EXPLORING THE VIRTUAL WORLDS OF ADVERGAMING

Chris Boyd
Malwarebytes, UK

Email cboyd@malwarebytes.com

ABSTRACT

The games market was worth US$90+ billion in 2016, and with an estimated billion hours a month globally spent playing mobile games alone [1], there has never been such great opportunity for making money where in-game advertising is concerned. However, that desire for profit also comes with problems for device owners, who frequently find themselves at the mercy of poor disclosure and intrusive advertising.

As adverts in gaming ('advergaming') ecosystems continue to become more sophisticated, so the potential complications grow for parents, children and gamers, who just want to play without having to worry about where their data is going (and how it is being used). Ad-blocking attempts in games have resulted in ads being embedded in such ways that they can't easily be removed, and the rise of new ad technologies in virtual reality (VR) raises questions about the visceral, direct nature of this form of communication.

In this paper, I look at:

- The value and origin of advergaming
- Convergence, ad types, cross-device buy in
- Heat maps, ad positions, achievements
- Mobile issues
- Ad blocking
- Real-world gamification, VR/AR.

ADVERGAMING: BIG MONEY

The global videogames market is a vast money spinner, with around US$41bn of its estimated US$90bn worth spent on mobile, US$34bn on PC gaming, US$6bn on consoles, US$2.7bn on VR, and just under a billion spent on eSports [2].

Advergaming – the process of displaying adverts in a game title, or making a game based entirely on a specific product in order to advertise it to the fullest extent and create band association with consumers – is now a fully fledged industry.

Videogame engine developer *Unity Industries* surveyed more than 2,000 gamers and developers [3] and found that:

- 78% of mobile gamers are open to having video adverts instead of paying for a game title
- 62% of gamers would regularly interact with ads for an in-game reward
- 62% of developers saw retention rates either climb or stay level after introducing ads to a title that previously had none
- Only 18% of gamers would pay up front for a game.

When companies such as *Zynga* are able to generate US$153m of revenue purely from in-game adverts [4], there are clear reasons why people would want to move into the ad-supported space.

THE ORIGINS OF ADVERGAMING

In 1978, what was arguably the first piece of advergaming was born when the text adventure *Adventureland* inserted a reference to another title by the same developers called *Treasure Island* [5]. From there, other forms of advertising followed including the placing of *Doom* mod CDs in cereal boxes, and the realization that visual adverts could be placed into game titles directly.

In 1983, *Coca Cola* released *Pepsi Invaders*, a Space Invaders clone in which the aliens were replaced with the word 'Pepsi' and the spaceships were replaced with coke bottles. Other companies followed suit through the years, releasing 'alternative' titles, which often required the purchase of child-focused food in order to gain access to them.

Early electronic toys were also forerunners of downloadable content (DLC), where the original product effectively becomes the marketing tool for additional financial buy-in. One such product, *Mr Game Show*, offered an electronic quiz; additional questions could be purchased via cassette tapes which were connected to the toy via a cassette player.

Twenty years on, tape and plastic have been replaced with digital downloads and always-on Internet connections.

For many children, their first introduction to the world of virtual reality would have been the *View Master*. Created in 1939, the viewing device was held up to one's eyes and circular disks containing stereoscopic 3D pairs of photographs created a 3D illusion.

Whether desktop, mobile, plastic toys or the brave new world of VR, all of these spaces are embracing advergaming in inventive ways – some of which potentially put the customer at risk from bad adverts, or tracking, or a combination of both.

CONVERGENCE

There was a time when hardware limitations meant that your phone, game device, computer, pager, and other essentials were all kept separate. Over time, convergence brought them all together and games consoles were marketed as 'all-in-one' entertainment systems.

