Drink & Drive: A Serious but Fun Game on Alcohol-Induced Impairments in Road Traffic

Frank Gaibler, Simon Faber, Sarah Edenhofer, Sebastian von Mammen
Organic Computing, Dept. of Computer Science
University of Augsburg, Germany
{frank.bernhard.gaibler,simon.alexander.faber}@student.uni-augsburg.de
{sarah.edenhofer,sebastian.von.mammen}@informatik.uni-augsburg.de

***Abstract*—In this paper, we present *Drink & Drive*, a serious game about the effects of alcohol in individual transport. Although there were a few projects in place, we were eager to offer a more attractive gaming experience compared to the preceding projects, especially as the effects of drunk driving should be communicated to a young audience. *Drink & Drive* implements a competitive third-person racing game relying on well-known game mechanics. The goal of *Drink & Drive* is the motivation of a safe arrival by systematically avoiding any alcoholic beverages if driving. Accordingly, collectibles on the track can influence the driver's state of perception, for the better and for the worse. The delicate balance between serious contents and gaming fun is established by placing great emphasis on a clear, playful design and the introduction of effective gamification elements that support an immersive, intrinsically motivating experience. In this paper, we motivate and present the design of *Drink & Drive*, we embed it into the context of related works and we provide preliminary results based on its presentation to forty students and faculty.**

I. Introduction

Due to technological advances, driving cars is becoming increasingly safe—serious accidents are mainly caused by human error. Hereby, the reduction of the drivers' perceptional and cognitive abilities through alcohol and other consumable substances such as THC [1] plays a considerable role. Although widely known, costly campaigns are run by governments to further raise awareness about this fact. In Germany, especially younger drivers (between 14 and 27 years) seem to underestimate the influence of alcohol on their driving abilities, see for instance [2]. A lack of internalisation and ineffective ways of teaching about the problem are two hypotheses that explain the gap between knowledge and self-assessment. As always, teaching facts without providing real experiences renders it hard to actually appreciate the stakes of a poor decision. Serious games can appropriately address this challenge [3]. Virtually, the impairment of a driver that results from a certain blood alcohol concentration (BAC) can be simulated considering perceptive distortion and prolonged reaction times. Hence, it is possible to provide a comprehensive, multisensory, potentially emotionally supported learning experience and not only bare facts about a hypothetical situation.

In this paper, we present our approach of tackling this challenge. Our implementation, *Drink & Drive*, is a serious game that wraps the issue of drunk driving in an appealing, accessible disguise. In particular, at a first glance, *Drink & Drive* resembles the popular video game title "Super Mario Kart" [4]. Despite of *Drink & Drive*'s cartoonish looks and its simplistic user interface, it is built on three goals that are motivated by its serious background. (1) The impairment of alcohol in a driving situation needs to be communicated. (2) The conveyed information needs to be based on scientific facts. (3) In order to render the teachings effective, *Drink & Drive* needs to be accessible and fun.

The main contribution of this paper is the concept of *Drink & Drive* enriching serious contents with actual fun gaming elements. Before we dive into the design details in Section III, we present related works in Section II. Here, we also outline differences and commonalities to our approach. Afterwards, we discuss our results and present some ideas around future work in Section IV.

II. Related Work

Elaborate research work has been published on the impairments to driving abilities induced by alcohol. The effects to the human body caused by a certain BAC are well examined and documented, for a quick introduction, see for instance [5].

Motivated by the adverse effects of alcohol in individual traffic, several attempts have been made to use simulation games to establish awareness about the associated risks.

