Handbook of
Digital Games
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Edited by

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Introduction

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In 1978, in his now classic Platonic book *The Grasshopper: Games, Life and Utopia*, the philosopher Bernard Suits wrote of a future in which the only human activity is game playing and where the human race has developed what he calls the lusory effect, a psychological attitude required of a game player entering into the play of a game. In complete contrast to the perception on working life and Wittgenstein, Suits argued that game playing is a voluntary attempt to overcome unnecessary obstacles and that playing games is a central part of the ideal of human existence; thus games belong at the heart of any vision of utopia. By the time of his death in early 2007, Suits should have been able to witness proof of a Darwinian evolution of the gaming utopia he foresaw 30 years before in the social fabric of modern life, which is driven by social connectivity, shared experiences, and collaboration, whether in real or virtual worlds. Be it political games, military games, business games, or recreational games, the boundaries between what is real and what is virtual are fused. All are but clues to our future, Suits argues, concluding that cultivation is our salvation.

Since Suits outlined his original vision, the cultivation of digital games has seen them grow at a phenomenal rate into a multi-billion-pound/dollar industry with a strong market share in the entertainment industry and heavily reliant on the rest of the industry for development and promotion. The digital game culture has gradually been shifting from the pull culture of the arcade to the push culture of the mobile device. The digital game culture began to shift in the early 1980s, along with the average age of the gamer, neither in the juvenile nor in the early adolescent range, but in the mid-30s range. Digital games are now played on a broad range of portable and fixed game consoles rather than being limited to a single technical platform, including desktop and tablet PCs, dedicated consoles, and mobile phones. We now have a popular game culture; games are imitating art and vice versa, game generations are fast producing game decay or bit rot, and game preservation has taken on
the role of saving our game history. Nowadays, it is the norm to expect a popular game to become a movie and vice versa.

Regardless of device and virtual environment, social connectivity allows people to share ubiquitous experiences anywhere, at any time, on any device, and over any network, often adapted to their individual needs and desires. The Web has been a huge contributor to the growth of digital games particularly via massively multiplayer online games (MMOGs), such as *World of Warcraft (WoW)* and *The Sims*, and social networking sites, such as Facebook. Social networking sites in particular have had a huge effect on the gaming community in a relatively short space of time, not least by raising the potential and actual audience of players that a game has to serve, even eclipsing those hitherto held by massively multiplayer online role-playing games (MMORPGs). Nevertheless, digital games critics argue that playing games is at best recreational and at worst desensitizing and degenerate and subsequently no match for the education and literacy that comes from reading physical books, despite their lack of interactivity, lack of fellow readers to share the experience with while consuming the book, and absence of ubiquity. Despite the polemic, digital games have justifiably earned their place high up on the list of “new” computational media.

All new media that led to the creation of lasting academic and/or industrial communities, when they emerged, shared two properties: They were mass media and they told stories that allowed us to reflect on what it means to be human. The cinema is one such example. When it emerged as new media in the early twentieth century, it gave birth to a lasting community of scholars and numerous industry-based communities. Computer games, which are interactive, have complex rules and intricate real-time computer graphics have the ability to tell rich stories and provide social commentary. With games such as *SimCity*, which requires public transport systems to achieve large-scale cities, *Civilization*, which provides a technology-driven view of the march of history, or *Grand Theft Auto: San Andreas*, with its graphic representation of street crime, it is clear that games tell stories and exhibit a kind of rhetoric based on the ideas baked into the underlying computational processes. Both cinema (older media) and games (newer media) currently have research and industry-based communities focused on exploring the sociological and humanistic elements of each media. As a consequence, modern computer games are the product of multidisciplinary research and development that exhibit constant technical advances and innovations in their game engines across many disciplines: computer graphics, AI (artificial intelligence), HCI (human–computer interaction), databases, network technologies, arts, social sciences, and the humanities, to name just a few.

It is not surprising that games resulting from multidisciplinary developments vary widely across communities. However, six common and potentially definitive characteristics define most games, if not all: rules, variable and quantitative outcomes, valorization of outcome, player effort, player attachment to outcome, and negotiable consequences. Furthermore, gamers, in their attempts to categorize games by their structure and content, build a game landscape that converges on four clusters: strategy games, first-person shooters (or rather games where the player controls an avatar in the game space based on vagrant positioning and camera placement),
progression and exploration games (such as exploration of story, character, or game world), and perfect information games (where all information on the game state is available to the player, sharing a resemblance to traditional physical games like Chess or Go).