This ensured that every console in every home had the ability to serve marketing, from first boot to just before switching off. This convergence has had the consequence of placing artificial barriers between the gamer and the game. Previously, the game flow was as follows:

1. Switch on device
2. Game loads
3. Game publisher's copyright/terms of service (ToS) presented
4. Play game
5. Turn off device

Now, the typical flow might be more like this:

1. Switch on device
2. Console updates applied (if any)
3. Dashboard loads (containing a mixture of adverts and wanted content)

4. Game loads

5. Legal/ToS/privacy policy (often detailing the ads/networks/how your data will be used) presented

6. Menu screen/DLC offers presented

7. Loading screen with ads for DLC

8. Play game (potentially containing dynamic/interactive ads)

9. Exit game with 'before you go'/'rate this'/social media buttons

10. Return to dashboard/ads

11. Turn off device

There are now numerous additional key steps in the process, during which ads can be served. The game being played serves as marketing for the DLC, which is how a game continues to generate revenue long after its initial launch.

Note that console dashboards try to display relevant content that may interest you prior to launching a game, so in theory, any attempt to load a game means being subjected to ads not only in the title in question, but also to ads unrelated to what you initially intended to do.

ADVERT TYPES

Before the rise of net-connected gaming consoles, adverts were infrequent because with no way to update them, product placement would quickly look outdated and out of place if locked into (say) a *Nintendo NES* cartridge. There was also no way for advertisers to get feedback on how well viewed/influential/disliked an ad was. These are known as static ads.

From the *Dreamcast* onward, Internet connectivity meant that static adverts could be replaced by always-on, always updatable adverts served by content delivery networks (CDNs) in much the same way as ads were served on web pages. This is known as dynamic advertising, and dynamic ads have almost entirely replaced static ads across all devices, from mobile to desktop.

One danger of dynamic advertising is that, as the ads are fluid, banners could be left blank should the ad network shut down or the paid spots be removed. If the ads appear on banners or billboards in the game world, this could be somewhat immersion breaking. *The Matrix Online* (2005) ran into such a problem, but placed the words 'Ad space for rent' on all of the empty ad hoardings.

There are interesting parallels to be drawn between developments in online and offline advertising. In the real world, out-of-home (OOH) advertising such as billboards and posters used to be limited by their static nature in the same way as non-net-connected in-game advertising, but they have now gravitated towards always-on, analytics-based approaches.

In the virtual realm, games with static adverts have similarly moved towards always-on, dynamic content.

CROSS-DEVICE BUY IN

Despite the 'all-in-one' approach to hardware, the delivery of content has never been so fractured.

In many cases, games have their narrative broken up across multiple media (transmedia narrative), resulting in what are

effectively more adverts for more products – with no buy in, you miss key portions of the story you're following. A famous example of this is *The Matrix*, with plot-crucial spinoffs including *Enter the Matrix* and *The Animatrix* to name but two.

The end result is that consumers are now subjecting themselves to additional forms of advertising or analytics in order to get the full picture.

Some desktop games will offer relatively low in-game rewards obtained through normal play, but create companion apps for mobile which provide easy ways to boost resources. For example, *Mass Effect Andromeda* offers an app, subject to *EA*'s various privacy policies, which helps players gather additional useful in-game items.

There's no real reason the main game couldn't have included higher volumes of resources to collect, but downloading the app potentially exposes the player to more advertising/analytics touch points.

GAME DESIGN AS SOCIAL ENGINEERING: HEAT MAPS

One of the major benefits of console connectivity and improved data analysis is being able to track how gamers play, right down to the smallest details. For example, producers of first-person shooters are able to generate 'heat maps', which provide a detailed rundown of where gamers go, how long they stay in particular locations, the general ebb and flow of movement over time, choke points, and so on.
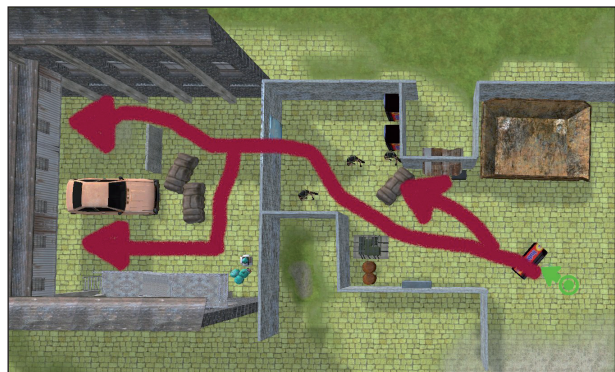

Figure 1: Heat map.

