

Designing a Massively Multiplayer Online Game as a Testbed for Social and Behavioral Model Research

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Abstract

Massively Multiplayer Online Games (MMOGs), in their aspect as online communities, represent an exciting opportunity for studying social and behavioral models. For that purpose we have developed *Cosmopolis*, an MMOG designed to appeal to a wide variety of player types, and containing several key research-oriented features. First, *Cosmopolis* consists of an outer game for larger-scale social modeling, as well as a set of subgames suitable for tightly-controlled sandbox-style experiments, all allowing a high level of data logging configuration and control by researchers. Also, *Cosmopolis* incorporates real-world newsfeeds in its in-game information system, as a means of creating a tighter mapping between online and real-world communities.

1. Objective and Motivation

A 2008 study by the National Research Council entitled “Behavioral Modeling and Simulation – from Individuals to Societies” [NRC 2008] discusses how we need to expand research in modeling and simulation to include models of individual and societal behaviors. In the study, it is pointed out that a technological infrastructure needs to be developed for behavioral modeling such that we can properly develop, test and then deploy such models. The study, in fact, suggests the development of a massively multiplayer online game (MMOG) for that infrastructure. Such an MMOG can be utilized as a test bed for models of individual and group phenomena.

Cosmopolis is an MMOG we are developing for this purpose. In designing the game, we have been motivated by the need to balance the diverse interests of players and researchers: players need a fun game experience, while researchers need the flexibility to perform various experiments of their own design. To accomplish these goals, we’ve designed the game to incorporate specific features to work towards these ends.

For players (the general gaming public), *Cosmopolis* will be an MMOG built around a world-building outer game and a collection of self-contained sub-games of any genre (action, puzzles, sports, etc.). *Cosmopolis* also contains a new approach to incorporating information channels into a game environment: dissemination of both in-game messages and real-world feeds. Previous virtual

environments do not have the ability to analyze information feeds from real-world events. We believe this ability is an important factor for effective simulation of virtualized social and organizational environments.

For researchers, *Cosmopolis* is a unique test bed and data source for studying social and behavioral models. These models can be of individual players or multiple players over time, as well as of non-player (AI) characters, or combinations of those. The game provides various and flexible methods to facilitate these needs. These methods include administrator-produced in-game events (natural disasters, etc.), specifically designed and instantiated experiments in subgames, and custom views of player data.

2. Theoretical Framework

Research into video games and their scientific uses has currently taken several paths. Work that has taken an HCI perspective has looked at issues of real world reaction to virtual appearance, [Yee and Bailenson 2007]. Other researchers have begun investigating the broader issue of how real world social phenomena translate into virtual spaces. Castronova specifically proposed that virtual worlds might serve as ideal platforms for experimenting with a wide variety of individual, organizational, and societal (IOS) models [Castronova 2006]. To demonstrate this point, he carried out a small scale experiment demonstrating that the real world concepts of supply and demand mapped reasonably to a virtual space [Castronova 2008].

A variety of researchers have also looked at the social structures that form in games and their relative strengths and weaknesses. Such analyses have been derived from qualitative and ethnographic observation of player interactions, from surveys of player opinions, and from social network analyses of the strength of ties between different players. One notable ethnography-based analysis is Pearce’s long term study of “Uruvian expatriates” (players of *Myst: Uru Online* who migrated to *There.com* after the first game’s abrupt closure), and the roles that

emerged among them. [Pearce and Artemesia 2009] Social network analyses have been specifically conducted using both *Everquest* and *World of Warcraft*, [Ducheneaut et al. 2006; Huang et al. 2009; Huffaker et al. 2009; Williams et al. 2006] demonstrating the relatively small levels of interaction among players within the same guild structures, while Johnson et al. have developed a model of guild formation patterns that also helps to explain the formation patterns of offline gangs. [Johnson et al. 2009]

All of these efforts fall into the general category of *mapping*, as described by Williams: researchers want to know how virtual actions and representations serve as analogs of real world actions and representations. [Williams 2009] By implementing a new MMOG, as opposed to relying on working in the diversity of extant MMOGs and virtual spaces, we can establish a unified mapping environment in which a variety of different phenomena can be explored, linked across a single space. Then, as our understanding of mapping principles develops, we will be able to implement and test different mappings with autonomy unavailable to a corporation beholden to a much more fixed game structure.