On the contrary, research on games is largely focused on game design with the latest research efforts seeking to exploit technologies from other complementary areas of computing and other disciplines in order to enable players to enjoy a ubiquitous gaming experience anywhere, at any time, on any device, and over any network that is adapted to their individual needs and desires, such as through recognition of their gaming prowess and effective opponent and teammate matching. The increasing research attention drawn by the player experience has gradually extended to the social and cultural aspects during game play and cross-cultural analysis of games. For example, in *WoW*, a data-mining infrastructure gathers and processes character data which are stored in an online character repository. As a result, game design now exploits, for example, both static and dynamic representation of game semantics, human and nonhuman autonomous player behavior prediction, team dynamics, avatar evolution, game world customization, story narratives that evolve with player behavior, and intelligent techniques for such processing.

A nonexhaustive list of current research areas includes:

- **Game design**, which has not yet established a theoretical basis for creating the virtual game spaces but is performed intuitively.

- **Game architectures and environments**, which enable routine construction of game engines and support environments. Three-dimensional (3D) games are currently built on top of a game engine that provides 3D model display and animation, collision detection, effects, AI, level design, and so on.

- **Intelligent narrative technologies** that deliver coherent, linear, and customized story flows that afford a player a high degree of agency in the world, that is, to move freely and perform actions as they wish. This involves developing representations of story structures that can be reasoned over and planned from to deliver a customized story experience to the player which requires a variety of techniques ranging from game design to HCI to AI.

- **Procedural content generation** spanning very large virtual spaces which are not completely generated by human authors. This requires game level, player, quest, background history, and asset design which in turn require computer graphics, animation, databases, and intelligence techniques.

- **Interfaces** which create novel game play experiences. The success of platforms such as Wii and games such as *Guitar Hero* yields nonstandard interfaces to the general public. These by and large require HCI techniques.

- **Real-time computer graphics** that are capable of execution in real time on current graphics hardware and techniques for animating players, performing lighting of game worlds, nonphotorealistic rendering, and collision detection.

- **Databases** which are capable of supporting large numbers of simultaneous users interacting in MMOGs.
• Networking that is capable of supporting multiplayer play while maintaining the consistency of the game world for all players in the face of rapid movement and frequent interactions. This requires techniques for dead reckoning and determining a player’s line of sight.

• Games for learning and education that develop new theories for exploiting game rules and worlds for enabling learning. This is gaining momentum for teaching traditional school subjects. At present, developing a game experience to teach specific kinds of knowledge is largely a game of skill and drill repetition.

• Nonhuman autonomous players that are able to interact with human players, express emotion, react in appropriate ways, and take effective action during game play. This requires AI techniques, including natural language processing, animation, and representations of nonhuman autonomous player profiles.

• Player recognition that tracks and records player actions for the purpose of individualizing the game experience. This requires AI techniques and representations of human player profiles.

• In-play player impact assessment that assesses the impact of in-play game design changes on players. This requires game play metrics, AI techniques, and either static representations or dynamic generation of game semantics profiles.

• Platform recognition that enables games to become platform aware in order to match players on similar platforms to one another based on their device capabilities. This requires AI techniques and device representations.

CHAPTER SUMMARIES

This handbook comprises chapter contributions from leading researchers and developers worldwide which are grouped into three broad parts spanning the research areas, both classic and emerging, outlined above: gaming techniques and tools, game play, and game design and development. Many chapters are relevant to multiple sections and therefore we have attempted to map the chapters to a single part based on their primary focus. The primary audiences of the chapters are game industry professionals and the growing interdisciplinary body of university academics and researchers who work in the digital game area as well as areas associated with digital games, such as game studies and design, social media, and all aspects of game development. A secondary audience is professional gamers and informed consumers seeking a deeper technical understanding. The parts and their chapters are now summarized in turn.

Part I: Gaming Techniques and Tools

The chapters in this first part are concerned with a diverse range of techniques and tools for digital games, encompassing adaptive and procedural content generation,
automatic narratives, collision detection, simulation of crowds, network issues such as synchronization, sharing of social information, collaboration, advertising, and the use of AI techniques for simulating game play.

