Cybersecurity Awareness Training provided by the Competence Developing Game GHOST

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***Abstract*—This paper introduces a Competence Developing Game (CDG) for the purpose of a cybersecurity awareness training for businesses. The target audience will be discussed in detail to understand their requirements. It will be explained why and how a mix of business simulation and serious game meets these stakeholder requirements. It will be shown that a tablet and touchscreen based approach is the most suitable solution. In addition, an empirical study will be briefly presented. The study was carried out to examine how an interaction system for a 3D-tablet based CDG has to be designed, to be manageable for non-game experienced employees. Furthermore, it will be explained which serious content is necessary for a Cybersecurity awareness training CDG and how this content is wrapped in the game.**

Keywords-Cybersecurity; Awareness; CDG; Serious Game; tablet game; business simulation.

I. INTRODUCTION

The use of digital systems is crucial in modern companies and one effort of digitization is to use these digital systems more efficiently. Through these efforts, more and more analog processes are no longer available. By that, nowadays almost all relevant records are stored in databases or on cloud based file servers. Accordingly, the analog data management will be reduced to minimum, if that has not already happened.

Of course, a well functioning digital working environment is required to ensure that the data are always available. If data are accessible everywhere and always for employees, then assailants are able to use these infrastructure, too. This issue is getting worse because nowadays, in modern digitalized systems, employees are owners of the keys necessary for data access. Consequently, it is no longer necessary for an assailant to attack the IT-infrastructure (IT = Information technology) or the IT-department. He can focus his attack directly on the data-using persons, e.g., with fishing-mails, social attacks, manipulated flash drives, etc. Despite this issue, this kind of always available data management is indispensable for modern companies.

As a result, it is essential to train non-IT personnel how to avoid cybersecurity risks arising within their daily digitalized work [1]. Already today, employees are often the biggest threat in the cybersecurity chain [2]. To offer an effective cybersecurity awareness training, it is important to establish a continuous training cycle to establish a long term behavior change **(**req. **7** (see Section II)**)**. It should be noted that too many topics in too short time increase the risk to overwhelm the exercisers which is also a reason for a long training cycle. Basically, a successful cybersecurity awareness training has to solve two tasks. On one hand, it has to attract the attention of the participants for a defined time period. On the other hand it has to convey the training content as efficiently as possible. Unfortunately, most of today's trainings solutions show weaknesses in dealing with both aspects. A very suitable solutions to address both aspects is the use of interactive computer based training methods **(**req. 6 (see Section II)**)** [1]. The use of gaming concepts in serious situations provides the possibility to transfer the motivation of a gaming situation into a serious learning context. In addition, games provide an environment which allows to choose risky or intentional wrong strategies just to figure out what will happen. Generally, there are three major kinds of games with a serious approach: Serious Games, Business Simulation/Games and the approach of Gamification. Further, there are different gradations of, e.g., serious games, which are not consistently defined [3].

However, instead of questioning 'What defines a particular game kind?' König and Wolf suggest to focus on the question 'What characteristics of which game kind are well suited for a specific application' [4]. For this, they provide the umbrella term Competence Developing Game that encompasses all 'serious' game types (digital and analog): 'A Competence Developing Game (CDG) is a game that has the primary purpose to teach knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development of the game player, by retaining the motivation of a gaming situation' [3].

Accordingly, this paper examines what features a digital CDG must have in order to enable a cybersecurity awareness training for (German) business users. Further, it shows how a specific CDG, in which these features have been realized, looks like. The game is called GHOST: Gamified Hacking Offence Simulation-based Training (see [18]).

In Section II, the target audience will be determined in more detail, to understand their preferences and requirements. Section III addresses these requirements to determine a suitable CDG game kind. In Section IV, it will be explained how a game interaction interface design for a huge audience group like, 'business users', could look like. In addition, in Section V, a study that examines game interaction systems will be briefly presented. Section VI

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describes the CDG GHOST which results from all previous considerations. Section VII offers a conclusion and an overview about future work and use.