Mapping is a difficult phenomenon to deal with in MMOG development because it is difficult to predict exactly how different experiences will map for different individuals. That said, game designers have done considerable work to try and understand the differing natures of play styles practiced by different individuals in online environments. Designers have long been aware of the emergent values and behaviors of different MMOG communities and attempted to foster a broader awareness of this fact in the community at large. Raph Koster, one of the designers of *Ultima Online* and lead designer of *Star Wars Galaxies*, famously formulated that “[An MMOG is] a community. Not a game. Anyone who says, ‘it’s just a game’ is missing the point.” [Koster 2009] Morningstar and Farmer, developers of LucasArts’s social game *Habitat*, encountered the same phenomenon and noted that “a cyberspace is defined more by the interactions among the actors within it than by the technology with which it is implemented” and that from a design standpoint “detailed central planning is impossible.” [Farmer and Morningstar 1990] While the rules and incentive structures for certain behaviors can be incorporated into MMOGs, players will be driven by their own motivations as well. Instead of looking at player growth as a process opposed to these rule structures, however, community development should be considered in tandem to them. Players’ reactions to the IOS models as implemented in the game environments will help to evolve our understanding of these models themselves.

That said, to apply these ideas to our specific development of an MMOG for the study of IOS models, it is still

necessary to develop both an understanding of the community that will play the game and a method for allowing investigators to translate the salient features of IOS models into game dynamics. While measuring players’ reactions to model implementations is essential, it is impossible to engage in accurate study without any theory of the base population. Bartle notably broke down players into four types based on discussion within a game’s forum about what people want out of a MUD (a precursor of modern MMOGs): Achievers, Explorers, Socializers, and Killers. Bartle posited that these player groups can exist in various stable states of flux, determined by the type of MUD that had been created [Bartle 1996]. Yee later followed up this work with an attempt at a multi-factor analysis of the survey results from players of different MMOGs, identifying three salient factors in players’ motivations for play: Achievement, Socialization, and Immersion (into a virtual environment). Yee also noted that these factors did not suppress each other, but might actually coexist within an individual at equal intensities, bolstering each other. [Yee 2006] As noted earlier, significant research has already been done to determine the demographics of several conventional MMOGs, though Aschbacher’s report on *Whyville* demonstrates the possibility for considerable demographic variability based on design, a phenomenon also at the heart of Pearce’s study. [Aschbacher 2004; Pearce and Artemesia 2009] Game designers can appeal to all or some subset of these perspectives via design choices, and in creating *Cosmopolis* we have sought to provide a framework that would support multiple combinations of desires. Additionally, given our expected ability to segment players based on their play habits and associations, we can hope to provide a more refined breakdown of play habits than has been previously found.

3. Method

The first subsection below discusses *Cosmopolis* in terms of its game design features for players, as influenced by the MMOG design guidelines mentioned in the background section. Key features covered include the outer game / subgame structure, and the game world’s information channel system with its novel inclusion of real-world newsfeeds. The second subsection describes the design features of *Cosmopolis* as a research testbed, and a discussion of the first experiment to be conducted. Both subsections incorporate examination of the engineering criteria used to build *Cosmopolis*.

1. Game design

As a game, *Cosmopolis* has a two-level structure: outer game and subgames. The outer game is a present-day city- and world-building simulation, including player-level and guild-level conflicts. The various subgames will be housed

in any buildings or areas in the world. This two-level format supports our aim of attracting as many players and player types as possible, consequently yielding data about a wide variety of individuals in distinct populations and about the relations among them.

To generate a wide player base, we aim to appeal to the several archetypes of players as described by Bartle [1996] and supported by Yee's later re-analysis [2006]: Socializers, Achievers, and Explorers. Socializers can freely interact in peaceful venues (i.e., outer game and some subgames), Achievers can compete in subgames or strive for leadership in the outer game, and Explorers can

discover new quests and subgames in various distinctive locales.