Over time, firms have started to make use of these heat maps in order to calculate the best location for ad placement. In the real world, we now see billboards and banners containing cameras which track their own 'heat maps', providing data that potentially includes head movements, general demographics such as age and gender, and (most crucially) whether people look at the ad or away, and for how long, as well as which portions of the ad attract their attention the most [6].

In a similar fashion, heat maps ensure that intelligent game level design goes hand in hand with exposure to branding.

AD POSITIONING

Using heat map telemetry and achievements, developers will look to obtain maximum exposure for their paid advertisements.

In first-person shooters, narrow chokepoints will lead to posters or banners at the end of corridors. Overturned vending

machines may be used as the sole source of cover in exposed areas, with the player popping out of cover from behind an advert. By the end of a shootout, the player may have physically stood up then crouched behind a brand logo 30 or more times without realizing it.

Figure 2: Overturned vending machine displaying brand logo.

As another example, players might be made to walk up a steep hill, at the top of which is a large, inescapable billboard promoting a brand.
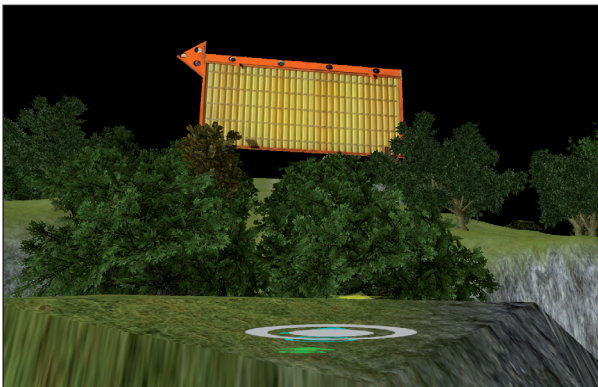

Figure 3: Billboard.

In the videogame *Alan Wake*, the DLC called *The Signal* featured a moment where Alan needed to make contact with a mysterious helper, while stranded in a demonic nightmare.

Upon obtaining a mobile, the character asked Alan '[can you] hear me now?'

This is a catchphrase from a popular ad campaign run by *Verizon* from 2002 onwards – humorously, about the *Verizon* technician trying to establish calls in a variety of unusual locations. While players may be unaware of this, the connection is made regardless when the protagonist drops his phone and it zooms in on the screen sporting a *Verizon* logo [7].

In effect, we have brand reinforcement potentially without the person receiving it being aware of the link. When they leave the game space and go back to their daily business, it's possible that accidentally running into the slogan in its correct setting could reinforce positive associations from the game with the product.

ACHIEVEMENTS

Achievements (as we know them today) are in-game rewards obtained for achieving specific goals, such as completing a level, collecting items, defeating a boss in a certain way, and

so on. Launched on the *Xbox 360* in 2005, they eventually migrated to popular PC platforms such as *Steam* and *Origin*. While they're a handy way for gamers to display their prowess, they also allow publishers to further fine tune their game budget and advert management.

In 2014, *Steam* released details of game completion based around achievement progress [8]. The stats showed that only 77% actually played the games surveyed, with 42% reaching the halfway point of said titles, 29% finishing the game, and 22% 'backlogged' – effectively, one in five games never actually loaded up and played. Even across AAA, big budget titles, game completion ranged between 40% and 66%.

As a consequence, not only will publishers 'front load' games with the most investment (it will be wasted investment if half the players or more won't see it), they'll also ensure adverts appear early and often. This may also contribute to a general feeling of 'advert fatigue' – gamers may think that all titles are bursting with promotion, but the reality is that, for the most part, wading through the early stages of a game will likely result in fewer (or no) ads viewed later on.

The addition of the now ubiquitous in-game achievements also provided game developers with an easy way to see exactly how far into the game players ventured before giving up.

Additionally, if developers notice gamers hitting specific achievements related to certain actions, they can adjust later content and expose people to more adverts. For example, are gamers picking up lots of collectibles? Why not place more in a supermarket and litter it with billboards?

MOBILE ISSUES

While mobile devices are ideally suited to casual gaming, the reality is that disclosure difficulties and developers able to use whatever ad set-up they like can cause major headaches for gamers. Mobile apps have embraced the advergaming philosophy, eschewing upfront payment in return for 'free' games laced with data collection, adverts, and in-app purchases.

