Rethinking Real-time Strategy Games for Virtual Reality

Samuel Truman, Nicolas Rapp, Daniel Roth, Sebastian von Mammen
University of Würzburg
Würzburg, Germany
{samuel.truman,nicolas.rapp}@stud-mail.uni-wuerzburg.de,{daniel.roth,sebastian.von.mammen}@uni-wuerzburg.de

ABSTRACT

Recent improvements in virtual reality (VR) technology promise the opportunity to redesign established game genres, such as real-time strategy (RTS) games. In this work we have a look at a taxonomy of RTS games and apply it to RTS titles for VR. Hereby, we identify possible difficulties such as the need for novel means of navigation in VR. We discuss conceivable solutions and illustrate them by referring to relevant work by others and by means of AStar0ID, an exploratory prototype VR RTS science fiction game. Our main contribution is the systematic inspection and discussion of foundational RTS aspects in the context of VR and, thus, to provide a substantial basis to further rethink and evolve the RTS genre in this new light.

CCS CONCEPTS

• **Human-centered computing** → *Interaction paradigms*; *Visualization theory, concepts and paradigms*; Interaction devices;

ACM Reference Format:
Samuel Truman, Nicolas Rapp, Daniel Roth, Sebastian von Mammen. 2018. Rethinking Real-time Strategy Games for Virtual Reality. In *Foundations of Digital Games 2018 (FDG18), August 7–10, 2018, Malmö, Sweden.* ACM, New York, NY, USA, 6 pages. https://doi.org/10.1145/3235765.3235801

1 INTRODUCTION

VR recently hit the consumer market, providing new opportunities for video games. VR is currently broadly understood as the presentation of a 3D virtual environment by means of a head-mounted stereoscopic display that is coupled to the physical head movement of the user. In addition, VR empowers the user to seamlessly interact with the virtual environment, for instance by means of 3D controllers. VR technology increases immersion by overcoming sensory inconsistencies between reality and digital worlds, e.g. by tracking the players' movements, by minimizing latency, and by increasing pixel or color resolution [9]. As a result, VR allows the player to become fully present in a virtual world and fosters the sense of "being there" [10]. In the context of RTS, VR can increase the immersion into realistic strategic command scenarios but also bring about novel futuristic elements of play by deploying different perspectives, augmented views and interaction opportunities. As a result, RTS game mechanics can be redesigned, intensified and extended, quickly reaching the point where previously distinct genres such as creative sandbox "god games" like Black & White or Townsmen merge with RTS mechanics. While close adherence to current genre definitions is not mandatory [3], we understand that VR can support the core mechanics of RTS games to yield even more intense, diverse, joyful game experiences. To support this notion, this paper discusses the realization of common RTS game principles in VR. As part of this discussion, we propose a continuum of perspectives which illustrates the differences among RTS games in terms of visualization and input modalities. We identify design challenges for VR RTS games, e.g. in terms of scaling or cyber sickness, and suggest possible solutions. Additionally, we highlight some newer and enhanced game mechanics, which arise from the migration of RTS to VR.

To provide a foundation for this discussion, we systematically introduce RTS games, their evolution, their elements of play, and their genre definition in Section 2. In Section 3, we first present a prototype VR RTS game and next, we consider the taxonomic dimensions of RTS games in general in the context of VR. We summarize our work in Section 4 and have a brief outlook on potential future works in this direction.

2 RELATED WORK

In this section, we first briefly put VR RTS games in the historical context of the RTS genre, emphasizing the evolution of play. After a subsequent summary of the basic elements of play of RTS games, we conclude this section with an analysis of the RTS genre in the context of an established, multi-dimensional taxonomy.

2.1 A Brief History of RTS Game Mechanics

The term RTS emerged from a collection of gaming habits and game mechanics [4]. RTS games combine the concepts of wargames and real-time control, of strategy and action games [5]. Their typical game mechanics evolved over time. In this context, several games particularly influenced the genre. For example, Modem Wars (1988) lacks features such as resource management but introduced combat related concepts adapted by later releases such as a multiplayer mode and fog of war[1] [4]. The basic dynamics of Dune II—harvesting resources, building bases, producing units and fighting battles to achieve victory—were inherited by subsequent games as well. Warcraft: Orcs & Humans (1994) extends Dune II's core feature by a multiplayer mode [4]. Simple controls, e.g. to select a unit or building by pointing and clicking as well as selection of multiple units render Command & Conquer quite accessible. These features can be found in almost every modern-day RTS game. Over

[1]Fog of war hides unexplored areas while revealing areas the player's units have already traveled about.