II. FINDING REQUIREMENTS BY UNDERSTANDING THE AUDIENCE

A study in German enterprises determined that the three most common reasons for employee related trainings are: the development of employee skills, increasing employee motivation and job satisfaction, and strengthening the employee-company relation (req. 1). The study also determined the obstacles that inhibit employee trainings. The identified top-two reasons not to train although there is a need are: no time available to dispense employees (43,8%) and missing internal capacity to organize a training (42,6%) [5]. A second study in German companies identified training costs and also the time issue as main reasons not to train employees. The three most common training methods are learning at the place of work (46%), external courses (28%) and in-house courses (<28%) [6].

In the case of learning at the place of work, the time an employee needs to be dispensed is limited to the actual duration of the training, because there is no traveling time (obstacle: no dispense time available) (req. 2.a.). The absence of traveling time is linked to the absence of traveling costs (obstacle: training costs) (req. 2.c.). By that, the organizational complexity of the training is also reduced, as employees must be covered shorter, and they are more easily accessible in crisis situations, etc. (obstacle: organizational capacity) (req. 2.b.). Accordingly in the case of a continuous training cycle, as needed for a cybersecurity awareness training and therefore for GHOST, learning at the place of work seems particularly advantageous. These considerations clarify why learning at the place of work is the most popular training method and therefore it should be the method of choice for GHOST (req. 2).

In addition to these employer-focused considerations, the CDG GHOST is after all played by employees. As explained in Section I, more or less every employee who uses digital systems for work reasons should participate in a cybersecurity awareness training. By that, the target audience is broad (req. 3). Since the GHOST-Research-Project is granted by a German ministry (Federal Ministry of Education and Research), the German employee sector was considered in first place. According to a report by the Federal Institute for Vocational Education and Training, the average German trainee is 19.7 years old. The report shows the first grouping called "16-year-olds and younger". The average age of all employees was 43 years in 2016, with a relatively balanced distribution between women (~ 47%) and men (~ 53%) [7]. In summary, it can be stated that the vast majority of the target group is> = 16 years and <67 years old, the average age is 43, and women and men are similarly distributed.

As already mentioned, the use of a CDG as a training instrument has the advantage that the motivation of a game situation can be transferred in a serious context. In order to use this advantage a CDG must entertain players in a fun way while keeping the serious content in focus. This aspect requires a CDG that matches the tastes and abilities of the target audience. But because of the diversified target group, it is nearly impossible to construct a CDG that fulfills the individual game taste of each subject. On the other hand, the development of many games that meet the individual taste of each player would be expensive and it would stand in opposite to the obstacle: ‘costs’. Following these remarks, a CDG that addresses a broad audience always represents a compromise in game design.

To find the major common denominator of each CDG-Player the ‘Pyramid Assessment Framework for ‘Competence Developing Games’’ ('PACDG-Framework') was studied with this objective. The PACDG-Framework represents a tool that delivers the capability to analyze different game kinds in a standardized way. To do so, the framework covers, among other things, the entire player perspective of a CDG [4], as it was proposed (also) in the well-known MDA-framework for conventional entertainment games [8]. However, the PACDG-Framework covers the CDG-Player perspective in the three steps: “Experience”, “Aftereffect” and “Impact”. The last two steps refer to the same idea: A CDG should lead to competence acquisition, where the competences should help to solve at least one real life problem (req. 4). The step “Experience” is all about the player’s claim to participate in an emphatic and positive gaming experience. In order to meet this claim, a high, entertainment game equivalent, quality must be delivered (req. 5).

Therefore, a CDG-based training that is accessible for all employees who use digital systems for work reasons should…:

- Req. 1. …develop skills, increasing motivation / satisfaction, strengthening the job relation.
- Req. 2. …take place at the place of work to reduce
  a. time expense and release time,
  b. organizational overhead and by that
  c. costs.
- Req. 3. …be accessible for every target group member.
- Req. 4. …help to solve a real life problem.
- Req. 5. …be similar in quality to an entertainment game.

Additionally a CDG for a cybersecurity awareness training should…: (see Section I)

- Req. 6. …use interactive computer based training methods.
- Req. 7. …occur in a continuous training cycle.

III. GAME TYPE SELECTION

As discussed in Section I and II, the use of interactive computer based training methods is suitable for a cybersecurity awareness training. By that, a serious game, a business simulation (supported by a computer based

simulation model) or a gamified work environment could be used (fulfill req. 6). Furthermore it is of course possible to develop a CDG in one of the named kinds with an entertainment game comparable quality (fulfill req. 5).