The various mobile markets are also awash with poor imitations of popular/licensed titles, many of which are barely functional scams which manage to serve ads before crashing, display false images on the previews, or turn out to be simple puzzle slider games instead of a *Grand Theft Auto* spinoff.

A look at the most popular apps in the game section on *Google Play* confirms the massive shift towards using gamer data as a form of payment for accessing an app (alongside further actual monetary payment for extra content): on 11 June 2017, the top 30 games comprised 69,995,744 downloads, 27 apps containing ads and 27 containing in-app purchases. All of them were free to download, because in a market where casual games are both cheap and quick to make, the return on ads far outstrips any development costs.

This 'cheap to make, DIY the distribution' aspect results in developers posting their games on forums and social networks to increase visibility in a cheap fashion. However, this indie dev approach can often backfire in terms of security, invasive advertising, or (in a worst-case scenario) damaged devices.

In July 2017, a developer posted on *Reddit*, asking whether it was really possible to earn money from ads in his/her mobile

game [9] (a common way to increase download rate). People who tried the dev's game (which owes its existence to the DIY ad-supported model) started to report bricked phones. The only solution to the problem – which had been caused by an oversized icon – was a factory reset of the phone. The desire to make money easily from ads, coupled with poor testing and a possible oversight by the app store in question, had resulted in people losing data.

As one commentator put it, 'Your ads made no money but you just made 80k in bug bounty.'

MOBILE PRIVACY POLICIES

Privacy policies are typically more important than EULAs or terms of use on mobile, which is why stores such as *Google Play* will link to/focus on privacy policies more than the others. The problem with privacy policies for mobile games is that:

1. The small screen is not fit for purpose where reading thousands of lines of legal text is concerned.

2. Many mobile games will make use of multiple ad networks, and require multiple privacy policies as a result, which causes further aggravation on a small screen.

This problem is particularly noticeable when reading the linked terms for popular mobile titles. If a gamer wanted to play *Tetris*, for example, they'd have to visit the linked privacy policies page and would witness four sections – online advertising, online analytics, mobile advertising, and mobile analytics, which (at time of analysis) comprised 212 separately linked privacy policies [10].

As all of these policies are provided by third-party companies, the game developer has no control over whether a page is live or down, whether the company has gone bust, or any other scenario which may result in the information no longer being available. It takes time to update the links, and until that happens, link rot grows.

When checking the linked privacy policies for *Tetris*, the results were not ideal:

Online advertising (122 linked policies):

- 83 worked
- 2 listed as N/A
- 37 'DOA' (offline/404/redirect to unrelated site or splash page)

Online analytics (15 linked policies):

- 8 working
- 3 N/A, 1 'not available'
- 3 DOA

Mobile advertising (61 linked policies):

- 14 working
- 23 N/A, 1 'uninstall'
- 23 DOA

Mobile analytics (14 linked policies):

- 5 working
- 6 N/A opt outs
- 3 DOA

Overall, of the 212 links:

- 110 worked (just over 50%)
- 36 were N/A/related (17%)
- 66 were DOA (31%)

In total, to be able to say 'I read everything available before playing Tetris' with a full understanding of what advertisers/ analytics firms were being used (and how they made use of their data), a gamer would have to read approximately 406,619 words.

To put that into context, George R.R. Martin's longest *Song of Ice and Fire* novel (*A Storm of Swords*) is about 424,000 words, and the entire *Lord of the Rings* trilogy is about 480,000 words in total. If the roughly 30% of pages that were DOA had been functional, we may have had a much higher word count to deal with.

As it is, reading an average of five words per second it would already take roughly 22 hours to read everything, much less understand all 400,000+ words made up of legal terms and conditions.

This is a truly astonishing number of words to attempt to read, in order to play a simple mobile game.

AD BLOCKING

Gamers have been attempting to block ads both in-game and on console dashboards for some years now, and – just like the so-called arms race on the desktop – ad publishers have responded in kind. Gaming is at a premium, especially on a console, where the initially cheap outlay for the gaming device (versus a high-end PC) is slowly cancelled out by monthly/yearly membership fees such as £39.99 per year for *Xbox Live Gold*. Having to pay additional fees yet still see adverts is enough to push many to remove advertisements.