FDG18, August 7–10, 2018, Malmö, Sweden

ACM ISBN 978-1-4503-6571-0/18/08…$15.00
https://doi.org/10.1145/3235765.3235801

time, camera perspectives have fundamentally changed. Originating from an exclusively two dimensional top-down perspective, most modern RTS games utilize 3D models to allow for a multitude of camera perspectives [1]. The shift to free camera perspectives made the transition to VR possible.

2.2 RTS Basic Elements of Play

In RTS games, the players need to manage interacting, interdependent units in real-time, pursuing some overarching strategy that culminates in shorter term tactics [11]. In this context, self-organization plays an important role, i.e. the extent to which the units coordinate their local behaviors by themselves and thereby succeed in achieving globally defined goals [12].

Often, RTS games reflect military conflicts, whereby an opponent's defeat is established once one's army, economy or base is destroyed. Certain RTS games can be won by aggregating achievements as in The Settlers 7. Economic success is important to build, maintain, and repair one's gaming assets—including buildings, military units, or advantageous technologies. These reinforce economic growth by mining, refining, harvesting or raiding. The specificity of the resources yields complex networks of interdependencies that need to be mastered by the player [11]. All the elements of play mentioned so far can be transfered to VR without the need for crucial changes.

Typically, gameplay takes place in limited areas called maps [11]. Over time, map design and presentation evolved from planar 2D textures to 3D terrains with differences in height. Maps of Dune II, for example, are two-dimensional and show no elevations of the terrain but drawn mountains and valleys. Later games relied on three-dimensionally rendered maps, indicating heights by means of perspective top-down or isometric views. Common elements of modern map design are hilly terrains, uncrossable territory for ground units such as mountains, obstacles or abysses and in some cases conditionally traversable territory such as rivers or seas (see Maelstrom: The Battle for Earth Begins or Sim City). The Settlers IV features height differences of the terrain in their game mechanics by making it necessary to flatten the ground before it is possible to construct a building. In Starcraft II, units on higher ground are at an advantage in battle against units on lower ground. Limitations of traversable areas can cause strategically interesting situations, for example narrow passages. Several games demonstrate how the environment can be utilized to foster additional game mechanics. Also, the smart exploitation of the environment can give the player an advantage in combat, as well as economic benefits.

While details of the terrain are important, so is maintaining an overview of the whole playground. In most RTS games we examined, a minimap was shown: A small, abstract representation of the map. It provides an overview and often the option to quickly leap to a certain location by clicking there. The possibility to interact anywhere on the map at any given time is an essential feature of the RTS genre. A first-person perspective, occlusion, and improper design can diminish the player's overview in VR. It is important to mitigate these issues.

Details about units' states and possibly also custom commands for the respective units are typically shown in another interface window. RTS is concerned with balancing high level overviews and low level commands which is reflected in the selection of the offered views. This balance is also reflected in common choices of input modalities. Selections and multi-selections in overview perspectives can be performed well using a mouse [8], whereas adjusting configuration details is supported by the breadth and precision of keyboard inputs.

2.3 Taxonomy

Based on the outlined goals, mechanics and common features of RTS games, we shed light on RTS based on an established multi-dimensional taxonomy [1] that sets them apart from other game genres. The first dimension for the classification of the genre is the **environment** of the game. The environment in RTS games is mostly dynamic which means that elements of the map can change over the course of the game. In addition to buildings being built or torn down and units moving, trees might be chopped down or planted (The Settlers IV) and landscapes remodeled (Maelstrom: The Battle for Earth Begins). There are, however, also titles like Warhammer 40.000: Dawn of War with static environments that cannot be manipulated. Next to the environment of a game, its **pace** determines its genre. As strategic thinking and tactical deployment occur concurrently, the final pace of an RTS title depends on the number of decisions needed/possible per time. This heavily depends on the actual time various processes take in the game. The taxonomic dimension of **time** is arbitrary in RTS games, i.e. building a house in the game, for example, does not require the same time as building a house in the real world. As a result, there are considerable differences regarding pace and time between RTS titles—often the player can even adjust the speed himself. The continuous, arbitrarily mapped real-time in RTS is accompanied by a geometrical, continuous **topography** that defines basic relationships between the involved units. Due to the clear definitions of winning or losing (Section 2.2), RTS games are considered finite in terms of their goals, or **teleology**. The player can compete against an artificial intelligence by himself or in teams, online or in local coop mode; or against each other, also in two or multi-team scenarios. Accordingly, the **player structure** of RTS games is rather broad. Any multiplayer modes automatically yield a great degree of non-**determinism**. In case of single player games, randomness in terms of environmental events or the opposed artificial intelligence behavior can also result in non-deterministic RTS matches. Although, in most games we investigated, saving multiplayer matches is not possible, there are exceptions such as The Settlers IV. In single-player modes, the game can potentially be saved at any stage at will and therefore has an unlimited **savability**. Since RTS games generally allow the player to observe every part of the map at any given time, their **view** is considered omni-present. The map, as outlined in Section 2.2, can either provide a view of the complete game universe or only part of it—which requires the aforementioned minimap or a zooming functionality.