However, every well designed cybersecurity awareness training will match the requirements 1 and 4 too. It is because the main CDG purpose would be to lead to competence acquisition, where these competence acquisition refers to the ability to perceive possible IT-Security threats (fulfill req. 1). As IT-Security issues are a real life problem, of course, such competences would support to solve a real life problem (fulfill req. 4). Therefore it can be assumed, that a capable development team has the ability to develop a CDG from one of the named game kinds that has the potential to fulfill the requirements 1, 4, 5 and 6.

So to choose the most suitable CDG game kind it is necessary to determine whether the requirements 2, 3 and 7 can be fulfilled.

„'Gamification' is the use of game design elements in non-game contexts"[9]. As a result, for the gamification solution a deeply integration of game elements into the computer environment of the employees would be necessary. Based on such integration, e.g., correct behavior such as scanning a flash drive or locking the screen during a longer period of inactivity could be rewarded with points (fulfill req. 2a-b). This solution would enable a permanent and time neutral training without the need of learning to handle the training instrument (fulfill req. 3 and 7). However, the necessary development effort would be high (game element integration in every used program and operating system) and the privacy protection question would need clarification (not fulfill req. 2c). In addition, the extensive system intervention could have unforeseeable consequences on the IT security of the manipulated operating systems and programs. For these reasons a gamification solutions does not seem suitable for a cybersecurity awareness training.

A closed 'Business Simulation' is characterized by the participants being placed into a well-defined and prepared action situation. A model calculation (the simulation) assesses the decision effects on the game environment. Further the model communicates the success of each action to the players [10]. Since a business simulation is similar to a board game the majority of the employees should not have any problem to handle the game (fulfill req. 3). In addition, many simulation games are turn-based anyway and thus predestined for a long continuous game cycle (fulfill req. 7). The problem here is that even if it is possible to organize multiple business game session at the work (fulfill req. 2a), fixed dates have to be coordinated between different employees plus the necessary setup and dismantling of the business game have to be organized in time (not fulfill req. 2b-c). That means, a business simulation can also not fulfill all requirements.

The third alternative are 'Serious Games'. Serious Games are video games where the primary purpose is not entertainment, enjoyment or fun, which does not mean that Serious Games are not entertaining. They just have another primary purpose, in kind of an ulterior motive [11]. A video game has the advantage of being fully flexible in terms of time. Further no coordination is required between employees nor an organization of the game setup and it can also take place at work (fulfill req. 2a-c) However, it is difficult to realize a continuous training cycle without a turn-based design and such a design is not intended for Serious Games (not fulfill req. 7). But indeed it is the only approach that has the potential to fulfill requirement 2.

At this point, a CDG reveals its strength. The solution is to mix up the game kinds. Serious Games are the only game type that fulfills the requirements 2a-c, but the turn-based design of business simulations supports a continuous game cycle. Accordingly the solution is to develop a Serious Game with Business Simulation (turn-based) game mechanics (see Section VI). Therefore, only the mix out of a Serious Game and a Business Simulation has the potential to fulfill requirements 1 to 7.

Due to this design choice, the biggest problem with meeting the requirements will be requirement 3 in which a CDG is demanded that is playable for every target group member. In requirement 5, the demand for a quality which is similar to an entertainment game is formulated. It needs to be kept in mind that not all members of the target group have experience with video games. It must therefore be ensured that requirement 3 can be met without losing number 5. Therefore, it is necessary to find an interaction-interface for a high quality video game that does not require any video game experience. Section V will introduce a case study that was performed to evaluate how a game interface has to be designed to meet requirement 3 even when the game uses a 3D-Environment to fulfill requirement 5. Section IV explains the game interface development and the case study design.

IV. DEALING WITH THE GAME INTERACTION ISSUE

Germany is the largest video game market in Europe with sales of 2.8 billion euros in 2015. Overall, the video game players are distributed as follows: PC / laptop 18.4 million players, smartphone 17.2 million players, console 15.6 million players, tablet 11.5 million players, handheld 8.3 million players. It should be noted that smartphones and tablets both use gaming apps, which means gaming apps with 23 million players in total have the largest player community [12]. Accordingly to that information even in the aimed target group the amount of people who have experience with gaming apps should be higher than with other video game mediums.