Even accounting for what can be blocked, notification on consoles is often not ideal. On a PC, a splash screen at boot up contains text which covers copyright, advertising, analytics and more, frequently including URLs that link to privacy policies or ToS. On a console, those same screens can't be paused, hyperlinks can't be clicked, and there's no easy way to read it properly. These various factors combined with recurring fees ensure there's a huge market for shutting down any and all tracking and advertising whenever possible.

GAMES CONSOLES, LAST GEN (XBOX 360)

Superficially, *Microsoft* console dashboards resemble the *Windows 8* 'tile' method of navigation, with multiple scrolling panels containing features, links, apps and games. A portion of those tiles typically link to *Microsoft* offers, game deals, and sales. Some gamers want to remain as ad-free as possible, which has resulted in many crude attempts at blocking specific types of content.

When advertisements first appeared on console dashboards, creative use of *OpenDNS* [11] allowed for ad blocking, and replaced advert/promotion-filled tiles with blank spaces.

Similar techniques have been tried with mixed results for dynamic advertising served up in game titles, and it's even more difficult to block static adverts which are part of the game world (essentially non-removable sprites), unless someone has created mods to quite literally paint them out of existence with replacement graphics.
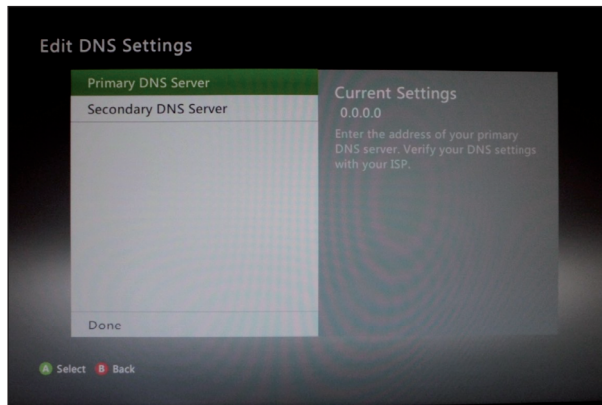
Figure 4: Editing DNS settings.

CURRENT GEN (XBOX ONE)

The current *Microsoft* console functions in much the same way as the last, so gamers can still target specific advertisements that are not to their liking. Switching DNS settings to a third-party service, then entering them into network settings, will turn a full screen splash for *YouTube* into an empty red box. While not aesthetically appealing, it does strip out the unwanted advertisements.

Even so, there are multiple possible issues with such an approach:

- DNS lookups are frequently used to determine where content should be downloaded from (i.e. which server is closest). If you're using US IP ranges but are based in Manila, this could impact download speeds.
- You don't know who is running the servers. You could be exposing yourself to bad actors.
- Gamers may need to whitelist specific *Microsoft* domains, or else achievements might not unlock correctly.
- Services such as *Netflix*, *YouTube*, instant messaging, or even simply updating the console and/or connecting to *Microsoft* servers may not be possible.

Anyone wanting to strip ads from their console dashboard needs to weight up the pros and cons, alongside researching the DNS services available and ensuring they're trustworthy before using them.

One of the newer ad techniques is to make the advert part of the gameplay – view an ad to progress a level, or power up, or keep playing – and if said advert is then removed or otherwise tampered with, the game may effectively fail to function properly and progress may be impossible.

This type of technique is mostly seen on free-to-play mobile games.

AD REMOVAL INSECURITY

The presence of adverts can lead to unnecessary security issues, should a gamer click through to dubious app installs on a mobile or drive-by exploits/malware/surveys on the desktop. However, security issues can also be introduced if the gamer decides to remove the ads from the system by more automated means.

Many tools and downloads exist which will supposedly remove or block adverts from the game being played. This is usually accomplished by the file being dropped in the game's data folder, in much the same way as a mod.

Unfortunately, many of these files turn out to be fake or malicious, which opens the computer up to malware, data theft, survey scams, or in particularly ironic cases, additional advertising.