3 METHODOLOGY

In this section, we pursue an inventory of the aforementioned taxonomic dimensions of RTS in the light of VR. Doing so, we discuss challenges and present solutions proposed by others, explain our conclusions and illustrate the results in the context of AStar0ID, a prototype VR RTS science fiction game for the HTC Vive.

3.1 AStar0ID

In AStar0ID, the player finds himself in a small asteroid belt, erecting buildings on the surfaces of the asteroids, harvesting energy and resources, and building a fleet of space ships to expand and defend the colony. The player is fully immersed into the scene. Scaled up by several dimensions, the player can directly interact with the game elements (Figure 1). The player interacts with the game using the 3D controllers of the HTC Vive hardware. The player can move units by selecting them and subsequently indicating any target position in space. The user interface (UI) is not implemented as a camera overlay, but is part of the game world. The player "holds" the UI in his left hand and can physically interact with it, just like an artist can interact with a palette. When a building menu is floating next to the player's left hand, buildings can be setup by touch-selecting the desired type and pointing at a target location on an asteroid's surface with the right hand. The player can move by walking in the real world. Winning the game requires fulfilling missions, defeating non-player character (NPC) enemies and expanding the colony. AStar0ID allowed us to systematically consider different options for transposing RTS dimensions to VR. In the following paragraphs, we present our findings.

Figure 1: AStar0ID Gameplay Footage. Top Left: Selecting a construction site. Top Right: Choosing building types on a command panel. Bottom: A photomontage of the immersion as experienced by the player.

3.2 Environment

Both, dynamic and static environments are feasible in VR. However, changes in the environment might promote cyber sickness. Cyber sickness refers to the tendency for some users to exhibit symptoms that parallel symptoms of classical motion sickness, both during and after a VR experience [6]. Cyber sickness can arise due to multiple causes, whereby visual cues that do not align with one's expectations (physiological or cognitive) represent an important factor. Therefore, we decided to maintain an environment in our prototype RTS VR game that does not change by itself. In AStar0ID, non-moving asteroids provide points of fixation which may reduce the experienced degree of cyber sickness [13]. Also, we added a fixed, half-transparent "ground plane" to the virtual world in order to give the player an additional point of fixation and prevent disorientation. Dynamic environments may also disorient the player due to change blindness, the human inability to recognize visual changes between images [7]. Additional visual clutter might also keep the player from successfully implementing a winning strategy [2].

Beside dynamics, there are plenty of other challenges regarding the layout of the environment such as the right scale of the environment model, the consideration of the player's avatar's height, the optimal placement of 3D objects to interact with, etc. One also needs to consider the physical effort incurred by the (environmental) interface design. These considerations are all the more relevant, the more degrees of freedom (DoF) the VR setup allows—from seated VR over room-scale to mobile setups, the DoF increase and the designer needs to ensure appropriate constraints are put into effect. To mitigate the outlined challenges concerning the layout of the virtual environment, we introduced several countermeasures in AStar0ID. For instance, we clamped the placement of asteroids to a certain height that can be comfortably reached by most adults and (not too young) children. An automatic height adjustment of all interaction-enabled objects would clearly be the next step, possibly based on the player's automatically inferred height (which is straightforward, if the player wears a head-mounted display). In order to explore basic RTS mechanics in VR, we did refrain from creating an environment larger than the immediately reachable room-scale aligned play space. However, utilizing minimaps (Section 2.1) in combination with teleportation-based locomotion, the environment could easily be expanded. However, it is likely that such a design would require further support visualizations, since managing one's units in a small room-sized 360^o environment can already be quite challenging.