In addition, it can be stated that touchscreens as used in smartphones and tablets have significantly changed the world of games in a short period of time. Modern touchscreen devices show a very intuitive interaction design that allows even children to use such a device successfully.

To explain why touchscreen devices are intuitive to such strong extend, a look at the three-layered brain model is helpful. To use a tool (in a computer context a tool means a device like a keyboard, a mouse, a game controller, etc.) humans have to make use of their neocortex. The cerebrum represents the highest layer in the brain model. In contrast, for 'touches', as needed during the use of a touchscreen device, humans only need to use the reptilian brain, which is represented in the lowest layer in the three-layered brain

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model [13]. Both aspects, (a) the widely use of gaming apps and (b) the intuitive aspect of modern touchscreen devices lead to the conclusion that a gaming app based CDG is the right choice for GHOST. Considering the broad target audience it is further reasonable to use a tablet based gaming app because of the larger screen size compared to a smartphone.

According to the last Section, a CDG should be similar in quality to an entertainment game (req. 5). Modern gaming apps with the scope to be played over a longer period of time (as it is planned in GHOST) implement a three-dimensional, high quality looking game environment regardless of the genre (see e.g. Lara Croft Go, Lego Star Wars, Jam League, Modern Combat, Asphalt, Bothers: a tale of two sons, etc.). By that, GHOST has to be a three-dimensional tablet based CDG. On the other hand, GHOST has to be accessible for every target group member (req. 3). Thus, an appropriate game interaction system has to be found, that allows three-dimensional tablet based playing even for people who have never played a video game in their live. However, there are well established interaction systems for videogames that are also adapted for touchscreen devices.

The three most common used are 1st-Person, 3rd-Person and God view. The idea behind the 1st-Person perspective is that the player sees through the eyes of his player-character (PC) [14]. In conventional video games, the player controls the PC with mouse and keyboard [15]. Touchscreen based 1st-Person games are usually implemented in landscape mode. To control the PC the left and right thumb are used. The left thumb is used in the lower left area of the screen to control the movement of the PC. The right thumb is used in the lower right area of the screen to control the viewing direction [16].

In games that implement a 3rd-person perspective, a camera is used, which is aligned to the top of the PC to show him completely. Sometimes 3rd-person is implemented with „Trailing" option, then the camera is anchored at head height behind the PC. In classic video games, the control is similar to 1st-person games [15] the same applies to the touch screen control.

A God View perspective, also referred to by the terms 'overhead', 'top down' and 'God Eye', provides a perspective in which the game map is shown from above. Usually the control is realized with the mouse [14]. Touchscreen-based God View games are often implemented by touching directly on the device. In such case the 'touch' on the device is equivalent to a mouse click. Additionally manipulations of the camera perspective are done by the usual multi-touch gestures (e.g., two-finger zoom). Consequently, any 3D gaming interaction system known from the Computer/Laptop can be adapted for touch screen based games.

It has to be noted, that the 1st-person and 3rd-person solution only replace mouse and keyboard through two equivalent virtual generated tools. By that, according to Schell [13], neocortex participation is still needed and whereby the advantage of a touchscreen solution is not exploited. Only the 'God View' interaction systems provide a solution that's natively transforms touch into interaction. As a result, this kind of game interaction should be manageable for inexperienced players and therefore is the right solutions for a touchscreen based CDG and GHOST.

However, this question cannot be clarified for the intended target audience based on the state of scientific research. There is a lack of empirical research that investigates the suitability of existing touch screen-based control and camera tracking paradigms for 3D serious games. However, since a well-functioning interaction system is elemental for the CDG success, a corresponding study has been carried out that will be briefly discussed in the next Section.

V. INTERACTION SYSTEM FOR A TOUCHSCREEN BASED CDG

A. Discussion of possible interaction systems

The main objective of the study is to investigate wheatear it is possible to find an interaction-interface for a high quality tablet based video games that does not require any video game experience. Such an interaction-interface would connect requirements 3 and 5 that seem as if they exclude each other. The presence of such an interface would open the possibility to develop a cybersecurity awareness training that fulfills all seven requirements in the first place.