The German non-governmental organisation "Alliance against Alcohol and Drugs in Road Traffic" (B.D.A.S.) provides simulators that offer a highly realistic experience of drunk driving [6]. Their first generation of simulators are turnkey driver cab's with space for a single person, steering wheel, manual shifting lever and pedals. A wide-screen and speakers provide for the feedback. A similar setup with extensive means of configuration and analysis has been developed by researchers from Seoul in collaboration with the local traffic authority [7]. B.A.D.S.' latest generation of drunk-driving simulators makes use of compact Smart or Renault Twizzy cars and augments them with an external projection. Following a parametric model, the users are shown how their perception and reaction are affected by different levels of BAC. Similarly to the mentioned simulators, *Drink & Drive* creates an experience of drunk driving based on a parametric distortion model of the user's perception and reactivity dependent on his (simulated) BAC. Yet, *Drink & Drive* does not rely on a comprehensive set of hardware gadgets. Instead, we try to provide an immersive experience engaging the users by

means of gamification. In this way, we also ensure that *Drink & Drive* is affordable and accessible to the broad public.

Another approach was presented by students and faculty members of the University of Calgary [8]. In their gamified simulation "The Booze Cruise" (TBC) they challenge the users in travelling the way back home from a party by car, while being under the influence of alcohol. Like our approach, TBC does not simply confront the user solely with an alcohol-augmented driving experience, but rather it tasks him with a specific goal (in this case: getting home safely). Also, TBC integrates game elements such as surreal obstacles to render the simulation more exciting, and thus more attractive to the user. We see two shortcomings in the design choices of TBC: The user steers the car from a third-person perspective. Given the large number of first-person racing games, we are convinced that a first-person perspective, i.e. sitting at the simulated steering wheel, does not jeopardise joyful gaming, at the same time it provides for a more realistic driving experience. Moreover, TBC uses a preset BAC which does not change while driving. Due to this rather limiting experience, we decided to introduce collectible items on the driving tracks in *Drink & Drive* which raise or lower the BAC also during the ride. By doing so, the user's initial loss of control may result in a vicious circle of alcohol misuse that boosts the driving challenge. The analogy to excessive alcohol consumption is a welcomed side-effect of our design.

Another virtual drunk driving simulator, the "DUI Simulator", was developed as part of the Global Game Jam in 2014 [9]. This simulator offers a third-person perspective and challenges the user to drive a car under the influence of alcohol while avoiding obstacles. The game ends when the car leaves the track. The simulated BAC as well as the car's speed are increasing with the achieved distance. This game offers an adequate simulation of alcohol-induced impairment and also supports a virtual reality headset. Its greatest shortcoming is the limited gameplay options due to the linear challenge. The game also suffers from the lack of a clear concept of competition.

The multiplicity of driving simulations, especially also frequently deployed systems such as [7] and [6], which teach the effects of alcohol-induced impairments emphasise their utility. Yet, we built on the preceding works in order to reach a broad audience and in order to effectively instil the dangers of drunk driving into a younger audience.

III. Methodology

This section shows how *Drink & Drive* stimulates the user's interaction and it covers the underlying models, including game mechanics and alcohol-induced impairments.

A. Interaction Elements and Interface Concept

Since *Drink & Drive* is a driving simulation, the player takes control of a car and interacts through it with the world around him. The final result is represented by Figure 1. As *Drink & Drive* needs to appeal to a broad group of users and especially to the younger audience, the user interface has to be simple and provide precise feedback. For our first implementation, we decided on simple visuals and an automatic car, which can accelerate forward and backward, turn left and right, and break – all by pressing standard computer keys, i.e. the arrow keys and the space bar, respectively.

Fig. 1: *Drink & Drive*'s first-person default view is reduced to a simple steering wheel dashboard and a few icons that represent the time left to complete the track (the heart icon in the upper-left corner), the achieved score (the diamond icon next to the heart icon), and the alcohol blood concentration (to the right-hand side).

In order to reflect the intoxication level of the driver, we applied different post-processing filters to the rendering viewport and we increased steering and acceleration effects to correspond to perceptional and cognitive lags. With an increased intoxication, these effects get stronger and more difficult to ignore. The underlying scientific model is detailed as part of the next section. At a rather high BAC, the driver faints and the simulation ends.