Currently, there are three completed or developing 3D subgames in *Cosmopolis*: WarPipe, Operation:Peace, and DungeonRun. WarPipe is a multiplayer action/shooter game for individuals or teams, featuring a detailed urban battleground and 1st/3rd person camera perspectives. Operation:Peace, a simulation designed for the United Nations Millennium Challenge, involves the detection and clearing of mines from a demilitarized zone (Figure 1). DungeonRun is a single-player fantasy-themed action/adventure game with AI-controlled monsters.

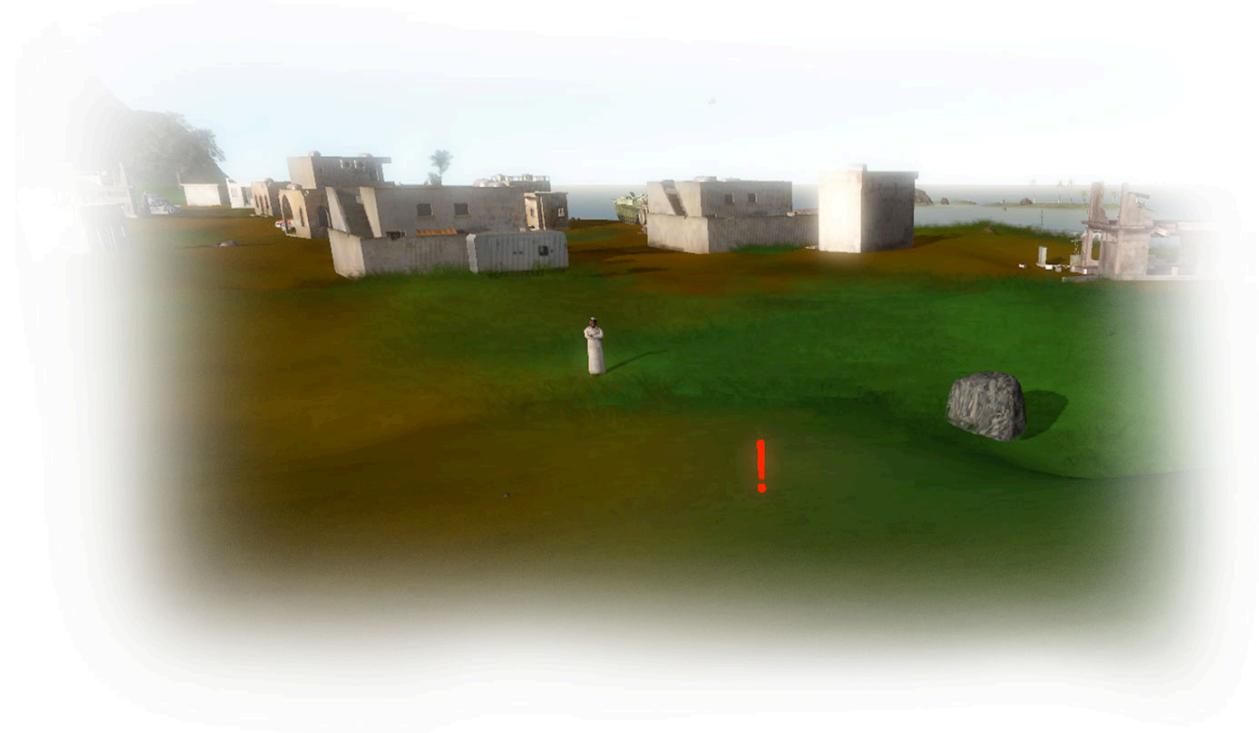


Figure 1: UNMC Operation:Peace Subgame

Besides providing a variety of gameplay genres for the different player archetypes, the subgames will have leaderboards relevant to the outer game. This is so that outer-game oriented players will be engaged when playing subgames, and vice versa, tying the virtual community closer together. For example, the guild that has the best leaderboard record for a city's subgames will rule that city for the next political cycle. Rulership of a city entails being able to set zoning rules for buildings, levy taxes on residents, and arbitrate the assignment of municipal jobs such as taxi driver, policeman, or subgame administrator.