From a theoretical point of view, a game that responds as intuitive as possible on touch screen input should be advantageous for the players. As shown in the last Section even the 'God View' interaction system relies on not intuitive multi-touch gestures for camera control. For that reason, a new interaction system for the GHOST prototype was designed.

These 'optimized' called interaction system provides the PC control via finger touch. The PC automatically moves to the location of the map where the map was touched. Even the interaction with game objects or non-player characters (NPC) works this way. If a player, e.g., touches a game object his PC will automatically move to the point next to the object. After arriving at this point an interaction dialog opens automatically. To remove the maybe not intuitive camera control the whole game map is divided in different camera zones (partly multiple zones in one room). Each zone provides its own static camera perspective. If the player controls his avatar from one camera zone to another, the camera angle changes automatically. The player is not aware of where the zone boundaries are, the camera angle change just happens. To help the CDG-Player's orientation, there is also a second 'optimized+' called interaction system where the camera change from one position to the next one appears in a smooth move.

Additionally to the three mentioned interactions systems (1st-Person, 3rd-Person, God View) both versions were examined in a blind study. For this purpose, a small game was designed where the participant had to find six game objects or NPCs to interact with. At the beginning of the test a participant is set in a game environment (a space ship) with six rooms and two corridors. The participant does not get any map because the study also refers to the orientation ability. Finally the time needed to complete the interaction tasks was measured.

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A total of five mini games, called 'demo versions', because they based on the GHOST source code, were developed:

- Demo1: 1st-Person
- Demo2: 3rd-Person
- Demo3: God View
- Demo4: optimized+
- Demo5: optimized

Deviating from the previous explanation of 3rd-Person interaction-systems the 3rd-Person PC control was changed. Usually the PC is controlled with the left and right thumb as in a 1st-Person tablet game.

Indeed, the interaction system in Demo2 uses a touch based PC movement control as in the 'optimized' demo versions. In addition, camera rotation was enabled by integrating a two-finger-rotate gesture for camera rotation. The classic two thumb control is still used in Demo1. Figures 1 to 4 are screenshots made of each demo version, respectively.

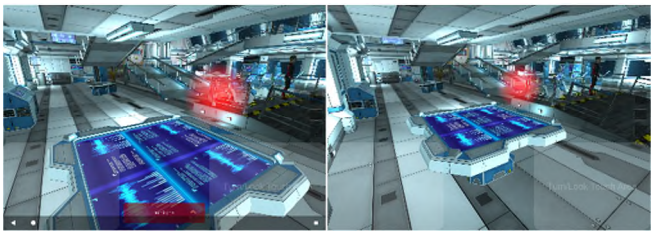

Figure 1. 1st-Person interaction system with dynamic appearing 'activate'-button for object interaction (Demo1).

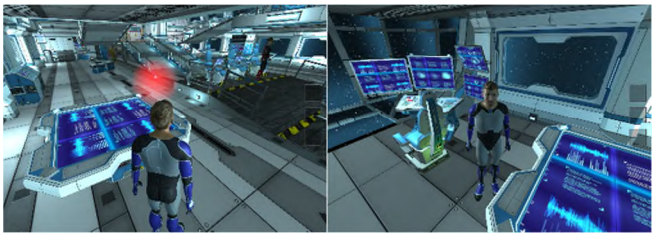

Figure 2. 3rd-Person interaction system before and after two-finger-rotate (Demo2).

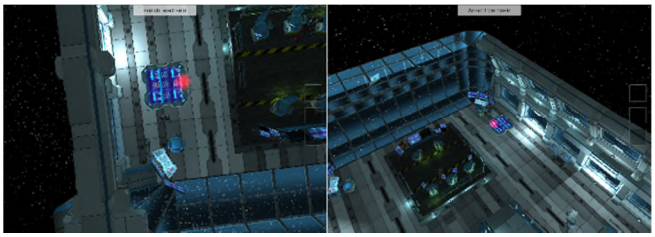

Figure 3. Good-View before and after gesture based camera rotation (Demo3).