Gamification elements have been introduced to engage the user. We deployed a high score system to get the user motivated to interact with the environment and to collect diamonds that appear on the track (Figure 2). The scoring system takes advantage of the basic human urge for sportive competition and will encourage him to repeatedly play the simulation and to improve his performance over time. Information about the game mechanisms, including the scoring theme, are conveyed to the user in a simple textually-guided tutorial, see Figure 3. To counterbalance the ease of achieving high scores, and to allow for a non-linear intoxication experience, we decided to design an interactive mode of alcohol consumption, too. Therefore, alcohol is represented as beer cans that can be picked up like diamonds (see also Figure 2). Of course, their uptake does not contribute to the user's score but increases his BAC and thus they hinder the driver from following an optimal route and reaching high scores. Due to the cans' placement at road constrictions or round a bend, the player either needs to drive very slowly to avoid them, which conflicts with the requirement to finish the track fast, or handle the driving mechanics rather well and follow a challenging trajectory. In the end, especially novices to the game quickly experience the simulated impact of alcohol, whereas advanced players hone their skills to avoid them.

Without further incentives, the user could simply drive as slowly as possible and, thereby lever the difficulty of the game.

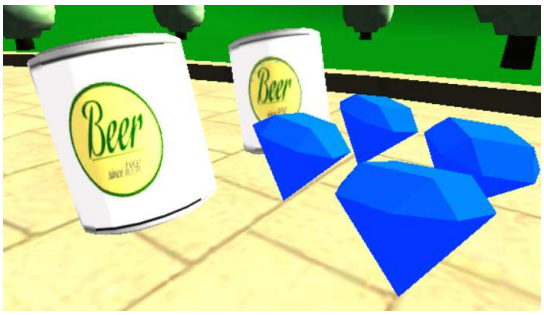

Fig. 2: Alcoholic beverages and diamonds can be picked up from the road - the first increases the driver's blood alcohol concentration, the latter his score.

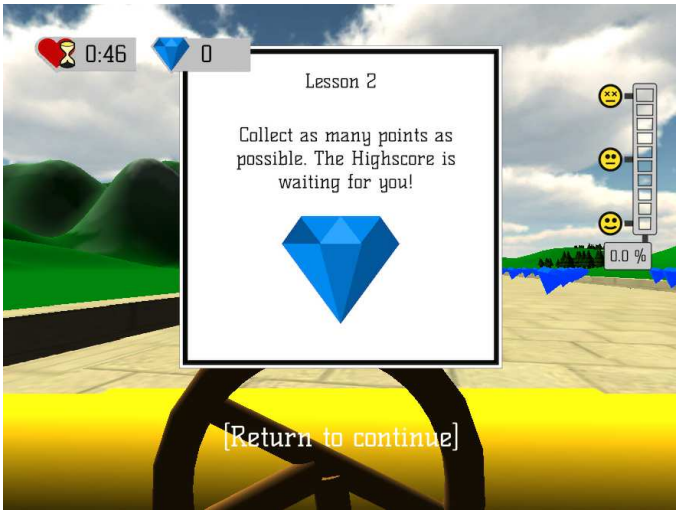

Fig. 3: A tutorial quickly steps through the game mechanics.

Therefore, some form of restriction had to be implemented. We decided to give the player a certain amount of time to complete one lap on the track. If he does, the timer is reset, otherwise the simulation ends. Similar to trendy endless runners and physics puzzlers such as Angry Birds, an infinite play is only prohibited by practical reason. As a result, there is always an incentive in returning to the simulation and in trying for a new high score.

Next to non-linear interaction with collectible items and to constant time pressure, we also introduce a linearly growing challenge factor (with an upper boundary). At later stages of the game, computer-generated opponents spawn on the track. They drive in the opposite direction, are not contenders and do not collect any of the track items. But they simply impede driving on an optimal route by blocking the player and pushing him around. Their anti-social interference may result in the driver's involuntary alcohol consumption. They spawn in greater numbers as the game progresses, however, there is an upper limit to maintain a playable level of difficulty.