Figure 5: Fake ad blocker.

There is also an element of physical safety to consider if, as expected, ad blocking/filtering moves into augmented reality (AR). If wearing AR devices while driving/walking/performing potentially dangerous tasks, it is impossible to say which of the below would be more distracting:

- Digitized adverts on an AR device
- Digitized adverts blocked on an AR device, by scrambling or blanking out
- Advertisers that have tried to negate the blocking, potentially causing unintended distractions or device errors.

An arms race on a PC, where one website can show conflicting messages related to displaying adverts, can be confusing enough, but in real life it could potentially become life threatening.

BREAKING THE FICTION

Unlike ad set-ups on console dashboards, gamers only really tend to take action against in-game adverts if they feel they break the immersion of the world around them.

In 2005, *Massive Incorporated* introduced dynamic ads into *Planetside* (set in the far future, in the deepest reaches of space), but the ads on banners were for movies such as *Deuce Bigalo: Male Gigolo* (complete with URL), and posters for soft drinks such as *Fanta* [12]. This led to one of the earliest attempts at dynamic ad blocking by gamers, via HOSTS file editing.

Another problem is the pristine nature of the adverts; nobody wants to pay money to place a product in game, only for gamers to despoil it in some fashion. In practice, this means videogames featuring destructible environments and dirty textures will be littered with bright looking, indestructible product banners no matter what's happening around them.

Rainbow Six: Lockdown (2005) featured posters for the movie *The Hills Have Eyes*, and gamers frequently mistook them for other players [13].

In-game ads seem to be waning in popularity in favour of mobile ads, console dashboards, and newer forms of tech which offer more flexibility.

THE MARCH TOWARDS VR: REAL-WORLD GAMIFICATION

Developers often try to get gamers to push messaging into the real world as a cheap and easy form of further advertising for the digital product – an early forerunner of augmented reality promotion.

One of the first major examples of real-world gamification occurred in 2012, when *Zynga* began selling words in *Draw Something* (a game where you draw a word in pictorial form for the other player to guess) to advertisers. In practice, players became commercials for products such as *Pepsi*, *Doritos*, and even sports teams, as they effectively spent minutes at a time staring at brands and logos and turning them into images, over and over, in rapid-fire rounds.

Another successful campaign from the same year was put together by *Ubisoft*, who had gamers 'unlock' a videogame trailer for *Assassin's Creed 3* by posting messages advertising the game on social media channels such as *Twitter*. Clearly, this makes little sense – the trailer would always have been released, whether gamers sent endless Retweets or not.

Figure 6: Ubisoft campaign.

Advertisers have learned from the techniques used in game spaces to make products inescapable. Just as developers would funnel players down corridors and have them use branded vending machines as cover, so real world promotions do the same thing.

In 2011, a 3.5-metre-tall *Coca Cola* vending machine encouraged people to lift each other up to the slot and obtain two cans for the price of one – all while physically having a large *Coca Cola* logo inches from their face [14]. Positive associations of working together to receive a reward thanks to a specific brand are created, and likely helps to feed back into later purchases.

VR/AR ADVERTISING

Whereas traditional VR takes place in an enclosed, digitized space, augmented/blended reality (AR) is something which looks to add digital elements to the real world around us. A good example of this is one of the earliest familiar examples: crudely overlaid graphics on sporting events from the 80s/90s.

There are two main types of virtual reality: headsets with powerful hardware/software built in, such as the *HTC Vive*, *Oculus* and *PlayStation4 VR*, and software powered, where the headset is an empty shell with the virtual aspect being provided by a mobile placed into the headset. *Gear VR*,

Google Cardboard, and any other number of cheap headsets which use either of the aforementioned VR operating systems are good examples of this.

While the majority of headsets are designed to allow you to use whatever form of VR you're most comfortable with, some try to push some level of 'buy in' into the brand as a whole. For example, the *Mattel View Master* ties product desirability to additional headset functions, such as a preview wheel (modelled after the circular wheels from the original *View Master*), which unlocks additional preview content.