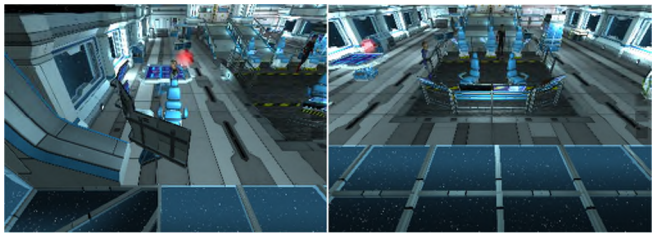

Figure 4. Adjacent camera zones in the optimized (+) interaction system (Demo4&5).

B. *Summary of Study Results*

TABLE I. SUBJECT DISTRIBUTION

	subject distribution				
	Demo1	***Demo2***	***Demo3***	***Demo4***	***Demo5***
age<=37	7	7	7	7	6
age>37	6	6	6	6	6
$\bar{x}$ age	39	38	40	41	41
SD age	17	16	16	15	15
n woman	6	6	6	6	6
n men	7	7	7	7	6
n	13	13	13	13	12

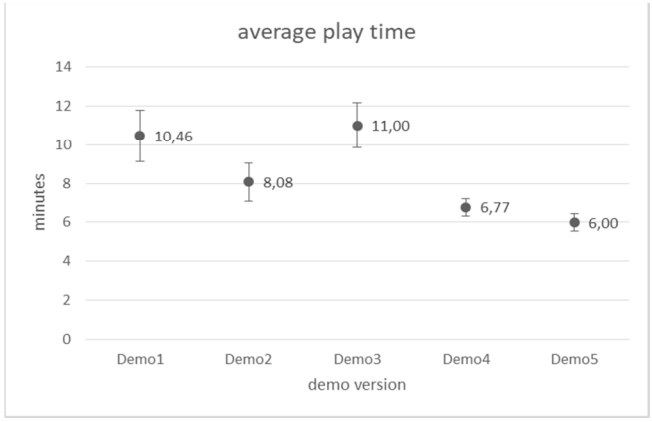

Figure 5. Average play time and 95% confidence interval.

In total 64 participants participated in the study. Table I provides information about the exact distribution of the test subjects to the individual demo versions.

An ANOVA was calculated and, by that, proved that the playtime differences are statistically significant ($\alpha = .05$; $F_{(4,59)} = 4{,}26$; $p < 0{,}0011$). Figure 5 shows the average playtime for each demo version. It can be seen, that the playing time of the demo version 4 and 5 are the shortest ones. As a result, the assumption that an intuitive interaction system simplifies the access to the game can be confirmed. By that, the 'optimized' or 'optimized+' interaction systems are the most suitable solutions for the GHOST-Prototype. Moreover the results show that there are performance

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differences between the groups <=37 and >37 and that demo version 4 and 5 minimize these differences.

VI. GHOST: A CDG BASED CYBERSECURITY AWARENESS TRAINING

Following the remarks of this paper, GHOST is a turn-based, tablet-based, serious game like, Competence Developing Game, which provides a cybersecurity awareness training for end users in companies. Furthermore, in GHOST a new intuitive interaction systems was implemented. By that, it has the potential to fulfill the seven requirements which were derived in chapter two.

Whether GHOST meets these requirements depends on the game design. First of all the game design tracks two aspects. It creates the space to experience which personal actions are positive respectively negative for the cybersecurity. Second, it demonstrates which and why IT-department activities are necessary and meaningful. By that, it allows the end user to notice missing activities in his/her company and in addition it will increase the employee's acceptance for such activities.

In case of a cybersecurity training too many topics in a short time period increase the risk to overwhelm the exercisers [1]. Therefore in the beginning each game round (playtime 30 to 60 min) treats only one serious topic. The IT risks are hidden between other tasks and rarely occur, as in reality. In order to evaluate which serious content should find its way into the GHOST CDG, Annex 'A' of ISO 27001 was analyzed (ISO/IEC 27001: Information technology – Security techniques – Information security management systems – requirements, see [17]). In Table II, the serious topic of each game round is presented.

