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Zombie Attack: A Simulation Game for Teaching Production Line Balancing

Rodrigo Luiz Gigante
Professor and Coordinator of Production Engineering
FACENS University
Sorocaba, Sao Paulo, Brazil
rodrigo.gigante@facens.br

Abstract

The teaching of logistical and operational concepts such as production line balancing can be significantly enhanced through the useof interactive simulation games. This work presents the application of Zombie Attack, a game developed in the FlexSim platform, as a didactic tool for introducing and practicing production line balancing in educational settings. In the game, players manage a factory that produces energy cells to keep zombies away from a surviving human city. The challenge involves aligning resources such as operators, machines, and internal transport to maintain an efficient production flow, avoiding delays, bottlenecks, and losses due to product deterioration. The game promotes hands-on learning of key concepts such as production pacing, workstation sizing, efficient resource allocation, and decision-making under financial constraints. This playful and engaging environment simulates real-world production imbalance scenarios, making it a powerful support tool for teaching production engineering, logistics, and operations.

Keywords
Simulation, Line Balancing, Engineering Education, FlexSim, Gamification, Production.

1. Introduction
Line balancing is a critical concept in production systems, involving the allocation of tasks and resources to ensure smooth workflow and minimal bottlenecks. Traditional teaching approaches often fail to convey the dynamic and interconnected nature of modern production lines. To address this gap, educational games and simulations have emerged as valuable tools in engineering education. Zombie Attack was developed as a pedagogical simulation game to teach production line balancing within an engaging and imaginative context: surviving a zombie apocalypse by maintaining the continuous production of energy cells. These cells are the only known deterrent against the undead, who now crave energy instead of brains. Students must manage a production facility under pressure, ensuring a constant flow of viable products while facing constraints in resources, deterioration of output quality, and random disruptions.

1.1 Objectives
This paper aims to: Present the design and educational application of the Zombie Attack simulation game; Demonstrate how the game introduces and reinforces production line balancing concepts; Analyze the learning outcomes from applying the game in an educational setting; Provide insights into how gamified simulations enhance student engagement and understanding.

2. Literature Review
The contemporary educational scenario faces the challenge of adapting to new technological realities and the demands of a constantly changing job market. Conventional teaching methodologies, often focused on the passive transmission

of content and the use of conservative resources, are insufficient to develop the skills and capabilities needed by today's professionals. In Higher Education Institutions (HEIs), where professional training is paramount, the need for innovative approaches that promote active participation, critical thinking and the practical application of knowledge becomes even more evident. In this context, active methodologies have gained prominence, aiming to place the learner as the protagonist of their learning process through discovery, investigation or problem-solving. These approaches promote a more humanistic and collaborative environment, where learning is more meaningful and knowledge is actively constructed, as opposed to traditional methods that start from theory to practice. In line with active methodologies, the use of playful and technological resources has shown promise in making the teaching-learning process more interactive and engaging. Among these tools, business games, serious games and gamification stand out.

Business games and serious games are teaching approaches that use simulations or game elements for educational purposes, not just for entertainment. They can generate a series of benefits in the teaching-learning process, such as learning content, developing skills and strategies, and improving cognitive and intellectual capacity. In virtual or simulated environments, players are involved in narratives that reproduce real processes and environments, learning through experimentation. Serious games, for example, can improve awareness of specific content and help change attitudes and perspectives. Their objectives, ultimately, aim to improve learning outcomes. Some games can simulate professional practices, helping students to think and act like professionals in areas such as engineering.

The use of business or company simulation games can bring significant benefits to the teaching of subjects in the Production Engineering course. Research indicates that games and related terms are closely linked to the teaching-learning process, with terms such as competence, leverage and experience indicating the objectives of the application of games. The application of games can occur in the classroom, case studies in companies or bibliographical research. The use of games in the academic and business environment can aggregate knowledge and stimulate competitiveness with a focus on results. However, research on academic articles at the National Meeting of Production Engineering (ENEGEP) between 2014 and 2019 revealed that, although the theme business game(s) has the largest number of publications (15 articles), serious games (1 article) and gamification (5 articles, including some already present in the business games theme) are still less explored in comparison. This lack of publications on the use of games in the teaching of Production Engineering may be related to the lack of promotion in the use of new active and playful methodologies.