However, the games themselves typically request permissions such as images, location and contacts, and are roughly 300MB of short preview areas which serve as a gateway to multiple pieces of paid DLC. As with DLC on consoles and PCs, in some ways the base 'game' is the advert for the downloadable content – the game content accessible without purchase is arguably a virtualized advert for paid additions.

At time of writing, virtual reality hasn't taken hold (sales of 2.3m a quarter versus 33.9m a quarter for wearable devices) [15], so the advertising used needs to be as targeted as possible to ensure advertisers feel they're getting their money's worth.

Advertising models for VR are still in their infancy, with many tools and techniques only now being fully developed, so for the moment the main way of advertising in virtual realms is the 'base game to DLC' approach; however, that is already starting to change.

MAJOR PUBLISHERS CREATE THEIR OWN TOOLS

Given the favourable stats for in-game advertising, there's a major push for ad-related solutions that publishers can deploy in their products.

- *Adobe*, which acquired video ad company *Tubemogul*, is developing VR ad solutions which focus on the cheaper mobile VR products. Adverts can be displayed in virtual cinema settings on the walls and ceiling of the digital theatre, and 'cards' for products can be placed before the user, which could also be used for discounts [16].

- *HTC*, creator of the *Vive* headset, has focused on eye-tracking technology ('Innovative VR Ads'), which can deploy 2D/3D placements, alongside cinema-scale adverts. The ad set-up is particularly sophisticated, and may remind some of the *Google Ads* sign-up procedure. There are development SDKs for both *Vive* and mobile, a fully featured sign-up/test/publish facility, sales and payout reports, examples of 2D ads (ad banners on a wall), big screen video (which you may see while on your VR device 'dashboard'), recommended apps and 3D model (for example, a character holding a branded banner).

HTC's ad platform is probably the most sophisticated around in terms of publisher options, and one of the stated goals is to potentially offset the cost of VR titles with ads, or even make them free (as in the case of mobile titles and, increasingly, games on PCs and consoles).

Heat maps in traditional games, cameras on eatery billboards, and eye tracking in VR headsets, mean the direct response to human vision in virtual spaces hands advertisers the ability to pinpoint what works and what doesn't in a way flat, 2D banner ads could never accomplish.

AUGMENTED REALITY ADVERTISING

360-degree film making is a fast growing area, with companies such as *Google*, *Facebook*, and *Nokia* all creating devices capable of immersive content (including, but not limited to, audio, visual and digital). Film shot with these cameras allows you to experience an event as if you were there, and can be panned/rotated with the mouse in a *YouTube* video, or experienced fully with a VR/AR device.

Nokia's *OZO* camera allows developers to integrate mixed reality such as game engine created elements and advertising in real time. [17]

CONCLUSION

The trend of using adverts to pay fully or partially for content isn't going to go away anytime soon, and it's clear from the new forms of ad tech being developed by both large independent companies and creators of VR devices that they expect this to be a major revenue generator.

It's possible advertising solutions are being pushed so hard partly because of the low uptake in VR sales, especially given the costs of the top-end devices. *HTC* is already developing a standalone headset which will likely be cheaper than the standard *Vive* model, and it's notable that the *HTC* in-game ad tool allows for both *Vive* and mobile ad development.

Elsewhere, the use of psychology and social engineering is far more sophisticated than in standard web-based banner ads, and it's much more difficult to block ads on consoles and in VR. Although there is (usually) only a low-to-moderate impact on web browsing, for both games and headsets it can be the difference between functional programs and broken games, services not working, updates not applied, or even exposure to potentially harmful content. Once ad techniques are sufficiently developed in VR spaces, the next step would be to integrate them into AR, but this will require sufficient consumer acceptance (see: *Google Glass*).

Regardless of delivery method, with adverts come tracking, analytics and similar concerns and issues to those on the desktop. While home-brew-style ad-blocking tools have been designed for augmented reality scenarios, it may well be that security companies need to start developing ad-blocking/tracker-negating software for VR.

Developing VR content is now easier than ever, with cheap dev tools freely available to purchase. Given the already mentioned safety concerns of digital elements being placed in our field of view during daily activities, it's possible that VR/AR advertising will eventually fall under real-world advertising rules and regulations, which – depending on geographic location – can be very strict.

