Gamification and the marketing of agricultural machinery

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Abstract

This chapter introduces an implementation of gamification for the simulation modeling of agricultural heavy machinery. The objective of this study is to demonstrate how adding a gamification platform can both streamline the development process for a complex machine and enhance its marketing. To achieve this objective, a farm tractor is described with a physics-based multibody dynamics approach to provide realistic dynamic simulation in real time. The human-in-the-loop aspect of the simulation model enables “drivers” to select alternative feature options that affect dynamic performance. Moreover, adding gamification to the user-parameterized machine simulation model makes it more engaging and motivating, because it introduces to the driving experience game elements such as goals, curiosity, challenge, fantasy, and control. Marketing and sales teams also benefit from model gamification by exploiting the game data produced, the improved ability to readily demonstrate machine features, and the more compelling experience enjoyed by the users to launch new and more fruitful marketing and sales opportunities. The main scientific contribution of this study is its demonstration of an implementation of gamification for simulation modeling, the usefulness of adding the gamification elements, and how these additions can lead to improved product development and marketing processes.

Keywords: gamification, simulation modeling, marketing, multibody dynamics, product development, tractor, agricultural machinery

7.1 Introduction

Traditional approaches to product development and to consumer marketing can be improved by taking advantage of society's interest in game-like environments. Gamification channels the stimulating potential of game mechanics into a non-game context to motivate user involvement (Hamari & Koivisto, 2015). In complex machinery, operators can play an important role in determining design needs and maintenance requirements. By introducing a game-like environment to product development, the simulation models for complex machinery can be better used to motivate user engagement in the product development process. In addition, a gamified simulation model can serve marketing and sales by prompting earlier and more fruitful customer interaction and promoting better customer feedback regarding products under development. Its continued application can improve the customer experience throughout the machine life cycle and lead to novel new business opportunities.

According to Koivisto and Hamari (2019), gamification refers to "a design approach of enhancing services and systems with affordances for experiences similar to those created by games". These game-like affordances may be related to, for example, enabling progression tracking, establishing a social setting that includes networking, cooperation, and competition, and promoting immersion such as role play, the use of avatars, and in-game rewards. These affordances motivate users toward targeted behaviors with experiences such as enjoyment, flow, and accomplishment. For more than a decade, gamification has been applied both in academics and industry (Dehghanzadeh, Fardanesh, Hatami, Talaee, & Noroozi, 2019; Deterding, Khaled, Nacke, Dixon, *et al.*, 2011; McDonald, Musson, & Smith, 2007). In academics, gamification is used as an advanced digital tool for teaching (Dehghanzadeh *et al.*, 2019; Kurvinen, Kaila, Laakso, & Salakoski, 2020; Liu, 2017). In industry, it is currently used mainly for training (Brough *et al.*, 2007; Li, Grossman, & Fitzmaurice, 2012; Stadnicka & Deif, 2019).

Many papers in the literature describe the use of gamification in product development. For example, one paper proposed a gamified design methodology to improve product development

by engaging user needs, emotions, and personality (Signoretti, Martins, Rodrigues, Campos, & Teixeira, 2016). The role of game mechanics in this user engagement process was also studied (Leclercq, Poncin, & Hammedi, 2017). Note that game mechanics are the regulations and procedures of the game that help to define the game-like environment for the intended users. In a concept design phase, gamification has helped to evaluate team-confidence and decision-making ability (Petersen & Ryu, 2015). In some cases, it has been also been used to analyze the design requirements for a mobile working machine (Jaiswal, Islam, Hannola, Sopanen, & Mikkola, 2018).

In general, an agricultural machine system is complex (Jaiswal, Korkealaakso, Åman, Sopanen, & Mikkola, 2019). Such complex systems can be modeled using a detailed physics-based approach such as multibody dynamics (Avello, Jimenez, Bayo, & Jalon, 1993; Jaiswal, Rahikainen, Khadim, Sopanen, & Mikkola, 2020). This helps to provide a realistic dynamic simulation of the machine. In other words, it provides a digital platform that can be coupled with the gamification concept. This gamified digital platform can be used to improve the design of such complex systems by including operator performance and feedback in the simulation model. Operator experience is not part of the traditional design process (Pahl & Beitz, 2013; Schulte, Weber, & Stark, 1993), which strives to define all design requirements at the beginning even though some may not be determined until later. This gamified approach has the potential to make the design process more straightforward, because the effect of different configurations on final product performance can be studied early. By its nature, such a platform can engage users from the early design phase.