**Chapter 1**

In this opening chapter, which is the first of three chapters on content generation, researchers from Imperial College, London, explore methods for automatically generating game content and games that are adapted to individual players through the modeling of player needs. They identify and discuss three main aspects: generation of new content and rule sets, measurement of this content and the player, and adaptation of the game to change player experience. Various types of games are presented to illustrate their approach.

**Chapter 2**

In the second chapter on content generation, the author from the University of Huddersfield, United Kingdom, surveys the state of the art in the increasingly important area of procedural content generation (PCG), whereby algorithmic methods are used to produce game content in order to satisfy the demand for complex detail and behavior in digital games. He discusses common areas of PCG implementation such as fractal terrain, RPG (role-playing game) loot generation, enemy placement, and resource distribution as well as more diverse areas such as mission objectives, dialog trees, character profiles, and behavior patterns and even emergent areas such as AI behavior and dynamic autonomous environments.

**Chapter 3**

In the third and final chapter on content generation, researchers from Tampere University of Technology, Finland, argue that procedural content generation is not well explored in browser environments and therefore utilize content generation methods to create content for a multiplayer browser-based fantasy game, where all the quests are generated dynamically at run time based on quest templates. They identify problematic areas of game design where PCG can offer valuable solutions, consider active-versus-preparatory PCG, describe common PCG content types and their production, and present the limitations and potential for PCG in game design. They show that their approach can supplement precreated content, expand overall content, and increase replayability.

**Chapter 4**

In an area closely related to content generation, this chapter considers automatic storytelling techniques to improve player experiences and considers the specific case of MMORPGs. The author from the National Chiao Tung University, Taiwan, argues that players often complain about weaknesses in the drama and story elements of
MMORPGs because they tend to spend much longer in these games than others and because allowing players to live their own stories through decisions and actions constrains the capacity for delicate story authoring. To tackle these issues, he presents some narrative intelligence techniques that can be used to address these problems to some extent. He also proposes methods for creating player memorials of in-game actions, such as video clips and comics based on game logs, so that players can remember and reminisce about their achievements.

Chapter 5

In this chapter, researchers from the University of North Carolina at Charlotte consider approaches for accelerating collision detection in games. They present a series of algorithms to replace the traditionally used tree-based spatial data structures with the graph-based navigation mesh that tends to be used for game character path planning. They argue that using a single data structure for both character navigation and collision detection acceleration in games can reduce the costs of construction and maintenance as well as shorten development time and require less memory overhead at run time. Their results demonstrate a 50% decrease in collision detection time between dynamic objects in comparison to k-d trees and show that navigation mesh accelerated collision detection outperforms spatial hashing accelerated collision detection across all tests.

Chapter 6

A research team from Utrecht University, The Netherlands, reveals how developments in gaming hardware and realism have made it possible to populate virtual worlds with high numbers of characters such that background crowds are able to give the player an increased sense of presence. Consequently, they examine the origins of crowd simulation, look at academic research approaches, and give practical guidelines on how to create crowds in virtual environments so as to minimize the resource expense while maintaining the sense of realism for the player. A compilation of metrics and results from perceptual studies forms usable guidelines for optimizing crowd behavior for a particular game.

Chapter 7

In this chapter, the author from the University of Bologna, Italy, overviews some of the main issues and proposed solutions for synchronizing distributed multiplayer online game nodes in a responsive and reliable way, catering for different distributed architectural solutions, such as client/server, peer-to-peer, and distributed (mirrored) game server architectures. He argues that, since multiple nodes may be employed to manage the same, redundant, portion of the game state, a high reliability and fault tolerance is ensured, but this is at the cost of requiring consistency management algorithms to be executed by these nodes. Since MOGs have strict responsiveness requirements, it is not possible to resort to traditional synchronization algorithms.
Chapter 8

Users play together to achieve goals or to conflict with each other and beat their opponents. This is the basis of digital social games and, in this chapter, a research team from Italy spanning the University of Rome Tor Vergata, Università Cattolica del Sacro Cuore, Italy, and Telecom Italia analyzes the key concepts of social information, that is, the primal material of social game interactions. They introduce a classification of current digital social games and consider social information and its presence in different games. They then elaborate on three case studies of social games and provide schemes of how social information is implemented and used in a digital gaming context. A model of social information exchange is introduced and developed at the level of scenarios, communication process, and most relevant messages.