The problem here is that traditional laws deal with static advertising such as billboards and banners. While some laws pertain to moving images on digital billboards, they may not mean much to entirely virtual adverts that can pop in and out of existence on the fly, based on an esoteric assortment of criteria such as device used, app running, location and profiling.

There are already battles being fought in the courts, as US parks try to restrict where gamers can use augmented reality apps in their environment [18]. No doubt the problem will be exacerbated as we run into previously unforeseen problems – with the technology being so new for public consumption, it's hard to say exactly what will go wrong and when.

One thing is certain: whether games console or headset, virtual spaces or enhanced reality, the mashup of sophisticated tracking, physical observation, social engineering and dynamic adverts is far in advance of anything we've previously seen on the desktop. It's imperative that we start thinking about possible solutions to potential problems now, before they take root and become an established part of the virtual and augmented space industry.

REFERENCES

[1] Murdock, A. Consumers spend more than a billion hours a month playing mobile games. http://www.vertoanalytics.com/consumers-spend-1-billion-hours-month-playing-mobile-games/.

[2] Takahashi, D. Worldwide game industry hits $91b in revenues in 2016. https://venturebeat.com/2016/12/21/worldwide-game-industry-hits-91-billion-in-revenues-in-2016-with-mobile-the-clear-leader/.

[3] Kobialka, D. Mobile game-devs see higher revenue from in-game ads. http://www.fiercewireless.com/developer/mobile-game-devs-see-higher-revenue-from-game-ads-says-unity-technologies.

[4] Jordan, J. Zynga generated $153m of revenue from in-game ads in 2014. http://www.pocketgamer.biz/chart-of-the-week/60848/zynga-generated-153-million-of-revenue-from-in-game-ads-in-2014/.

[5] ESA. In game advertising. http://www.theesa.com/games-improving-what-matters/advertising.asp.

[6] Doctorow, C. Crashed computer at Oslo pizzeria reveals covert facial recognition scheme. https://boingboing.net/2017/05/11/public-private-surveillance.html.

[7] Baig, E. Verizon's 'Can you hear me now' guy now at Sprint. https://www.usatoday.com/story/tech/columnist/baig/2016/06/05/verizons-can-you-hear-me-now-guy-now-sprint/85458446/.

[8] Aaron, J. 22% of Steam games go unplayed, but the numbers are misleading. https://venturebeat.com/community/2014/04/10/according-to-the-steam-global-stats-project-22-of-purchased-games-go-unplayed/.

[9] Reddit. Is it actually possible to make money from mobile game ads? https://www.reddit.com/r/gamedev/comments/6575nr/is_it_actually_possible_to_earn_money_from_mobile/dg8mmia/?context=10000.

[10] EA advertising networks links. http://tos.ea.com/legalapp/WEBPRIVACYAPPENDIX/US/en/PC/.

[11] Reddit. How to block xbox ads. https://www.reddit.com/r/gaming/comments/n5831/how_to_block_xbox_dashboard_ads/.

[12] Walsh, T. Massive ruins Planetside. http://www.secretlair.com/index.php?/clickableculture/entry/massive_ruins_planetside/.

[13] Slashdot. In-game ads. https://slashdot.org/comments.pl?sid=180301&cid=14928275.

[14]   Ads of the world. The friendship Machine.
        http://adsoftheworld.com/media/ambient/cocacola_
        the_friendship_machine.

[15]   Sharwood, S. VR headsets even less popular than
        wearable devices. https://www.theregister.co.uk/
        2017/06/02/idc_augmented_and_virtual_reality_
        headset_tracker_q1_2017/.

[16]   Roettgers, J. Adobe is developing ad solutions for
        VR. http://variety.com/2017/digital/news/adobe-vr-
        video-advertising-1201996008/.

[17]   Martin, C. Nokia updates VR ecosystem, enables
        mixed reality for advertising.
        https://www.mediapost.com/publications/article/
        299434/nokia-updates-vr-ecosystem-enables-mixed-
        reality.html.

[18]   Claburn, C. When can real world laws invade
        augmented reality fantasies? A trial in Milwaukee
        will decide. https://www.theregister.co.uk/2017/06/
        07/permits_for_augmented_reality_games/.