioned that the car felt bigger than it probably was. One user however, found that the car was represented as bigger in the web browser application.

All of the users in this age group found the VR experience to be overall better that the 2D one. Some mentioned the possibility of purchasing a VR headset themselves. None mentioned the necessity of proper hardware, unlike in the earlier age group.

The users in the 55+ age group, similarly to the ones before, were all familiar with virtual reality technology. None used the headset on a regular basis. One user reported to have been shown a VR headset in the past.

When asked if VR was more comfortable when viewing the car, all of the users answered with an overall positive answer. All of them mentioned one caveat however – that being the setup process of the headset. Such process is indirectly part of the experience, thus counts as valid and valuable points about the future of mainstream VR implementation.

Two out of the four participants did not feel particularly motivated to look around for details as observed in the younger age groups, though they very much appreciated the vehicle as a whole. The other two users were indeed more immersed in the experience.

All of the users also liked the representation of space and proportions, though two have mentioned that the scaling seemed a bit off. They could not exactly pinpoint where.

As a whole, the older generations found it to be a very pleasant experience, even with the above mentioned small setbacks. The users were the most optimistic about the technology, mentioning the power and potential of virtual reality.

Opinions on VR technology potential

A second batch of questions was formed around the potential of virtual reality to replace certain aspects of the purchasing process of one's vehicle, which were asked after the browser/VR experience – these questions and answers were as follows:

1. Do you see VR as sufficient for...

    a. independent inspections/reviews (with the help of a tutorial) from home?

        The 22-26 age group – 5 out of 6 answered positively. One person stated, that she needs to feel the materials used inside of the car.

        The 30-40 age group – all answered positively, with one user stating the potential time saving.

        The 55+ age group – all answered positively.

    b. independent vehicle configuration from home?[3]

        The 22-26 age group – all answered somewhat positively, with the emphasis that it is indeed better than the web browser. Half mentioned the necessity of proper scale, colour representation, thus suggesting that some real life elements may be hard to reconstruct.

        The 30-40 age group – all answered very positively.

        The 55+ age group – all answered positively.

    c. independent vehicle ordering from home (potentially to your doorstep)?

        The 22-26 age group – half answered no, stating the need to see a car in person before purchase, with the other half stating that it may very well be viable in the future.

        The 30-40 age group – 4 out of 6 stated that it may be viable and they see themselves ordering a car like that in the future (some mentioned the need of a return window, much like when ordering online). Two people answered with no, stating the need to see the car in person.

[3] Much like the web browser configurators.

The 55+ age group – 1 out of 4 users stated that it may be viable in the future. The others did not see a possibility of ordering a vehicle before seeing it in real life beforehand.

2. Do you see the potential for VR technology to replace...

a. physical showroom locations entirely?

The 22-26 age group – all answered negatively. The users felt there must be some sort of alternative way to view a car in reality before purchase.

The 30-40 age group – 5 out of 6 people answered positively, but there must be some sort of quality guarantee or right to return. One user answered negatively.

The 55+ age group – all answered negatively, stating that there must be some sort of way to look at a car before purchase.

b. locations with limited space, such as in city centres?[4]

The 22-26 age group – all answered positively, if there is some sort of warehouse/showroom to see a vehicle in person.

The 30-40 age group – all answered positively, some stating that it would be a huge time saver when looking for a car. Like the age group above, there must be some warehouse/showroom to see a vehicle in person.

The 55+ age group – once again, all were positive to the idea, yet there must be some main showroom to see a vehicle in person.

c. pre-purchase test drives?

The 22-26 age group – all were negative. Users stated, that they cannot see a viable simulator, which could emulate how a car behaves or what noises it makes (suspension, wind- and tire noise etc.).

The 30-40 age group – all were also negative, stating the above similarly. One person mentioned however, that with the rise of electric cars, the differences between cars are going to be very minor, thus VR test drives could be enough.

[4] Showrooms were to be only at the outskirts of the city, much like warehouses.

The 55+ age group – once again, all were negative. Users did not see a viable way of emulating the feel of different vehicles.

Conclusions

In conclusion, while users were generally very optimistic about stepping into a virtual reality vehicle configurator, the technology still has its caveats in terms of execution – such being the setup and overall lack of mainstream support. Similarly, in future applications, the possibilities of what can and cannot be simulated were indeed asked (test drives, interior materials etc.). Yet, once again, the immersion and freedom of movement, looking for places and spaces not shown in press photos or official configurators, left the users with a good idea of the potential of the VR technology. Some users felt a natural need to stand up, move around their bodies to try and see all that is to be seen.

It is important to note that such car viewing is obviously only viable with new cars. The complexity and cost which a car brings, are only further emphasised when purchasing a used vehicle. Furthermore, a car purchase is indeed a big investment for most people, which was reflected somewhat in the different age groups' opinions on a door-to-door purchase via VR.

As a last, personal note, vehicle configurators did not evolve much since around the 2010s. The system still bases mostly around still pictures or renders, chosen by the manufacturer (Volvo[5], Porsche[6]). Some however, give a chance of a 360 view, which ironically, are sometimes more limiting due to frustrating controls (Mercedes[7], BMW[8]). It is worth mentioning that there is one very well executed web browser configurator – Audi's[9]. It offers a free view around a real time render of the car, whilst also being interactive. This could very well be the ideal configurator as proposed here, only with the step of implementing virtual reality support.

[5] Skonfiguruj swoje S90 Recharge | Volvo Cars Polska
[6] Porsche Polska – Cayenne
[7] Konfigurator i ceny | Mercedes-Benz
[8] Konfigurator (bmw.pl)
[9] Stylistyka > RS 5 Sportback > A5 > Audi Polska | Przewaga dzięki technice

Details to improve for future surveys and research

Further projects could evolve onto being more interactive in the virtual reality implementation, similar to that in the Audi configurator or videogames. This meaning, more freedom of movement, better details (modelled luggage compartments) or a panel to select colours, wheels etc. by users themselves. A larger group of users on which we could do research would result in further steps of improvement of the VR technology. Another point of to mention would be of course be the novelty effect VR has, even for people who used it before. It is neither people's, nor the technology's fault per say, but it is still very much recognizable and to be taken into account when trying to be most objective. Lastly, a partnership with a car showroom/dealer could mean, that we could research the viability of VR headsets in car configuration on the main demographic – people looking to purchase a new vehicle.