A gamified digital platform can offer additional advantages in terms of various aspects of marketing such as research, analysis, and product sales and promotion. From the marketing perspective, gamification is considered a value-added service in the form of feedback and interaction tools for users (Huotari & Hamari, 2011). So far, gamification for marketing has been applied mainly in consumer markets, where the focus is on improving loyalty, establishing positive word-of-mouth (WOM), and promoting engagement in brand communities (Hwang &

Choi, 2020; Xi & Hamari, 2020; Zichermann & Linder, 2010). Such targeted behavioral outcomes are strongly linked to branding. At first glance, this might not seem to apply to business-to-business (B2B) markets, where purchase decisions are typically influenced by attributes that are more concrete than brand such as price and delivery. However, the importance of B2B branding has been recognized, and this importance is growing (Leek & Christodoulides, 2011). For example, Bruhn, Schnebelen, and Schäfer (2014) found that customer-to-customer (C2C) interactions in brand communities provide customers with functional, experiential, and symbolic benefits that also increase brand loyalty in B2B markets.

The objective of this study is to demonstrate a gamification platform for complex working machinery to streamline the design process and marketing aspects. To this end, a farm tractor is considered as a case example. The tractor is modeled using a multibody dynamics approach, i.e., a physics-based modeling approach. The demonstration includes an affordance that enables progression tracking. Operators can customize their tractors to improve performance, and the tractor model offers three engine options. Incorporating game elements such as goals, curiosity, challenge, fantasy, and control is intended to motivate the users to engage in the simulation process. Within this setting, user experiences, game data, a survey, and interviews are assessed. Based on the findings, the advantages of integrating the gamification platform into B2B brand communities and enabling social and immersive game-like affordances are discussed.

The remainder of this chapter is arranged as follows. The procedure for modeling an agricultural machine is described in Section 2. Section 3 gives an overview of the gamification concept and its implementation. Section 4 provides the example of a farm tractor in a deformable-ground environment. It also includes a discussion of possible business opportunities. Finally, the conclusions are offered in Section 5.

7.2 Modeling an agricultural machine

A realistic dynamic simulation model of an agricultural machine can be developed using the

multibody system dynamics approach. In this approach, several equations that can be solved in real time are employed to describe the dynamics of the machine. The dynamic equations may couple different engineering areas such as hydraulics and control systems. The real-time capability enables the solution of the complex equations in a time less than the simulation time-step of the model. This can provide users with a sense of continuously operating the machine without any computational glitches.

The literature offers several formulations to describe the multibody simulation of a working machine (Avello *et al.*, 1993; Bae, Han, & Yoo, 1999; Bayo, Jalon, & Serna, 1988; Bayo & Serna, 1989; Jalon, Alvarez, Ribera, Rodriguez, & Funes, 2005). In this study, the simulation employs a semi-recursive formulation based on a velocity transformation (Avello *et al.*, 1993), which results in a computationally efficient approach suitable for real-time applications. Figure 7.1 proposes a design process that can be used to facilitate a user-parameterized simulation model.

Figure 7.1. A design algorithm to build a parameterized multibody model

7.2.1 Design process for parameterization

When parameterizing a multibody model, a base model is made first, and the parameterized parts are provided as add-ons (Mohammadi, Kurvinen, & Mikkola, 2019). Model requirements such as geometries and the kinematic and dynamic properties of the machine are collected to build the base model. The design specifications are collected for model parameterization. Depending on the number of parts to be parameterized, a separate file approach or a spreadsheet interface approach is taken. When the number of parameterized parts is less than or equal to five, for example, separate XML files are used along with the base model, which is also an XML file (Mohammadi, 2017). Otherwise, a spreadsheet interface is used, which is connected to the XML file of the base model using a script written in any programming language, such as Python (Jaiswal, 2017). Based on the parameterization requirements, the parts are assembled

to carry out a feasibility analysis. If the feasibility analysis succeeds, the model is tested, and the design is iterated based on the model requirements.

7.2.2 Environment modeling

The dynamic behavior of a customized real-time multibody model is dependent on the description of the virtual environment (Jaiswal *et al.*, 2019). To ensure a realistic dynamic simulation, it is essential to have an accurate description of the environment as well as the machine. Depending on simulation requirements, modeling certain environmental components makes it possible to represent the physical environment graphically. These components can contain complicated geometries and texture mapping. For this study of agricultural machinery, a deformable terrain environment can be modeled to facilitate the dynamic simulation in real time. This can be accomplished by combining mesh-based and particle-based methods, as already shown in Jaiswal *et al.* (2019).

7.3 Gamification

Gamification is a process of introducing game related elements in a non-game context to produce an enjoyable game-like experience (Werbach, 2014). In other words, gamification helps to motivate users to participate in various tasks and activities that can be otherwise non-attractive. The engagement of users is one of the prime advantages of gamification. With the addition of gamification, there comes a sense of challenge that results in new insights being realized that can be applied to non-game related activities. The gaming aspect encourages the basic human instinct to accept challenges, overcome hurdles, and ultimately win (Aparicio, Vela, Sánchez, & Montes, 2012).