Gamification is another related term that has emerged in this context, defined as the use of game design elements in non-game contexts to engage and motivate people. Unlike simulators, gamification uses game mechanisms to stimulate learning and make teaching more interesting and engaging. It can be a complementary or alternative form of learning, being applied after students have gained theoretical understanding. Gamification has grown in the business and educational sectors because it develops pleasure in activities. Its insertion in the academic context is driven by the culture of the new generation, which seeks more attractive ways to retain attention, such as simulating real-world situations adapted to the language of students. Gamification can involve students in solving real problems, helping them to give meaning to what they study. Examples of applications include the analysis of lean culture supported by gamification elements and the application of gamification in teaching to explore gaps in the literature or study theories used.

Simulation-based learning has become increasingly prominent in engineering education, allowing students to interact with realistic environments and scenarios that encourage critical thinking and problem-solving. Simulations enhance understanding of manufacturing dynamics by visually representing operational complexities, helping students understand abstract concepts such as productivity and takt time.

Gamification further amplifies this effect, increasing motivation and engagement. Gamification elements such as points, challenges, and narrative context enhance cognitive and affective learning outcomes. In the context of manufacturing engineering education, these elements can lead to a more intuitive understanding of process balancing and flow efficiency.

The application of simulation software such as FlexSim in academia is increasing. FlexSim allows users to model discrete-event systems and perform performance analyses, making it well-suited for teaching concepts such as

queueing theory, scheduling, and capacity planning. For example, simulation tools are useful in developing students' skills to model real-world industrial systems.

Line balancing, in particular, has been explored through a variety of educational strategies, including interactive tools and workshops. It advocates experiential learning models that allow students to engage in trial-and-error scenarios, reinforcing theoretical foundations with practical challenges.

The combination of simulation and gamification—as implemented in Zombie Attack—creates an experiential platform that mirrors complex manufacturing challenges, bridging the gap between academic theory and practical application.

3. Methods

Zombie Attack was developed by FlexSim using FlexSim software, a discrete event simulation software widely used in academic and industrial settings. The game is available on the FlexSim website at: https://www.flexsim.com/general/zombie-simulation-game/. The game simulates a simplified but realistic production environment, where players manage a factory responsible for producing energy cells that protect a surviving human city from zombie attacks (Figure 1).

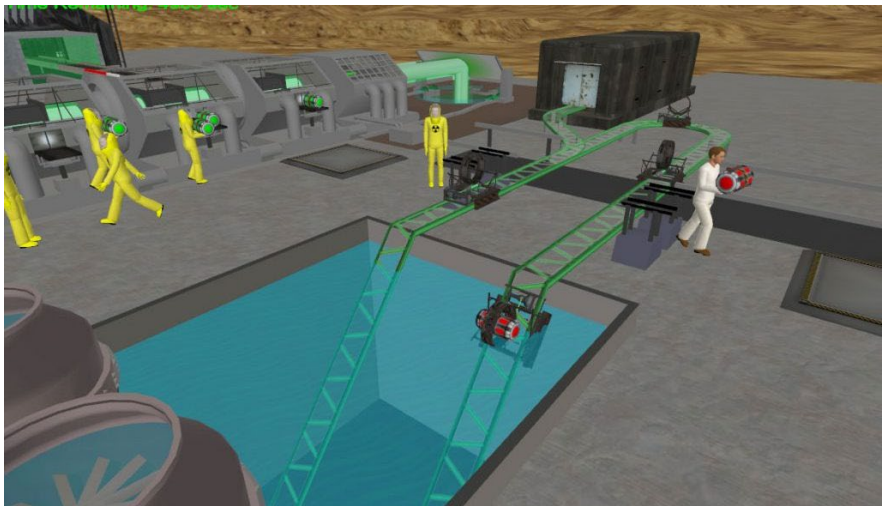

Figure 1. View of the game

The game scenario includes four workstations, each representing a stage of the production process. Players must allocate operators, manage machine scheduling, and control internal transport systems (e.g. conveyors or forklifts) to maintain a stable production flow. Each workstation has a time and processing capacity constraint, requiring careful planning to avoid bottlenecks (Figure 2).