Chapter 9

Continuing the exploration of collaborative gaming, a research team from Brunel University, United Kingdom, considers the development of multipurpose collaborative games which integrate both lusory and ludic dimensions. They propose a framework incorporating both dimensions and present the implementation of a collaborative supply chain game. They demonstrate that such collaborative games are both resolute and entertaining.

Chapter 10

In contrast to the previous two chapters, researchers from the IT University of Copenhagen, Denmark, consider the use of AI-infused players. They argue that, while strategy games are closely related to classic board games such as Chess and Go, there has been little work on the use of AI for playing strategy games. They therefore consider how to create AI that plays strategy games through building and comparing AI for general strategy game playing.

Chapter 11

Moving away from game mechanics, research from the University of Antwerp, Belgium, considers the emergent area of advertising within digital games. They discuss the history and taxonomy of the use of advertisements in games, showing how brands can be integrated into digital game environments and how the phenomenon has evolved throughout the years. They consider the current effectiveness and future prospects of the advertising medium, discussing and juxtaposing research concerning people’s awareness and evaluation of in-game ad placements and examine how gamers really think and feel about commercial practices inside their favorite games.

Part II: Game Play

The second part of the book brings together chapters that are focused on various aspects of game play, accommodating immersion, player experience, game aesthetics,
mobile game play, meaningful gaming for education, and retrospective examinations of gaming and game play.

**Chapter 12**

In the opening chapter of this part, researchers from the University of York and University College London, both in the United Kingdom, review immersion in relation to other concepts that are used to describe gaming experiences. These include concepts that are not specific to games such as flow and attention; generic conceptualizations of the gaming experience of which immersion may form a part, such as incorporation; and specific concepts around immersion, engagement, and involvement such as presence and other formulations of immersion. They describe an experiment that positions immersion in relation to presence, thereby providing an empirically founded understanding of these rich, subjective experiences.

**Chapter 13**

This chapter argues that studying the experiences of game players is a nontrivial undertaking due to the dynamic, interactive, and complex nature of the media. Consequently, researchers from the University of Münster, Germany, propose an integrated model of player experience (IMP) that distinguishes between the preuse (choice), use (play), and postuse (effects) phase and accounts for personal (player traits and states), media (game characteristics), and contextual (setting and social environment) variables. Based on the IMP, they provide an overview of available means to study player experience and describe how they have been and can be used and what advantages and disadvantages they have. Their purpose in doing so is to guide each step from formulating research questions and hypotheses, the operationalization of variables, and the selection of suitable research methods when carrying out user-centered game studies.

**Chapter 14**

In this chapter, the author from Aalborg University, Denmark, explores player engagement by investigating how it is described in relation to digital games, how it can be evaluated, and how it can be used in the design of gamelike applications. In particular, he focuses on the willingness of the player to continue playing, termed “continuation desire.” He argues that this is an essential consideration when designing and evaluating digital games and interactive narratives. Consequently, he proposes a model of continuation desire, which is based on an empirically identified range of causes of the desire to continue playing, and various methods that can be used to assess and evaluate continuation desire are described in order to illustrate how it is possible to assess the levels of continuation desire experienced by players while playing and when returning to play a game. The practical use of the continuation desire model and the evaluation methods are demonstrated through a case study of an interactive storytelling application: the “First-Person Victim.”
Chapter 15

In this chapter, the author from the University of Bolton, United Kingdom, considers games from the point of view of them being aesthetic objects and therefore argues that they can be understood using theories originating in the philosophy of art, and the players of such games can be studied by empirical investigations into the aesthetic values that influence their choice of game. Thus, by tracing a series of player satisfaction models and positioning these in the context of other work in the area, he extrapolates answers to the questions of how and why people play games. He argues that understanding aesthetic preferences for particular kinds of play in terms of the underlying neurobiological substrates associated with the emotions of play may provide the basis for establishing an empirically derived trait theory of play.