In other VR RTS games such as Brass Tactics (2018) and Landfall (2017) the environment is also static. The maps of both games contain fixed elements e.g. mountains, rocks, trees or flat areas that are not changed over the course of a skirmish. The maps in Landfall are designed in such a way that the player gains an overview of the hole map without leaving his initial position. As Landfall is played with a conventional gamepad, selecting gestures are not required either. In Brass Tactics the player looks down on a limited map projected on a table. He moves across the map by "pulling himself" with the controllers—dragging backwards after fixing a target ahead.

3.3 Pace

Too slow or delayed computations can have a tremendous, negative impact in VR RTS. Even if the frame rate is maintained at a high level for rendering, stalling the means to interact or the game's mechanics drastically diminishes the gaming experience. Next to computational limitations that might affect the experienced pace, the choice of perspective might as well: While a first-person perspective lends itself naturally for VR games, the required travel (as in Herzog Zwei) reduces the pace of the game and might also disrupt its flow. When considering room-scale VR, the player's speed of movement represents yet another important factor in terms of pace. Safe and sound facts about a player's visual perception that directly apply for well-directed views do not suffice to warrant the player's uptake of processes visualized in VR, if either not guided well or if the player merely moves too slowly.

These deliberations also apply to AStar0ID where it can be difficult to maintain the overview and control of the whole map. Yet, we decided on a 1:1 mapping of movement as it increases immersion and prevents cyber sickness [6]. Teleportation, i.e. the immediate change of location based on a target-release input mechanic, offers an alternative means of navigation without side-effects (e.g. seen in Fallout 4 VR, 2017). However, due to the small map of AStar0ID, teleportation does not apply well, see also Section 3.5. In a way, minimaps implement teleportation but introduce a compact interface for specifying the navigation target. Considering minimaps for VR, one could rely on the common 2D implementations that teleport the player to a specific point on a map. This approach could be extended to consider height as well by letting the player drag upwards once the target location in 2D has been specified. A great integration of first-person movement and instantaneous leaps has recently been shown in Townsmen VR. Here, the player can zoom out with a pinching gesture (with his arms) and literally scale up his strides to reach another dimension of distances—shrinking the game world to a miniature map, if only until zoomed in again.

3.4 Time

The pace of a game is directly influenced by the time that certain processes take. Starcraft, for example, offers a rapid play-style where some players perform up to 400 actions per minute [11]. Performing actions based on single keystrokes strongly abstracts from the actual interactions. Hence, it is a matter of game design, whether and to which degree an interaction task should be abstracted. If the speed of performing interaction tasks is given great importance in light of the game mechanics, the designers need to consider the potential danger this may inflict due to the real-world constraints the player is faced with: Rapid movements may render warnings of chaperon boundaries ineffective. Because of this, processes such as production of ships or their movements are slowed down in AStar0ID. In Brass Tactics, for instance, such dangers are avoided by restricting the player to one spot.

3.5 Perspective

Perspective is the most obvious dimension to change with the introduction of VR. Therefore, this dimension is discussed at greater detail. It is vital to understand how changes to the perspective add certain benefits and challenges to the gameplay. We suggest to describe, classify and evaluate the perspective in RTS games in terms of two sub-dimensions: Projection space and interaction space. The projection space indicates to which extent objects within the game are being rendered and perceived as three-dimensional by the player. The boundaries of this sub-dimension are (A) the entire game being rendered and perceived as completely flat on a flat screen and (B) the ground rising in height, every unit in the game being rendered as a 3D model and occupying not only space on the surface but potentially also above and the player being fully immersed. The interaction space indicates to which extent the player interacts with the game in two or three dimensions. Again, two opposing extremes are conceivable: The player's interactions restricted to 2D or the ability to provide natural 3D input, i.e. considering (at least) six degrees of freedom per hand-waved controller.

The classification of the projection and interaction space results in a continuum representing different scenarios of the two interwoven sub-dimensions. We refer to it as the **continuum of perspectives** (Figure 2). The continuum begins with the realization of the projection and interaction purely in 2D and ends with both sub-dimensions presenting and capturing in 3D. In-between these two extremes, other scenarios are situated, for instance, there might be a full 3D game in VR that the player interacts only relying on 2D input. In total, we have identified a set of seven possible scenarios that build on top of each other and broadly cover the range of perspectives in VR RTS games.