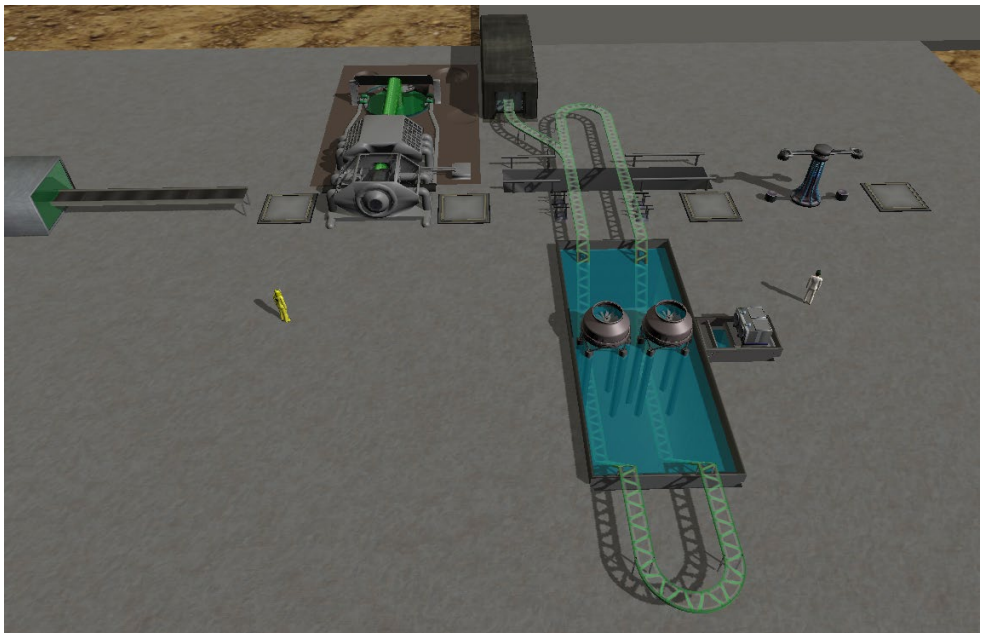

Figure 2. Workstations

The game was implemented in the undergraduate course in Production Engineering. Students worked in teams of 3 to 5 members, with each session lasting approximately 15 minutes. They were presented with a base scenario and then faced successive rounds with additional complexity, such as resource constraints, random interruptions, and demand fluctuations.

After each round, students participated in teacher-facilitated debriefing sessions. These discussions encouraged critical thinking and reflection on decision-making, resource allocation, and the impact of imbalances on production efficiency.

5. Results and Discussion

The implementation of Zombie Attack yielded both qualitative and quantitative results. A group of 40 first-semester manufacturing engineering students in 2024 participated in the activity. Data was collected through post-activity surveys and performance assessments. A comparison of pre- and post-activity assessments showed an improvement in understanding bottlenecks, resource leveling, and productivity optimization.

During the game, students naturally engaged in collaborative decision-making, applying techniques such as task reallocation and buffer optimization. Instructors observed an increase in participation, especially among students who previously struggled with the theoretical content. These results are in line with other studies that claim that gamified simulations improve both cognitive understanding and student engagement in engineering education.

6. Conclusion

This paper presented Zombie Attack, a gamified simulation developed in FlexSim to teach key concepts of production line balancing. The game places students in a fictional, yet operationally realistic scenario, where they must manage a factory under pressure, align production resources, and maintain output quality to survive a zombie apocalypse.

The educational benefits observed through classroom application suggest that the game effectively enhances student engagement and comprehension. By integrating core production engineering principles into an interactive and playful environment, the simulation promotes active learning, critical thinking, and systems-based problem solving.

All objectives outlined in this study were successfully met: the game design was described, its didactic purpose was illustrated, and its educational potential was demonstrated through observed improvements in student participation

and understanding. The simulation also contributes uniquely to the growing field of gamification in engineering education, offering a replicable and adaptable model for teaching production concepts.

Future work may include the collection of quantitative data to formally assess learning gains and the development of variants of the game to explore other operations management topics, such as inventory control, scheduling, or quality assurance.

References

AMÉRICO, Marcos; NAVARI, Shelley C. Gamificação: abordagem e construção conceitual para aplicativos em TV digital interativa. GEMINIS – Grupo de Estudos sobre Mídias Interativas em Imagem e Som, UFSCAR, São Carlos - SP, ano 4, v. 2, n. 2, 2013. Disponível em: http://www.revistageminis.ufscar.br/index.php/geminis/article/view/163. Acesso em: 20 set. 2016.

Antonio, D. G., Werneck, A. M. F. & Pires, S. R. I. Simulação, cenários, jogos e cases aplicados no ensino da Engenharia de Produção. In: Simpósio de Engenharia de Produção, XII, Bauru, 2005.