To render *Drink & Drive* attractive for our target audience, we developed a flashy, eye popping style that we deployed consistently throughout the game, see for instance Figure 4. Simulating three different daytimes creates atmosphere and allows the user to experience the effects of high BAC under

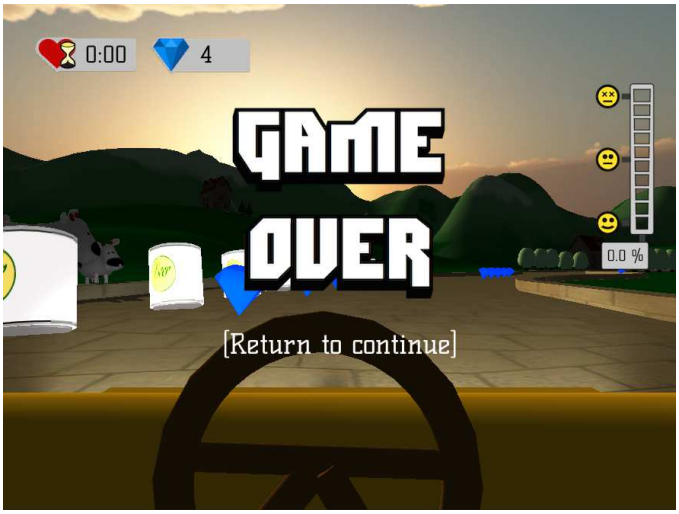

Fig. 4: We developed a trendy style to attract our young target audience (14 to 27 yrs).

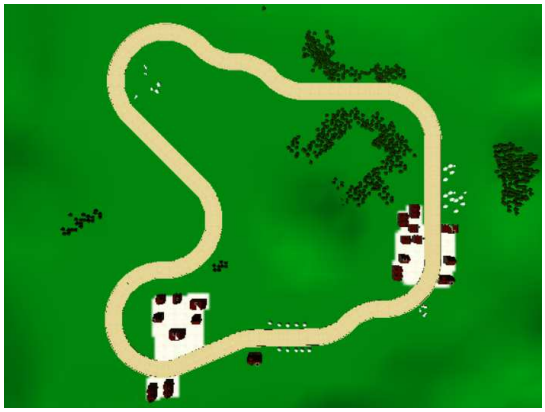

Fig. 5: The default track seen from above. The windings impose user interaction without pushing the challenge too far.

different conditions. The immersion is rounded off using an easy listening tune for the background music and brief, cartoonish sounds to underpin various user interactions such as picking up items.

B. Simulation Model and Scenario

The car represents one of the most important aspects of *Drink & Drive*'s game mechanics. Again, we needed to balance realism and simplicity. The car is able to interact with everything on the track, but it cannot somersault and it does not easily lose traction. The user is therefore always able to continue driving and any potential frustration due to a lack of experience driving real cars is avoided. Along the same lines, a realistic damage model would have been counterproductive due to the expectedly great degree of frustration by the user. We designed the track in such a way that it would support the learning process about intoxication. This determined its relatively short distance and its slightly curvy flow (Figure 5).

With the track being static, other aspects of the scenario had to be flexible and versatile, as to not lead to a repetitive

BAC in ‰	Effects
0.3	- Slight decrease in vision performance, of concentration and judgement - Impaired reflexes
0.5	- Speed is miscalculated - Vision decreases by about 15% - Reduced hearing
0.8	- Vision decreases by about 25% - Tunnel vision - Reaction time prolonged by 30 to 50% - Balance disorders
1.0-2.0	- Further deterioration of vision performance - Disorientation and problems with spatial vision - Significantly disrupted responsiveness - Loss of the ability to accept criticism
2.0-3.0	- Strong balance and concentration problems - Memory gaps and confusion - Vomiting and muscle relaxation
at 3.0	- Unconsciousness and memory loss - Weak breathing and loss of reflexes
at 4.0	- Paralysis, coma and death

TABLE I: The adverse effects of alcohol on the human body.