In terms of engineering, *Cosmopolis* is designed to be an engaging game, with state-of-the-art graphics and effects (Figure 2). The game engine has been built from the ground up with the primary objective of supporting a massive, changing world seamlessly. By design, *Cosmopolis* needs to be able to support large cities and wilderness in addition to providing a cohesive experience across the subgames and the outer game. For example, the current game world has a total area of 8 km², and supports importing real world height data to recreate small islands, etc.



Figure 2: Cosmopolis Game World

Cosmopolis, being a persistent world, also needs to retain the changes players make to the world. For instance, the engine supports dynamic terrain deformations; a grenade blast that deforms the land will permanently deform the land (unless fixed up by a player). This characteristic of the world gives players an immersive experience when they come back and find continuity from their previous exploits.

All of the action in *Cosmopolis* is handled by an event-based networking model. Each event has certain properties that define how it will be perceived in the subgame and the outer game. This approach enables us to be flexible with regards to the level of interconnectedness between the subgame and the outer game as desired by the researchers and game designers. Subgames could be designed to be completely isolated sandboxes like MMOG instances (like the *DungeonRun* subgame) or be seamlessly integrated with the outer game (like the *Operation:Peace* region-based subgame or a neighborhood basketball court). This system is also data-driven so designers can tweak the various parameters without having to ask the engineers to rebuild the game for each tweak. This also reduces the burden on the subgame engineers as they need not worry about the integration with the outer world for components like particle systems, sound, character movement and animation, etc.

In *Cosmopolis*, the in-game information system is a collection of channels through which messages flow. Channels may display news feeds from the real world or

commercial advertisements; channels may publish in-game announcements publicly or regionally; channels may be configured as special chat lines between players. We aim to present messages efficiently and effectively to and between players, as well as to support the framework for the study of information spread and analysis.

For example, we are building an in-game virtual economy system that has a commodity market and currency exchange market. All the commodity prices and currency exchange rates are synchronized periodically with incoming real-world rates. Data extracted from information channels may also change the behaviors of NPCs (implemented as artificial intelligence-driven software agents). Warnings of “terrorist attack” or “earthquake danger” may cause NPCs to flee an area. Rumors of “unrest” may coincide with NPCs behaving in a less friendly manner towards players or each other. Stock market gradients can also change the personalities of the NPCs, e.g. increasing makes them happier, and decreasing makes them nervous.

As *Cosmopolis*'s information system is relatively untested, it is an open question as to all the ways it will affect players. However, some speculation is possible. Players may be influenced by the game world's or NPCs' responses to certain events as described above. For example, NPCs are programmed to respond to earthquake predictions in a certain manner, and the players can learn from NPCs' actions. Another example is that players may choose to

move to a region where commodities are becoming relatively more valuable. Also, there may be information channels that show players certain data (such as social networks) from the game, to see if providing such information alters player behavior.

2. Research test bed design

As a research test bed, *Cosmopolis* offers a critical degree of experimental flexibility beyond the data-logging capability of the standard MMOG. Our overall design comprises a federated model architecture: each subgame is a potential lab for a different social and behavioral model, maintaining interoperability with the outer game world model. Subgames may be added, and gameplay of the outer world can be tweaked, all to meet the needs of researchers who use our game to validate or collect data for their models. While all in-game events will be logged, we will be specifically providing appropriate data export, reporting, and visualization capabilities so that researchers can easily analyze the experiments that they design and conduct in the game environment. Exported data would include player characteristics and activities, relational information such as who played with whom, performance outcomes, geo-temporal activity sequences and so on.

From an engineering standpoint, the subgames' content and logic is completely isolated from the outer game except for a controlled data access pipeline. This enables administrators and researchers to set exactly what part of the outer world this subgame can modify, to prevent any unexpected behavior. This also means that in the event of any bug or design inconsistencies in any of the subgames, it can safely be taken down without affecting the rest of the game.

The event-based networking model enables efficient logging management, which is vital for researchers using *Cosmopolis* as a data source. The logging parameters can vary from player to player, subgame to subgame, based on the needs of various researchers. The current networking model has a separate gameplay and analysis server. The analysis server can be tasked to perform near real-time processing in addition to logging the data.