CORRÊA, Henrique L.; CORRÊA, Carlos A. Administração de produção e operações: manufatura e serviços: uma abordagem estratégica. 4. ed. São Paulo: Atlas, 2017.

CORRÊA, Henrique L.; GIANESI, Irineu G. N.; CAON, Mauro. Planejamento, programação e controle da produção: mrp ii/erp: conceitos, uso e implantação: base para sap, oracle applications e outros softwares integrados de gestão. 5. ed. São Paulo, SP: Atlas, 2007.

FARDO, Marcelo Luis. A gamificação aplicada em ambientes de aprendizagem. RENOTE Revista Novas Tecnologias na Educação, v.11, n. 1, 2013a. Disponível em: http://www.seer.ufrgs.br/index.php/renote/article/view/41629/26409. Acesso em: 19 ago. 2016. https://doi.org/10.22456/1679-1916.41629.

FARDO, Marcelo Luís. A gamificação como estratégia pedagógica: estudo de elementos dos games aplicados em processos de ensino e aprendizagem. 2013. 106 f. Dissertação de Mestrado (Mestrado em Educação). Programa de Pós-Graduação em Educação. Universidade de Caxias do Sul, Caxias do Sul, RS. Disponível em: https://repositorio.ucs.br/xmlui/handle/11338/457. Acesso em: 17 maio 2017.

FARIA, Ana Cristina de; COSTA, Maria de Fátima Garmeiro da. Gestão de custos logísticos. São Paulo: Atlas, 2005.

MIGUEL, Paulo A. C. Estudo de caso na engenharia de produção: estruturação e recomendações para sua condução. Revista Produção. São Paulo, v. 17, n. 1, p. 216-229, 2007. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-65132007000100015&lng=pt&nrm=iso&tlng=pt. Acesso em: 13 nov. 2016. https://doi.org/10.1590/S0103-65132007000100015.

OLIVEIRA, Luciano Valente et al. Utilização do conceito de gargalos em uma linha de produção - uma análise da interpretação do conceito. In: ENCONTRO NACIONAL DE ENGENHARIA DE PRODUÇÃO – ENEGEP, 35., 2015. Fortaleza. [Anais...]. Rio de Janeiro: Associação Brasileira de Engenharia de Produção (ABEPRO), 2015, p. 1-9. Disponível em: http://www.abepro.org.br/biblioteca/TN_STO_206_219_27447.pdf Acesso em: 30 out. 2016.

ORLANDI, T. R. C.; DUQUE, C. G.; MORI, A. Gamificação: uma Nova Abordagem Multimodal para a Educação. Biblios, Brasília, n.70, 2018. Disponível em: http://www.scielo.org.pe/pdf/biblios/n70/a02n70.pdf. Acesso em 01 nov 2021.

Pereira, T. A. Metodologias ativas de aprendizagem do século XXI: Integração das tecnologias educacionais. In: Congresso Internacional ABED de Educação a Distância, Foz do Iguaçu. Anais eletrônicos... Foz do Iguaçu: ABED, 2017.

Sauaia, A. C. A. Laboratório de Gestão: simulador organizacional, jogo de empresas e pesquisa aplicada. (3a ed.), Manole: Barueri, 2013.

SILVA, A. R. L. da et al. Gamificação na educação. São Paulo. Pimenta Cultural, 2014.

TUBINO, Dalvio Ferrari. Planejamento e controle da produção: teoria e prática. 3.ed. São Paulo: Atlas, 2017.

VIEIRA, A. S.; SAIBERT, A. P.; NETO, M. J. R.; COSTA, T. M.; PAIVA, N. S. O estado da arte das práticas de gamificação no processo de ensino e aprendizagem no Ensino Superior. Revista Brasileira de Ensino Superior, Passo Fundo, v. 4, n. 1, p. 5-23, 2018.

ZICHERMANN, G.; CUNNINGHAM, C. Gamification by Design. Sebastopol: O'Reilly Media Inc., 2011.

Biography

Rodrigo Luiz Gigante is a professor and coordinator of production engineering at FACENS University, Sorocaba, Sao Paulo, Brazil. He earned his master in Production Engineering from the University of São Paulo (2010); Bachelor of Applied Mathematics and Scientific Computing from the University of São Paulo (2007). His areas of expertise are Operational Research, Discrete Event Simulation, Scheduling, Queue Theory, Production Planning and Control and Logistics.