and ultimately boring experience. To keep an element of surprise, diamonds and beer cans are randomly distributed along the track. In order to ensure that the driver is not forced into any obstacles, i.e. to ensure that skilled driving provides for a smooth escape from any beer cans on the track, we defined spawning areas for the two types of icons (which could overlap) and allowed the spawned icons to shift and rotate within predefined ranges. This technique is similar to calculating potential solutions to inverse kinematics based on time and space constraints, see for instance [10]. Cars driving the opposite direction also add to a varied gaming experience. They implement a simple behaviour, following a given path as closely as possible.

The realistic demonstration of the effects of alcohol is an important part of the model. It is based on data from the German federal centre for health education [11]. Table I summarises the physiological impairment. We focused on visual effects. With an increase in BAC, our visual perception blurs, gets shaky, loses colour and the edges get darker. Impacts on our sense of hearing is another important facet. Sounds appear muffled and less clear. Consequently, the feedback from and the knowledge about our environment is heavily diminished. To infer concrete numbers, we assumed a 20 year old, 1,75m tall male driver, weighing 75kg. We further assumed a beer can to contain half a litre of (Bavarian) beer with 5% alcohol strength. This leads to one beer equaling about 0.3‰ of BAC. The body shuts down at around 3‰. As a result, collecting ten cans of beer results in loosing the game.

There are no impediments at the beginning of the game. The player always starts the ride sober. Intoxication first results in a slight deterioration of clear-sightedness. Next, serious impairments start taking effect. At 0.6‰, the vision gets darker at the edges and the hearing starts to get dull. Camera and sound filters are used to simulate this. For instance, a fisheye effect distorts the image and a vignette is laid over the picture to darken the edges (see Figure 6). An increase in alcohol results in prolonged reaction times, diminished ability to assess speed, and heightened readiness to take risks. We translated these changes into a faster simulation. Given the relatively long period of alcohol degradation, the player cannot experience this process in the game.

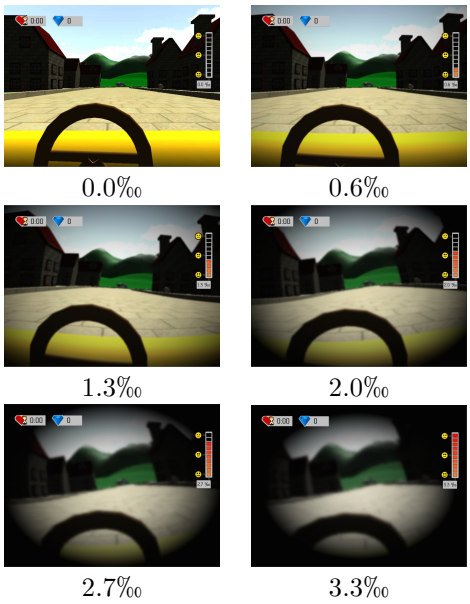

Fig. 6: Succession of increasingly low performing vision with increasing blood alcohol concentration.

IV. Results & Future Work

Different from its precursors, *Drink & Drive* offers a fun and informative gaming experience about alcohol misuse in road traffic. It implements a scientifically backed model of perceptional and reaction impairments similar to numerous serious, non-game simulators but it also introduces gamification elements to engage young players. The impairment model is based on scientifically determined facts, but the corresponding visualisation can only be an approximation. In general, *Drink & Drive* is not set out to achieve great realism but rather to integrate the serious contents that are valuable and the game elements that trigger intrinsic motivation to engage the players. In particular, we tried to realise some of Koster's work, speaking to the users' competence, to establish relationships with the game contents but also social links providing a competitive environment, and to ease the user into playing, maintaining his autonomy as much as possible [12].