For product development, a gamification implementation should provide positive experiences for the users. In turn, these potential future users of the simulated machine will come away with a positive impression. In this way, marketing of the machine product begins even before

it initial design is complete. Gamification coupled with digital platforms can be most effective by providing an interactive and social platform. The prime aspect is to motivate and engage users to achieve a goal. By allowing users to explore and utilize the product at the beginning, feedback is generated that can help the product designers target and achieve a more user-centric product. Furthermore, a user-specific game design may improve user satisfaction leading to increased productivity and end-user creativity (Werbach & Hunter, 2012).

Several approaches to implementing the concept of gamification have been proposed in the literature. In this study, however, the approach introduced by Aparicio *et al.* (2012) has been used. For an effective gamification process, Aparicio *et al.* (2012) proposed the following steps.

1) Identification of the prime objective of the task or activity that needs to be gamified
2) Identification of one or more transversal objectives that should capture the interest of users – Based on these objectives, a system is developed using game mechanics that can help to enhance the motivation and interest of the users.
3) Selection of the appropriate game mechanics to achieve the objectives and facilitate user motivation – According to the self-determination theory by Ryan and Deci (2000), instilling intrinsic motivation in users is accomplished by satisfying their psychological and social needs such as autonomy, competence, and relationships. Some examples of game mechanics for autonomy include avatars, fantasy, a configurable interface, privacy and notification control. For competence, examples include optimal challenge, positive feedback, intuitive controls, points, levels, and leader boards. For relationships, groups, messages, and connections to social networks are important.
4) Analysis of the usefulness of the implemented gamification based on factors, such as fun, user satisfaction, service quality, and quality indicators – Fun can be analyzed by examining playability metrics. This can be achieved by testing the users based on specific metrics and based on a questionnaire on the gamified process. A heuristic evaluation by experts can be used as an alternative to specific metrics. Effectiveness can be analyzed with a service quality model that uses predefined quality parameters. Here, a comparison can be carried

out between the values of the quality parameters prior to gamification and after the implementation of gamification.

7.3.1 Elements of a game

Game elements are introduced in a gamified application. A list of crucial game elements was identified by Read (2009). Key elements include goals and obstacles (which can be explicit contexts and enforced rules), challenges (which can be limited resources or a time constraint), and fantasy (which can be avatars and a realistic three-dimensional environment). However, Deterding, Dixon, Khaled, and Nacke (2011) concluded that compiling a universal list of game elements is not possible. Other possible examples of game elements include leader boards, ranks, badges, difficulty index, levels, team play, and playfulness.

In this study, the simulation model for a customizable agricultural machine, the farm tractor, offers a choice of three different engine models. The game elements introduced are a goal, curiosity, challenge, fantasy, and control. Figure 7.**2** illustrates the gamification algorithm employed.

Figure 7.2. Gamification algorithm employed in this study

7.3.2 Methods of data extraction

The quantitative information extraction procedures begin by recording the game data and analyzing it to support decision making on a particular phenomenon (Render, 1997). The recorded game data serves as quantitative information for the study. Interviewing operators is one of the viable methods for extracting qualitative information (O'Leary, 2017). Methods used can include factual interviewing, narrative interviewing, confrontational interviewing, and focused-group interviewing (Kvale, 2008). In this study, semi-structured face-to-face interviewing is used to collect feedback from the users about the playability of the gamified

application.

7.4 Case example of a farm tractor

The farm tractor model shown in Figure 7.**3** is used as the case example for this study. As explained in Section 2, the tractor is modeled using a semi-recursive multibody formulation. The tractor model has nine degrees of freedom (DOFs). Six DOFs are for the translation and rotation of the tractor in three-dimensions, one DOF is for the steering mechanism, and two DOFs are for the lifting and tilting of the front-loader. The front-loader is controlled by four double-acting hydraulic cylinders, two each for the lift and tilt mechanisms. The tractor model includes user parameterization. Operators can select one of three different engine options. To facilitate the dynamic simulation of the tractor model, a deformable sand field environment is described. This environment was introduced by Jaiswal *et al.* (2019).

Figure 7.3. Real-time tractor simulation model in a deformable sand field environment

7.4.1 Gamification of the farm tractor model

The tractor model in Figure 7.**3** is gamified by incorporating a goal, curiosity, challenge, fantasy, and control, as explained in Section 3. The rules, settings, and boundary conditions of this gamified application depend on the game mechanics used by the tractor model. In tractor operations, because of a restricted field of view, the operator has limited information about the position, angle, and weight of the bucket. Therefore, the goal of the gamified tractor model is to load and transfer approximately 500 kg of sand particles from a pile of sand onto the ground near the fence. The user interface developed to achieve a gamified experience for the tractor simulation model is shown in Figure 7.**4**.