Chapter 16

A research team from Hochschule Bremen, Germany, considers mobile games, such as Angry Birds, Pig Rush, or Tiny Wings, as rule systems based on the physical movement of a player in a world merging the real world with virtual dimensions. They argue that the changing context of play transforms the play experience and opens up new design possibilities and consequently the chapter focuses on gaining a comprehensive understanding of mobile game play and the particular way of playing mobile games, uniting both traditional and novel facets of gaming and play. At the center of their study are games as systems, the contexts of play, and the activities of the players. By analyzing relationships between game systems and contexts of play, they conclude that mobile game play is a moment of everyday life activity.

Chapter 17

This chapter explores how multiple discourses present in film, photography, video games, and machinima may be related when commercial video games are present in secondary education classrooms combined with other new or traditional technologies. Through this, the researchers from the University of Alcalá, Spain, seek to encourage the development of new forms of literacy within the framework of a participatory culture and explore how conversations between children and adults as gamers or producers can contribute to drawing awareness to the rules of these interactions. Using an ethnographic approach from a school study, they analyze the relationships between the video productions, the game, and the stories generated by the players both inside and outside the game. Their results demonstrate how video games combined with other technological tools can be educational tools contributing not just to motivation in the learning processes but also to children developing new ways of being literate individuals.

Chapter 18

Another research team from the University of Alcalá, Spain, continues the digital games for education theme by exploring the different roles that commercial video
games can play as integrated learning tools in primary and secondary education. Their goal is to design innovative educational contexts which contribute to creating responsible citizens who possess a critical awareness of the new communication scenarios provided by today’s technology. Furthermore, they hope to understand how commercial video games can inspire a motivation to learn and develop thinking skills. From their data, they observe how certain commercial video games allow a hidden curriculum to arise, making it possible to develop specific thought processes and skills acquisition while promoting positive attitudes such as a respect for the environment or collaboration with others. Their chapter is based on the data collected during a large research project, the aim of which is to explore how commercial video games provide innovative educational opportunities in the classroom that bring children and adults into the new digital scenario. They examine relationships between real and virtual universes as situated cognition processes involving game situations based on different simulation videogames, such as SimCity.

Chapter 19
Researchers from Flinders University, Australia, report on over a decade of work to research, collect, and preserve the production and reception histories of local digital games in 1980s Australia and New Zealand. “Play It Again” is a collaborative project between researchers at several Australasian universities and three cultural institutions, the ACMI (Australian Centre for the Moving Image), the New Zealand Film Archive, and the Berlin Computerspiele Museum, where engagement with retrogaming and other communities is central to the approach of the project.

Chapter 20
In the final chapter of this part, the author from the Université de Montréal, Canada, argues that, as digital games have evolved, game designers have sought to create more complex experiences without alienating potential players. Consequently, he presents a retrospective study that focuses on the rise of the cooperative mode of address in game design, which he defines as the way game publishers and designers have addressed potential players in a more inclusive way than the competitive paradigm associated with the early days of gaming in arcades. It is discovered that this paradigm encompasses the overt address to players in promotional material as well as the implicit address inscribed in the various systems that take part in the immersive experience.

Part III: Game Design and Development
The final part draws together chapters that focus on the design and development aspects of digital games. The chapters address a range of topics: emotion in games, spatial game structures, ontological analysis of digital games, entertainment software design theory applied to human computation games, gender differences in game
development, game development for learning, game design based on child development theory, and independent game development.

**Chapter 21**

In the first chapter in this part, researchers from the University of Southern California and IST—Technical University of Lisbon, Portugal, argue that despite considerable progress in physics, graphics, sound, and storytelling, most games still tend to be essentially linear, feel scripted, and break player immersion due to nonbelievable character behavior. Consequently, they propose the use of emotion for improving the player experience through a psychology-based framework that draws on techniques from the arts for drama and storytelling to help game designers elicit emotion in players, simulate emotion in nonplayer characters, and interpret the players’ emotions. In doing so, they review relevant psychological theories of emotion and computational models of emotion and discuss their implications for games.

**Chapter 22**

An important aspect of digital games is its spatial structure. Researchers from the National Chiao Tung University, Taiwan, argue that this is determined by the system architecture and program code and consequently analyze the deployment of puzzles and quests in varied spatial structures and the mechanisms for players to balance their skills with the current challenges so as to sustain their gaming flow. They reveal how other gaming factors, such as storylines, resource allocation, and reward systems, match such spatial structures in game design to provide coherent gaming experiences. Categorizing spatial structures into three basic types (ladder, maze, and grid), they map their association to game genres and corresponding design principles and introduce a hierarchical architecture for hybrid games, which maintain the players’ sense of balance and fairness in terms of game task arrangement.