In a competition on interactive simulations, we presented *Drink & Drive* to about 40 people, most of them students. They voted the game to be the best out of 15 projects, including interactive simulations about ants foraging, bee colony defence, and medical surgery. Criteria in the competition comprised the complexity of the scientific model, usability, and visual appeal. As a next step, we will present *Drink & Drive* to a younger subset of the target audience (at ages 14 to 18) and inquire about their findings. We hope this study to allow for various finishing touches before releasing *Drink & Drive* to the public.

There are several directions that we would like to pursue as future work. For instance, we would like to explore the benefits (and challenges) of using virtual reality headsets such as the Oculus DK2 [13]. Along the same lines, we have also been deliberating about a more natural motion-based input control [14] – a mobile version could utilise built-in accelerometers for steering. A mobile version would also allow for a much wider audience to experience the benefits of driving sober.

REFERENCES

[1] A. Ronen, P. Gershon, H. Drobiner, A. Rabinovich, R. Bar-Hamburger, R. Mechoulam, Y. Cassuto, and D. Shinar, "Effects of thc on driving performance, physiological state and subjective feelings relative to alcohol," *Accident Analysis & Prevention*, vol. 40, no. 3, pp. 926–934, 2008.

[2] Statistisches Bundesamt, "Verkehrsunfälle: Unfälle unter dem einfluss von alkohol oder anderen berauschenden mitteln im straßenverkehr." Annual Report, Wiesbaden, October 2014.

[3] L. Zamboni, L. Gamberini, A. Spagnolli, S. Cipolletta, G. De Giuli, and I. Tion, "Serious games in social intervention: Designing technologies to promote safe and healthy behaviors," in *Proceedings of the 9th ACM SIGCHI Italian Chapter International Conference on Computer-Human Interaction: Facing Complexity*, CHItaly, (New York, NY, USA), pp. 139–142, ACM, 2011.

[4] R. P. McMahan, A. J. D. Alon, S. Lazem, R. J. Beaton, D. Machaj, M. Schaefer, M. G. Silva, A. Leal, R. Hagan, and D. A. Bowman, "Evaluating natural interaction techniques in video games," in *3D User Interfaces (3DUI), 2010 IEEE Symposium on*, pp. 11–14, IEEE, 2010.

[5] The Drinkaware Trust, "drinkaware.co.uk–for the facts." Published online https://www.drinkaware.co.uk/, June 2015.

[6] Bund gegen Alkohol und Drogen im Straßenverkehr, "Alkoholfahrsimulatoren." Published online http://www.bads.de/agieren/alkoholfahrsimulator/, April 2015.

[7] I.-K. Hong, J.-B. Ryu, J.-H. Cho, K.-H. Lee, and W.-S. Lee, "Development of a driving simulator for virtual experience and training of drunk driving," in *3rd International Conference on Road Safety and Simulation*, 2011.

[8] J. R. Parker, N. Sorenson, N. Esmaeili, R. Sicre, P. Gil, V. Kochlar, L. Shyba, and J. Heerema, "The booze cruise: Impaired driving in virtual spaces.," *IEEE Computer Graphics and Applications*, vol. 29, no. 2, pp. 6–10, 2009.

[9] T. Suominen, M. Luimula, A. Peltola, A. Autio, and P. Ketola, "Dui simulator." Published online http://globalgamejam.org/2014/games/dui-simulator, 2014.

[10] M. Shaker, N. Shaker, M. Abou-Zleikha, and J. Togelius, "A projection-based approach for real-time assessment and playability check for physics-based games," in *Applications of Evolutionary Computation*, pp. 430–442, Springer, 2015.

[11] Bundeszentrale für gesundheitliche Aufklärung, "Kenn dein Limit." Published online http://www.kenn-dein-limit.info/, October 2014.

[12] R. Koster, *Theory of fun for game design*. O'Reilly Media, Inc., 2013.

[13] Oculus VR, Inc., "Oculus rift - virtual reality headset for immersive 3d gaming." Published online https://www.oculus.com/rift/, January 2015.

[14] IGN Entertainment, Inc., "Wii remote." Published online http://www.ign.com/wikis/wii-u/Wii_Remote, December 2012.