

Making Invisible: Communication as Core Mechanic in Non-Mimetic Simulation Games

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ABSTRACT

We chronicle the design of a digital game to teach team coordination. The structure of play is based on information flows in fire emergency response work. Because the game mirrors abstract components of emergency response, not fire or smoke, we term it a *non-mimetic simulation*. In this paper, we describe game design changes resulting from play experiences, focusing on modulating information visibility and game mechanics to encourage communication and cooperation between players. We show how the interaction design mantra of making visible does not always apply when creating non-mimetic simulation games. Instead, non-mimetic simulation design must sometimes make invisible to distribute pieces of an information puzzle, in the context of game rules and play.

Keywords

Game design, non-mimetic simulation, team coordination, modulating visibility.

1. INTRODUCTION

Play is a natural human activity embodied by games; digital games are an emerging cultural medium enabling social play. Location-aware games leverage embodied interaction [1] to create immersive experiences where the player is free to move and socially engage with others. The *core mechanic* of a game is the set of actions that players perform repeatedly, creating play [4]. We define the core mechanic for educational games that simulate team coordination in fire emergency response by creating rules and interfaces.

Fire emergency responders (FERs) work in dangerous, dynamic environments, where they integrate and share information. Team coordination is essential for safe, effective operation. We examine practices of FER team coordination [6] and develop simulations that capture information flow, team structures, and communication modalities. These *non-mimetic simulations* create play around team coordination, not fire and smoke [5].

We are developing a location-aware non-mimetic simulation game to teach team coordination from a grounding in FER work practice. The game design is unique, employing communication as core mechanic. The design directs communication by distributing information availability and need between game roles. Although we generally subscribe to Norman's interaction design mantra of "making visible" [3], design for information differential requires intentionally modulating visibility. We discuss how adjusting the information available to players impacts their communication, and how game rules impact cooperation. Designs are developed to motivate participants to engage in cooperative play, to create an engaging and rewarding educational experience.

2. FOUNDATION IN WORK PRACTICE

Our design of location-aware non-mimetic simulation games is

based on FER practice. An ongoing ethnographic investigation at one of the world's largest fire education facilities, Brayton Field, is being undertaken [6]. This investigation includes semi-structured interviews about team structure, communication, and information needs with expert responders. A second component observes burn training exercises, in which students set up command, search for victims, and put out live fires. The investigation reveals design implications for teaching team coordination skills: information differential, mixing communication modalities, and use of audio cues [6].

In fire emergency response, firefighters are situated within the fireground of the emergency incident, experiencing the environment directly. As they move, their vantages change, and new information must be communicated back to other team members. Officers outside the fireground, who observe the incident within a larger context and access information artifacts (such as maps), coordinate the firefighters by providing information and strategy. The result is information differential: the sources and formats of information vary between parts of the team. Participants engage in distributed cognition [2], communicating about and planning around direct experiences and dynamic information artifacts. Firefighters and officers communicate with each other using either face-to-face or radio. FERs mix these communication modalities, as face-to-face is fast and easily understood, but radio reaches everyone, even those far away. Audible cues from equipment and the environment subtly inform FERs about fireground and teammate status, enabling remote sensing by overhearing through the radio.

3. GAME DESIGN

We iteratively develop games embodying the design implications of information differential, mixed communication modalities, and audible cues. The implications suggest the economical form of non-mimetic simulation to distill communication and information requirements without representing the concrete aspects of fire emergency response, such as fire and smoke. We are designing location-aware non-mimetic simulation games to meet the needs of team coordination education. Our research plan will consider the benefits of *stationary games* played on computer workstations, as well as location-aware games.

To simulate the information access of FER team members, we develop two game roles. *Seekers* move in the real world with a concurrent presence in a 2-D virtual world, searching for goals and avoiding virtual threats. The *coordinator* helps the seekers through an incomplete view of the virtual world. Seekers are an analog for firefighters in the fireground, while the coordinator is like an officer outside with information artifacts. Goals map to victims to be rescued, while threats are like fire and falling debris.

Seekers don a wearable computer with a global positioning sensor; the computer maps the player's real world position to an avatar's virtual world location. The avatar's location determines when seekers collect goals or are attacked by threats. The coordinator observes game state through an interactive map.

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Players in each game role have access to complementary pieces of information about the game, creating information differential: seekers experience the real world environment directly and have detailed access to information about the virtual world at their location. In contrast, the coordinator views the virtual world in limited detail from overhead, which simulates the information artifacts and contextualized overview of an officer.

Because essential information is split up between players, communication is part of the core mechanic. Both sides of the team communicate using radio. Seekers communicate with each other face-to-face while co-located, or use radio when distributed. In this way, players mix communication modalities. Audible cues describing game state for an individual are mixed with outgoing radio from that player, to enable overhearing.