Figure 7.4. The gamified graphical user interface of the tractor model showing the restricted field of view for the driver

Curiosity is introduced to the gamified tractor model by restricting the field of view of the driver, as is the case in an actual tractor. Challenge is introduced by limiting fuel and rolling angle. Both are monitored via the fuel gauge and roll inclinometer. Fantasy is introduced by running the simulation in a real-time simulator with a motion platform. The simulator gives realistic feedback during maneuvers and operations. Control is introduced using the bucket height, tilt, and weight indicators to provide users with the accurate position, angle, and weight of the bucket. To provide better tractor control, the simulator screen includes a tachometer, a speedometer, and gear and brake indicators.

As users drive the gamified tractor, their data is recorded. Based on the time required to achieve the stated goal; and other factors such as engine selection, fuel consumption, and rollover occurrence; a leaderboard can be compiled to monitor relative performance. The leaderboard can track the performance of 30 or more users comprising both experienced and inexperienced. In addition to the leaderboard, impressions about performance and other aspects of the user experience can be collected by making a questionnaire available beforehand and by organizing structured face-to-face interviews with the users afterwards.

7.4.2 Product development opportunity

What is learned from the users and what is recorded from their operation of the simulator can be used to modify, optimize, or validate the design of the tractor model. For example, a user-to-user comparative analysis of front-loader arm movement could be carried out. Based on relative performance as established by the leaderboard, tractor designers could then adjust front-loader arm length, for example, to optimize tractor efficiency. Jaiswal *et al.* (2018) explored the possibility of identifying key functionality design requirements for mobile working machinery. In addition to tractor functionality aspects, the user game data can also be used to identify key engine parameters, such as average fuel consumption. Using these data, machine design and operation related bottlenecks can be identified and optimized.

Features that most users deemed unsuitable can be initially identified from the game data and further confirmed through the interviews. Based on the findings, the product concept could be revised and these unwanted features could be eliminated. Furthermore, the gamified simulator experience can help to identify the driver interface features preferred by the users. For example, they may prefer to see machine data indicators such as the speedometer, inclinometer, or fuel gauge as a heads-up display (HUD). Understanding this preference early on could be invaluable for companies who are willing to integrate HUD-based technology into their vehicles.

7.4.3 Marketing opportunity

This study results is a gamified digital machine platform that most companies can integrate into the design and validation of agricultural machine products under development. Building a brand community and content marketing is not new to the heavy machinery industries. For example, John Deere is a well-known international farming equipment company. John Deere has worked to build brand identify and a brand community since the 19th century with its customer magazine “The Furrow” (Pulizzi, 2013).

The gamified digital platform also supports marketing by providing an easy and inexpensive demonstration of a particular agricultural machine. The parameterization capability of the machine simulation model gives it the capability of reaching a larger audience, irrespective of the availability of components. Moreover, potential customers can be given the opportunity to test a machine they are interested in and exercise it in various scenarios such as the deformable sandy environment used in this study.

In addition, the proposed gamified digital platform of a tractor can be integrated into traditional digital marketing channels such as an online customer magazine or social media platforms.

In the demonstrated solution, the gamified affordances enabled achievement or progression

tracking. That is, users were able to customize their tractors to improve performance. Stimulating user competitiveness in this way helped to motivate users to make more use of the gamified platform.

Affordances that enable social and immersive experiences (such as sharing game-play video, encouraging customization of the tractor, and providing avatars for game play) can be used to motivate brand-relationship behaviors. Shared user content is a specific form of word-of-mouth, which is known to positively influence attitudes and behaviors, as shown in the study by Herold, Sipilä, Tarkiainen, and Sundqvist (2018). Furthermore, the gamified digital platform allows users to exercise control over and associate themselves with the machine, which helps them to develop psychological ownership (Jussila, Tarkiainen, Sarstedt, & Hair, 2015).

7.5 Conclusion

The objective of this study was to demonstrate a gamification platform for complex machinery that can be used to streamline the design process and improve aspects of marketing and sales. A farm tractor was modeled as a case example using a physics-based multibody dynamics approach. This provided a realistic dynamic simulation of the tractor in real time. The parameterization design process allowed users to select an engine from three different engine options. The tractor model was gamified by incorporating the game elements: goals, curiosity, challenge, fantasy, and control. The role of gamification in this demonstration was to motivate users to engage with the simulator.

In the gamified tractor model, the goal was to load and transfer a moderate amount of sand particles from a pile of sand onto the ground near the fence. The user experience was collected in the form of performance data and data collected from a questionnaire and face-to-face interviews. This data serves to identify needs and optimize tractor design. The gamified tractor offers interesting marketing opportunities when integrated into digital marketing channels. The gamified application can have extensive outreach across versatile media platforms. Future

studies can focus on studying the varying user experiences under similar conditions. Furthermore, future studies could investigate potential misuse of the gamification concept in the context of marketing.

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