3.5.1 Purely 2D. The first scenario (S1) describes 2D RTS games that are operated by mouse and keyboard and displayed on a screen. As a result, the interactions are restricted to 2D as well. Dune II (Figure 3(a)), for example, fits S1. Most of the games of S1 are played using a top-down perspective, sometimes with a zooming option. In S1 Fog of war can vary in two ways: Either unexplored areas are covered completely or only hostile troops are hidden. Complementary to the unit management in 2D, a 2D overlay user interface allows to select options and choose commands. While the player can see every game element at any time, there can be occlusion between the elements themselves. For instance, a unit could potentially not see another unit that is standing on the other side of a wall.

3.5.2 2D Isometric. The perspective in the second scenario (S2) differs from S1 in the camera angle. Objects of the game are still rendered in 2D, but isometrically and thereby introduce 3D appearances. Interactions are performed in the same way as in S1. Age of Empires (Figure 3(b)) is an example of S2.

3.5.3 3D. In the third scenario (S3), the game is rendered in 3D. This applies to most modern-day RTS games, for instance the well-known RTS representative Starcraft II (Figure 3(c)). In contrast to S2, all the graphical assets are provided in full 3D, any perspective changes are solely introduced by changes to the camera configuration. Concerning the interaction space, however, nothing changes compared to S1 or S2. The player still uses mouse and keyboard as input devices. Adding the third dimension is an important step forward in RTS as the new dimension introduces several new opportunities. Most importantly, it is now possible to rotate the

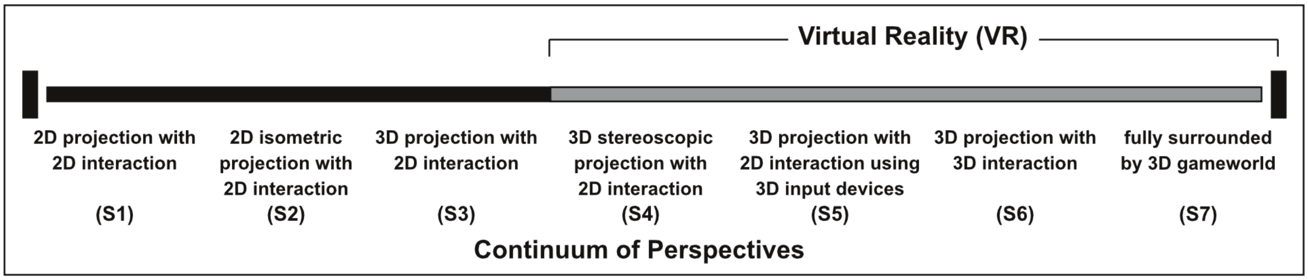

Figure 2: Continuum of perspectives in RTS games considering the dimensions of visualization and inputs.

camera along any axis. Thus, a "free camera" perspective can be implemented.

3.5.4 Virtual Reality. Scenario number four (S4) introduces several new aspects to both the perspective and the interaction space sub-dimension. As in S3, the game units are rendered in 3D but are now presented stereoscopically and through a head-tracked, first-person perspective. As a consequence, the use of fog of war can cause problems, when the player cannot see the environment any longer, becomes confused or disoriented. Due to the first-person perspective, it can be more challenging for the player to keep an overview of the hole map. Objects can block the line of sight so the player has to move to be able to see behind them. Also, events can occur unnoticed, because they may take place outside of the player's field of view. Since an overlay-based UI would affect the player's view, it could be translated to objects in the game world. Another option is the presentation of the UI as a head-up-display (HUD). A common example for a HUD is a status display at the border of the field of view. In scenario S4 we assume to still make use of non-spatial controllers, such as mouse, keyboard, or gamepad. Landfall is a game that fits S4.

3.5.5 VR with 2D interaction space. In scenario five (S5) mouse, keyboard and gamepad are replaced by wireless motion controllers. Since the player is not bound to a desk any longer, in-game navigation can be controlled like in room-scale VR. Yet, in this scenario, we do not consider the full 3D interaction space, yet. Instead, we consider the player navigating in a virtual world with a flat surface, even though the presentation of individual game units might well be rendered in 3D. As a consequence, the player observes the game from a top-down view through a first-person perspective. Interactions could be realized by touching elements on the surface by means of the controller. Fog of war could be used again to hide local areas of the map without causing negative side effects, as in S4. Occlusion due to VR, as described in S4, would not occur here.