**Chapter 23**

The author from the University of Turin, Italy, argues that designers and programmers constantly use naïve interpretations about games and therefore proposes a social ontology of games that can lead designers and programmers to develop games without subjective points of view, but rather with an objective knowledge of the fundamental game properties. He argues that the ontology of games is always social and examines three examples of ontological analysis of games: the structure of gaming interaction, the role of rules in digital games, and their simulation attempt.

**Chapter 24**

Players are capable of solving difficult problems through human computation games while ubiquitous gaming provides opportunities to solve those problems. Consequently, in this chapter, researchers from Miami University, Florida, outline the
Introduction

characteristics of human computation games and ubiquitous games in a variety of disciplines, describing their key components of such solutions and articulating their distinguishing characteristics from other types of entertainment software. They focus on entertainment software design theory as applied to human computation games, outlining the fundamental characteristics of such games and offering approaches for applying human computation games to promote player engagement and adopt application.

Chapter 25

In this chapter, researchers from ETR Associates and the University of California, Santa Cruz, argue that the essentialization of gender apparent in the stereotypes found in the most popular video games is off-putting to many girls. Consequently, they present their study aimed at better understanding the role of gender stereotypes in the gaming preferences of girls and boys and the conditions under which they vary. Analyzing the content and game mechanics of 231 games made by middle school girls and boys in the United States, they found that girls’ games were more likely to focus on the players’ experience and to engage the player in a storyline, social relationships, conversations, and problem solving for the social good, while boys’ games were more likely to include violence against nonhumans and objects and focus on victory, competition, or conquest and take place in larger-than-life settings. However, their further analyses revealed that these gender differences were better explained by prior computer and gaming experience and whether or not students made their game with a partner or alone.

Chapter 26

Focusing on children’s learning through building video games, researchers from the College of Charleston and the University of Pennsylvania ask the question, what kind of building and what kind of learning is going on in making games? In answering this question, they investigate a decade’s worth of research surrounding children’s learning through designing and building their own digital games: first by examining the sharp spike in various software applications specifically geared to allow youth to create their own video games and second by exploring children’s learning as they interact online and the overall nature of game-making communities in fostering creative collaboration among youth. They highlight successes and propose curricular and pedagogical recommendations for a more seamless incorporation of game-making technologies and approaches into schools.

Chapter 27

In this chapter, researchers from Eindhoven University of Technology, The Netherlands, examine how various properties of play have inspired and can inspire new design directions for digital games and intelligent play objects. Play theories from a child development perspective are described and related to concepts from
game design, such as game mechanics and dynamics. They also discuss how different properties of play relate to children practicing social, emotional, physical, and cognitive skills in a playful and fun context. A well-known model of digital game design is the mechanics, dynamics, and aesthetics (MDA) model, which attempts to bridge the gap between game design and development, game criticism, and technical game research, and the authors present an adapted version of the MDA model as a tool that supports considering the richness of play design opportunities when creating dynamics, mechanics, and aesthetics for diverse forms of play from a designer’s and a player’s perspective. They illustrate the application of the adapted model by describing four design case studies of tangible intelligent play concepts for different contexts of use related to different properties of play: an interactive storytelling mat for young children, an intelligent ball pit for young children, a system that supports children sharing the use of bikes during school play time, and intelligent play objects for a trading game with a design intention of supporting social interaction.

Chapter 28

In this final chapter, the author from University of Edinburgh, United Kingdom, explores the social worlds that shape the process of independent game development. He argues that no specific study has yet been set on (independent) developers’ active engagement in their own social worlds and how they inform different aspects of digital game production (design, development, marketing, distribution). Consequently, he attempts to describe and reflect on the daily work practices of independent game developers, with special emphasis on a local network in Cambridge, and to provide an understanding of the meanings and functions of the microsocial relationships that structure their process of game making, both spatially and procedurally. He concludes that local regular activities where independent developers participate work as spaces of learning, practice, and informal transactions that can help technically, creatively, and motivationally those interested in game development. Within these relationships, developers meet the needs of knowledge-based, artistically driven, and entrepreneurially oriented capitalist enterprises such as digital game production.