We have developed a stationary game running on laptop computers. Seekers move virtual world avatars using the keyboard, instead of walking. Study conditions embody mixed communication modalities by adjusting the co-location of participants, enabling some face-to-face communication in one condition, while requiring the use of the radio in another.

4. ITERATIVE DESIGN CHRONICLE

The game is designed to encourage communication and coordination among team members. Information differential distributes complementary perspectives of the game world. The greatest differential exists between the two game roles. Through pilot tests and user studies, we iterate the design of information differential and game rules to effectively encourage emergent FER-like communication and behavior.

Typically, in interaction design, it is essential to make information visible [3]. However, in non-mimetic simulation games, visibility must be modulated. We find it important to shift information availability to encourage communication, play through the core mechanic. Adjusting game rules encourages cooperation. Both are essential to learning and engagement. We chronicle three phases of the design, discussing changes to the visible information in the player interfaces and the ways in which we modify game rules.

4.1 Phase 1: Unbalanced Visibility

Design. In the first phase of the design, the coordinator's overview is detailed: the exact location of every seeker, goal, and threat is visible; the coordinator is nearly omniscient. Each goal requires a single seeker to collect, making the process quick and simple. Walls (which prevent seekers from passing) are visible only to the seekers, while bases (locations where seekers are safe from threats) are visible only to the coordinator. The threats are made visible to the coordinator, but made invisible to the seekers, who have a meter that indicates the distance to the nearest threat (Figure 1). Cartesian coordinates of the game map are shown to the coordinator, and each seeker can see their location (X, Y) through the game interface.

Evaluation and shortcomings. This phase of the game design was tested with a series of pilot studies. We discovered that, due to the game rules and information available to the coordinator, it was unnecessary for seekers to work together to be effective. Seekers were simply a way for the coordinator to affect the game world, never needing to make their own decisions. This is in contrast to FERs, who make decisions based on the situated environment and communicate back to the commanding officer. In this phase, the coordinator told each player exactly where to go and what to do. Each seeker complied. Players did not enjoy the game; they rarely needed to make decisions or work together.

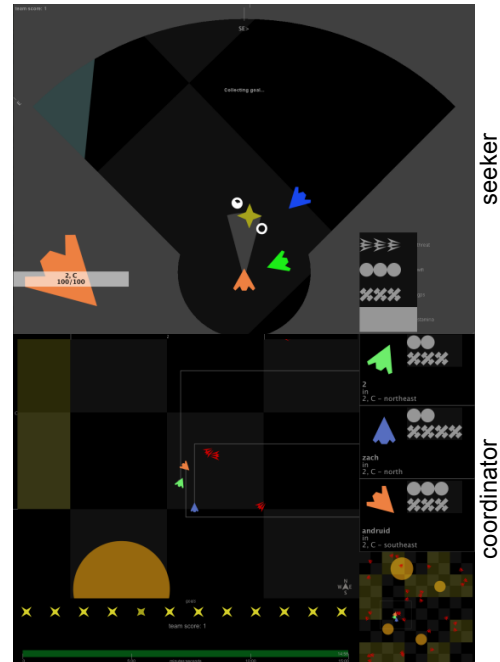


Figure 1. Phase 2 game design. The seeker's threat indicator, held constant in each phase, shows nearby threats, but s/he cannot see them. The coordinator can see a pair of threats closing in on the group.

Location was difficult to discuss, as the wrong ordering of numbers would cause confusion.

Information was *too* visible to the coordinator, and *not enough* was available to seekers. The result was autocratic control of the group by the coordinator. Since the coordinator knew what was happening and what to do, that player was the only one who mattered. Seekers, lacking visible information, had nothing valuable to contribute to the group, and thus did not engage with the core mechanic of communication.

4.2 Phase 2: Shifting to Seekers

Design. We transition information from the coordinator interface to the seekers' and adjust game rules to encourage seeker cooperation. We manipulate information differential by changing visibility and simplifying navigation to create interdependency.

We introduce cooperative goals, which require multiple seekers to collect them. Some goals require a single seeker, while others require the entire team. All goals are necessary to win the game.

Visibility of the goals is a manipulation of information differential. The exact location and nature of a goal (the number of seekers required) is only visible to the seekers that find it. The coordinator can see which map regions contain a goal, relying on the seekers to provide specific information. We thus make invisible the goals to the coordinator, to encourage two-way communication and reduce autocratic control of the group. This makes the role of seeker essential: not only must they collect the goals, they must locate them and report back in order to coordinate with other seekers.

To simplify communication about navigation, grid coordinates replace the Cartesian coordinates. Map regions are indexed on a grid and identified by a letter and number combination. This makes location less certain, but easier to discuss.