To separate the account management from gameplay logic, *Cosmopolis* uses web services to perform authentication and initiate game connection. This also paves the way for enabling researchers to control different parameters of the game from the browser. For example, they could add buildings, move objects, or change the weather.



Figure 3: WarPipe Subgame

The first research experiment on *Cosmopolis* will be performed using the WarPipe action (shooter) subgame

(Figure 3). The research team will thoroughly control the experimental configuration of WarPipe, and also administer

surveys and access all centrally logged information about player activities in both WarPipe and the outer game.

The current experimental design is to run two custom-designed variants of WarPipe and study the behavioral norms of individuals who are only able to play one of the two variants, as expressed by the players' actions in the outer game and in their responses to surveys.

The primary distinction between the two game variants will be a programmatic attempt to emphasize the importance of individual autonomy in one and individual dependence in the other. This will be done by having one variant permit players to respawn after dying (before a specific round of the game has ended), and the second disallow respawns. Anecdotal evidence gleaned from shooter games that incorporate these two different mechanics suggest that this design can successfully stimulate certain responses. The ability to respawn has traditionally encouraged riskier player behaviors (because of the lower cost of failure), while inability to respawn requires players to coordinate with each other and play more carefully if they wish to survive. Prior to public deployment of the experiments, the games will be thoroughly tested by small groups to make sure that these requirements are present.

By confining players to these different game styles, the experiment aims to influence players' perception of normal behavior within game environments. Hypothetically, providing stimulus for certain normative behaviors within one game-like virtual environment will create a stimulus for behaviors expressed within a second virtual environment; specifically, a shooter game that is geared towards teamwork will encourage team formation in the outer-game environment as well. Formally stated: a player who is confined to a shooter variant modified to encourage team formation (by forbidding respawning) will demonstrate an increased proclivity for team formation and social interaction in the *Cosmopolis* outer game than will someone playing the variant designed to encourage individual initiative (by permitting respawning).

In addition to looking at norm formation in virtual spaces, this experiment also serves as a study of the mapping principle: the idea that certain game behaviors map to other areas. Investigations of mapping specifically engage the question of how actions taken in games and virtual environments can be interpreted in real-world environments, but by showing that a behavior maps between virtual environments, it will be possible to suggest that there may be a real principle underlying the virtual behavior that it could be considered reasonable to map.

4. Discussion

MMOGs are widespread and popular online communities; *World of Warcraft* alone boasts millions of player characters. The significance of *Cosmopolis* is its uniqueness as an MMOG designed specifically as a research testbed for social and behavioral models, with a correspondingly high degree of researcher control over experiments performed in and data gleaned from the game world. A few of the key features that *Cosmopolis* incorporates are a system of nested subgames, a world-development dynamic and mechanisms such that players can permanently deform the landscape, and a channel-based information system that allows players to be broadcast new information. While these features help to make the game novel and fun, they also have specific applications for scientists opting to use *Cosmopolis* as a research platform: subgames are a way for researchers to conduct isolated experiments; the modifiable nature of the world allows for events to occur that may dramatically alter the main game environment, providing fodder for scientists interested in the evolution of online communities; and the information broadcasting systems will allow different messages to be broadcast to different portions of the community to help manage experiments conducted on the entire player community. Furthermore, ready access to a high-fidelity data set means that researchers will have an easier time determining the impacts of different treatments on the community in *Cosmopolis* than do researchers of more closed gaming environments. Also, all *Cosmopolis* interactions are eminently documentable, and may be used to explore the mappings between game world and real world societies. Our first experiment, comparing the outer game behavior of players from two variants of the WarPipe subgame, will initiate this exploration.

It is impossible for one MMOG to be considered the definitive online game, and *Cosmopolis* is not intended to be that. But it is an extremely important step in opening up game environments for use by researchers, and one that will help support the work of many scientists interested in studying game environments and how different phenomena manifest within them. At present we must finish designing and running our own first experiments within *Cosmopolis*. Even before having reached this point, however, we hope that the demonstration of the feasibility of *Cosmopolis* will encourage other researchers to look to game environments - either *Cosmopolis* or their own more specialized platforms - as avenues for research into human activity.

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