3.5.6 VR with 3D interaction space. With the extension of the flat surface by a third dimension, the sixth scenario (S6) offers game maps that rise in height. Yet, the maps and thus the game units are still restricted to surfaces. Again, interactions with the three-dimensional game units are realized by the motion controllers. Brass Tactics (Figure 3(d)) represents a game of this scenario.

3.5.7 Fully immersive VR. The seventh and last scenario (S7) is the complete opposite of S1 in terms of projection and interaction. It lifts the surface-bound restriction of S6 and game units can now be located anywhere around the player. Thus, the player is now immersed into a fully featured 3D game world. AStar0ID implements this scenario (Figure 1).

As stated in the introduction, the RTS genre originated from the amalgamation of the action and strategy genres. Within the context of this scenario the player is engaged and surrounded by events (Figure 3(e)). Therefore, especially aspects of the action genre can be emphasized. Due to the the possibility to move in 3D, new strategies and combat styles can be used. Units can fire weapons that do not focus on a single target but deal areal damage. Opponents could try to dodge these attacks. Accordingly, the actual size of a unit has an impact on its performance in battle. The larger a spaceship, the easier it can be hit. Missiles can be intercepted by the surroundings or other units. Armies or colonies can hide behind

(a): Dune II **(b): Age of Empires** **(c): Starcraft II** **(d): Brass Tactics** **(e): AStar0ID**

Figure 3: Comparison of perspectives in accordance with the continuum shown in Figure 2. It stretches from scenario S1 (2D visualization and 2D interaction) on the left to S7 (Full immersion in 3D) on the right.

asteroids so the player could overlook them. As pointed out in the context of S4, immersion requires great efforts towards guiding the player's attention. Otherwise, crucial events might be overlooked as well. In AStar0ID, this is realized by means of markers and pointers in the game world. Large, orange pointers highlight areas of interest (Figure 1). Also, we use spotlights to highlight important objects and utilize holographic controllers which demonstrate crucial movements to the player. Often in RTS games the player has an omni-present perspective. This may seem difficult to achieve in VR, because of the first-person camera. Although it is typically true, we found that scaling the player size to world size dimensions fosters a perspective similar to omni-presence: If the player is much bigger than all objects in the scene, he is able to administer the happenings as if exposed to an omni-present perspective as in scenarios S1 to S3. Occlusion also poses a challenge. Objects interfering with the player's line of sight may have a negative impact on the gameplay. One way to mitigate this problem is toggling to wireframe mode. While in wireframe mode, only the edges of the 3D objects in the scene are rendered. Like in scenario S4, implementing fog of war may result in disorientation or confusion.

4 SUMMARY & FUTURE WORK

In this work, we retraced the evolution of RTS games and motivated its migration into VR. We identified the elements of play in RTS, laid out their classification in terms of a multi-dimensional taxonomy and discussed RTS in VR based on these deliberations. We drew analogies to (VR) games outside of the RTS genre and referred to RTS VR titles that realized one or the other implementation approach that we discussed. To understand the new opportunities in terms of perspective that VR introduces to RTS games, we systematically elaborated on seven different scenarios considering projection and interaction spaces. In this light, we not only considered the presentation and interaction with the units of the game but also typical RTS game mechanics such as fog of war that are tightly interwoven with the offered gaming perspective. We backed our discussion with the experience we gained in developing a room-scale VR RTS prototype and explained how we handled particular difficulties. We found that (1) VR bears great potential to boost the RTS genre, that beyond the usual VR-related issues such as the lack of player guidance, (2) special attention needs to be paid on game mechanics that are tightly interwoven with projection and interaction spaces. (3) The means of full immersion, including the use of 3D controllers, shows how previously fixed perspectives could easily be blended by merely adjusting the player's avatar's scale.

The opportunities for VR RTS need to be further explored. But considering the taxonomic dimensions of RTS in the VR context already provides one with the ability to systematically conceptualize and implement according titles without changing the iterative, incremental, user-centered development process that is widely adopted in games. Yet, there are still various immediate opportunities for further investigation. We see the need to extend maps to span across multiple (virtual) rooms, to explore seamless transitions between minimap navigation and scaling in VR. Our current intuition is that teleportation will not be necessary any longer in this context. Minimap navigation could open up opportunities for novel game mechanics. One aspect that we barely touched upon in this paper is multi-selection in VR, which we feel needs to be researched further as well. Although multiplayer support is a major characteristic of modern day RTS games, we are yet to explore its potential for VR. The increase in accessibility of VR hardware will facilitate gaining a larger user base and investigating the potential for social VR RTS games.