The idea behind GHOST's game design is to minimize the organizational effort. By a trick, GHOST still provides player the illusion of playing together. Every GHOST training is designed for 8 players in two groups at the same time. The training consists of 16 units (game rounds) in total. However, each round gets a specific time period in which the round is active and ready for play. In this period each player can choose the moment to play the round individually. At the end of the time period the GHOST-System calculates, based on each individual result in a group, a common group result which is the starting point for the next round. If, e.g., a player misses to participate in one round the whole group result will be weakened. This kind of game design uses the business simulation advantages like group motivation and the enforcing of a specific continuous training cycle without the disadvantages of complicated appointment organization. Nevertheless GHOST allows even real multiplayer experience. The Round 7&8 as 15&16 require all 8 players to participate the training at the same time. Each group has to be in one physical room, the merging of the groups takes place via internet. These real multiplayer rounds serve as highlights of the complete training cycle. However, since two multiplayer rounds are played at one appointment, accordingly only two appointments must be arranged. As a result GHOST provides 16 play rounds and only requires the coordination of two appointments, which results in a huge reduction of the organizational effort compared to business simulations. Table II shows the assignment between serious content and game rounds.

As already mentioned, the serious content in GHOST is hidden between other tasks. To assure a simple knowledge transfer between the game environment and the real world it seems to be obvious to build an office environment inside the game. Accordingly, the player would solve everyday work tasks inside the game world to come across serious content from time to time. This would result in a game that simulates an office for a game player whose position is currently an office, means playing-office in the office.

TABLE II. GAME ROUNDS

Round	***Serious topic***
1	Screen lock
2	Handling of foreign flash drives
3	Phishing-Mails
4	Backups
5	Mobile Devices (especially Smartphones)
6	Websites, software installation, own IT infrastructure
7&8 (MP)	Passwords, Information encoding, Emergency response, Environmental Security, Backups
9	Access rights
10	Environmental Security, safe workplace
11	Virus prevention, Keylogger, Work delegation
12	Network Devices, Audits,
13	Log files, Access Right Management
14	Quiz Round
15&16 (MP)	Flash drive, Information encoding, Phishing-Mails, Malware, Passwords, Emergency response

MP = Multiplayer

This would most likely ruin the fun aspect of the game, what would gamble away the main advantage of a CDG, the transfer of the motivation of a game situation to a serious context. For this reason, the game was moved 50 years into the future. The players find themselves in a science fiction scenario on a space ship named GHOST. They experience a journey of sixteen laps (one lap one round) and figure out quickly that someone tries to sabotage the mission by infiltrating the ship's computer systems.

As a crew member each player has to handle a lot of day-to-day tasks, which are intentionally similar to 2017 tasks in a normal office. Nevertheless, a player has to be constantly on guard while interacting with the computer systems or other aspects in his environment. The assailant could start the next cyber-attack in any moment, with any strategy.

VII. CONCLUSION

GHOST is a novel approach to perform a cybersecurity awareness training for end users in companies. As shown in Section II such a training should fulfill at least seven requirements to match employer and employee expectations. However, this paper shows that the exploitation of the CDG concept provides the necessary resources to develop a

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suitable game design. It turns out, however, that the game control, due to the large target group, requires a closer examination. Therefore a study was carried out that solving this issue (evaluate req. 3). How the serious game content was systematically developed out of the well-known ISO 27001 is also explained.

Summarized a GHOST training can take place at the place of work to reduce the time expense. Since an extensive preparation is not needed the organizational overhead is reduced. Both aspects also reduce the training costs (req. 2a-c). Because of its sophisticated empirical evaluated (see Section V) interaction systems even employees without any game experience can participate the training (req. 3). In addition, this interaction system helps GHOST to have an entertainment game look and feel (req. 5). The turn-based, business game inspired, game design allows further a continuous training cycle, that is made possible with a computer-based training (req. 6 and 7). Moreover, the social significance of - and the increased attacks on- IT systems leave no doubt on the real life relevance of the underlying problem (req. 4).

In this discussion, only requirement 1 was left unmentioned. Requirement 1 demands a CDG to help an employee to develop skills, to increase his motivation and satisfaction and to strength the job relation. As already shown requirement 1 aspects have been taken into account throughout the GHOST development. Nevertheless requirement 1 can only be substantiated by field studies. However, the GHOST prototype will be ready for use in short future. Accordingly, for the experimental verification of the GHOST aftereffect a field study is already planned and will be performed in April 2018. The study will provide the possibility to validate the GHOST aftereffect and, by that, to prove the fulfillment of requirement 1 that is not addressed in this paper. After the evaluation of the GHOST aftereffect GHOST will be used for cybersecurity awareness trainings in real life.

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