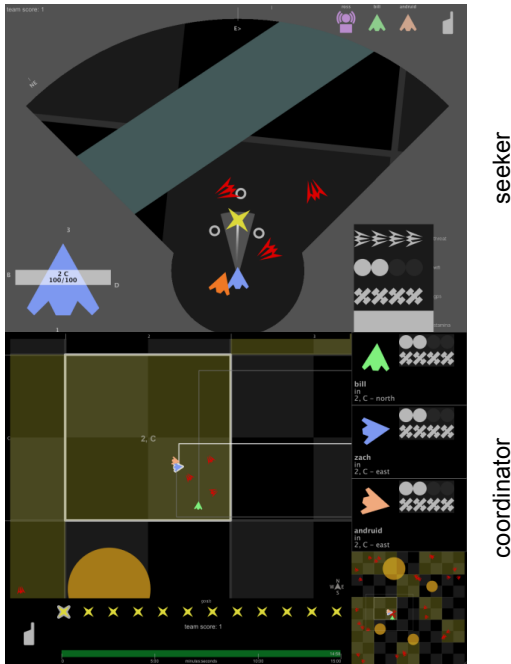


Figure 2. Phase 3 seeker and coordinator interfaces. The blue seeker, “zach”, is about to collect a goal with the orange seeker, “andruid”. The pair are about to be attacked by threats. Note that in the coordinator interface, only the region containing zach and andruid is highlighted, indicating it contains a goal *somewhere*.

Evaluation. This phase of the game design was tested with a long-term user study of 10 teams (four members each) playing eight games. Players reported having fun, enjoying working together. Communication becomes two-way; all players engage with the core mechanic. Seekers operate on their own, making decisions based on the local environment. Some teams elect a seeker leader, who may countermand orders from the coordinator based on situated details of the terrain. Teams experiment with different strategies. Emergent behaviors resemble those of FER work practice.

Shortcomings. Despite the successes of the new design, problems remained. Because the threats were invisible to seekers, and because they move quickly, coordinators could not warn seekers effectively and would eventually give up. Threat attacks appeared random, detracting from enjoyment.

While cooperative goals encouraged players to work together, lack of feedback on *who* was actually contributing to goal collection inhibited the success of cooperative play. Sometimes, three players would gather around a goal to collect it, two would be contributing, but one had not positioned their avatar correctly. The visualization indicated two players had started collecting (Figure 1). The third player, seeing that the goal was being collected, would believe that they were contributing, when they were not. Some teams preferred goals that required fewer seekers, because the point value of the harder goals was not worth the effort.

Although the grid coordinate system is easier for players to communicate, seekers would still get lost. While location was visible, they did not know the direction of other locations.

4.3 Third Phase: Refining Visibility

Design. We address discovered problems by further adjusting information differential (Figure 2). We modulate visibility in the

game interfaces to simplify and encourage communication.

Coordinators rarely communicated about threats in micro, because it was ineffective to do so. Threats move too quickly and radio communication is too slow. Instead, coordinators preferred to communicate about them in macro, indicating map regions that were safe, and which were dangerous. We make threats visible to seekers, giving them the opportunity to react and emphasizing their detailed view. This frees the coordinator from ineffectually communicating about nearby threats, allowing the player to focus on the larger picture.

In response to ambiguity about which seekers are participating in goal collection, we make visible goal collection attribution in the seeker interface. Each collecting seeker sees the connection between their avatar and the goal itself when they are collecting it. Status indicators show *who* is collecting the goal through color, instead of indicating the number of players helping. This disambiguates goal status.

We add navigation aids to the seeker interface, to make visible the seeker’s position within its current context. We add an indicator that shows not only the seeker’s current location, but also the direction of the other nearby grid regions.

Evaluation. The third phase design has been played by the design team, including an expert FER, and deployed in a FER student pilot study. The students were enthusiastic, and displayed excellent communication ability. They used FER jargon to re-contextualize the game. Visibility of the threats in the seeker interface allowed the coordinator to communicate about them in macro, rather than micro-manage the group, a cited problem with some officers in FER work.

5. CONCLUSION

We present game designs for teaching team coordination. In the designs, communication and coordination are essential activities that players perform to play, part of the core mechanic. The degree to which participants engage in the core mechanic is directed by information differential and visibility between player roles. While the mantra of making visible is central to interaction design, we find that in non-mimetic simulation games it does not always hold. Instead, to encourage players to interact and share information non-mimetic simulations must *modulate visibility*, by making visible to some players but invisible to others. Here, we making invisible by hiding the goal locations from the coordinator or making visible to another role, showing threats to the seekers.

6. REFERENCES

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