LUDOGRAPHY

Westwood Studios. *Dune II.* Virgin Games, 1992
Strategic Simulations. *Battalion Commander.* Strategic Simulations, 1985
Technosoft. *Herzog Zwei.* Sega, 1989
Ozark Softscape. *Modem Wars.* Electronic Arts, 1988
Blizzard Entertainment. *Warcraft: Orcs & Humans.* Interplay Productions, 1994
Massive Entertainment. *Ground Control.* Sierra Entertainment, 2000
Lionhead Studios. *Black & White.* Electronic Arts, 2001
HandyGames. *Townsmen.* Headup Games, 2016
Blue Byte. *The Settlers 7.* Ubisoft, 2010
KD Vision. *Maelstrom: The Battle for Earth Begins.* Codemasters, 2007
Creative Assembly. *Total War: Warhammer.* Sega, Feral Interactive, 2016
Ensemble Studios. *Age of Empires.* Microsoft Studios, 1997
Maxis. *Sim City 2000.* Maxis, 1993
Blue Byte. *The Settlers IV.* Ubisoft, Blue Byte, 2001
Blizzard Entertainment. *Starcraft II.* Blizzard Entertainment, 2010
343 Industries, Creative Assembly. *Halo Wars 2.* Microsoft Studios, 2017
Blue Byte. *The Settlers DS.* Ubisoft, 2007
Blizzard Entertainment. *Starcraft.* Blizzard Entertainment 1998
Hidden Path Entertainment. *Brass Tactics.* Oculus Studios, 2018
Force Field *Landfall.* Oculus Studios, 2017

REFERENCES

[1] Espen Aarseth, Solveig Marie Smedstad, and Lise Sunnan\a a. 2003. A multidimensional typology of games.. In *DiGRA Conference*.
[2] Alan Baddeley. 1992. Working memory. *Science* 255, 5044 (1992), 556–559.
[3] Mikhail Mikhaĭ Bakhtin. *Speech genres and other late essays.*
[4] Simon Dor. 2014. A History of Real-Time Strategy Gameplay From Decryption to Prediction: Introducing the Actional Statement | Kinephanos. (2014). http://www.kinephanos.ca/2014/real-time-strategy/
[5] Peder Larson. 2002. *Command and conquer.* Technical Report. tech. rep., Stanford University.
[6] Joseph J. LaViola, Jr. 2000. A Discussion of Cybersickness in Virtual Environments. *SIGCHI Bull.* 32, 1 (Jan. 2000), 47–56. DOI: http://dx.doi.org/10.1145/333329.333344
[7] Li-Qian Ma, Kun Xu, Tien-Tsin Wong, Bi-Ye Jiang, and Shi-Min Hu. 2013. Change Blindness Images. *IEEE Transactions on Visualization & Computer Graphics* 19, 11 (Nov. 2013), 1808–1819. DOI: http://dx.doi.org/10.1109/TVCG.2013.99
[8] I Scott MacKenzie. 1992. Fitts' law as a research and design tool in human-computer interaction. *Human-computer interaction* 7, 1 (1992), 91–139.
[9] Mel Slater, Vasilis Linakis, Martin Usoh, Rob Kooper, and Gower Street. 1996. Immersion, presence, and performance in virtual environments: An experiment with tri-dimensional chess. In *ACM virtual reality software and technology (VRST)*, Vol. 163. ACM Press New York, NY, 72.
[10] Jonathan Steuer. 1992. Defining virtual reality: Dimensions determining telepresence. *Journal of communication* 42, 4 (1992), 73–93.
[11] Gabriel Synnaeve. 2012. Bayesian programming and learning for multi-player video games. *Disertacnı práce* (2012).
[12] Sebastian von Mammen. 2016. Self-Organisation in Games, Games on Self-Organisation. DOI: http://dx.doi.org/10.1109/VS-GAMES.2016.7590361
[13] Sebastian von Mammen, Andreas Knote, and Sarah Edenhofer. 2016. Cyber Sick but Still Having Fun. In *Proceedings of the 22Nd ACM Conference on Virtual Reality Software and Technology (VRST '16)*. ACM, New York, NY, USA, 325–326. DOI: http://dx.doi.org/10.1145/2993369.2996349