Can Parallel Worlds Converge?
Time Use and Activity Engagement in Virtual and Physical Environments

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Presentation Outline

Introduction, Background and Objectives
Rules of the Game
Player Game Engagement
Player Regimes: Cluster Analysis
Time Allocation for Combat
Time for Traveling
Conclusions
Exhibit 6: Time Spent Increase, Video and Social Media

Global Web Traffic to Social Networking Sites

- Time Per Person (HH:MM:SS)
- Unique Audience

Source: The Nielsen Company
Introduction

- **People are increasingly engaged in the virtual world**, often simultaneously with physical world activities (Taylor 2006; Mahmassani et al. 2010)

- These activities can be conceptualized as a subsets of activities that occur in either or both worlds.

- Travel behavior and time use analysts have shed some light on this eclipsing by examining the **role of information and communication technologies for work-related activities, from both a work management perspective** (Guiliano 1998; Golob and Regan 2001, Mahmassani et al. 1993) and a **travel/spatial location perspective** (Mokhtarian et al. 2004, Mokhtarian 2003; Gould and Golob 2002)

- In regards to leisure and social activities, less is known about the extent to which the virtual world may have eclipsed “real world” engagement.

- A major obstacle has been obtaining data on actual participation, but the **computer-based nature of virtual activities (social media, games, etc...) allows event logs of individuals’ activities in the virtual environment to be recorded.**
Introduction

• Gradual Eclipsing or Convergence of Two Worlds...
Objectives

- This paper examines the time allocation of players inside virtual gaming environments. By doing so, different aspects of time use related to online gaming are investigated:

  1) *Relationship between game engagement and time of day/week?*

  2) *How is time for travel related to time allocated to other activities?*

  3) *How do players allocate combat time based on tradeoffs between potential gains and incurred costs?*
Everquest II is a fantasy massively multiplayer online role-playing game (MMORPG) developed by Sony Online Entertainment.

Release Date: November 8, 2004

At the start of June 2006, Everquest II had around 175,000 subscribers globally. Today well above 200,000. More than 1500 servers run the ENTIRE world of EverQuest II.
MMORPG’s -- their significance

World of Warcraft – WoW
> 11 Million subscribers

MMOG Subscriptions Market Share - April 2008

- WoW 62.2%
- EQII 1.2%
- City of Heroes / Villain
- The Lord of the Rings Online
- EverQuest
- EverQuest II
- EVE Online
- Rift
- Final Fantasy XI
- Lineage II
- Lineage
- RuneScape
- All Others
- Others
- 4.3%
- 6.2%
- 6.3%
- 6.4%
- 7.5%
- 5.8%
- 0.8%
- 0.8%
- 0.8%
- 0.8%
- 0.8%
- 0.8%
- 0.8%
- 0.8%
Descriptive Statistics

- 82% Male
- 18% Female
- 84% US
- 16% outside US
Rules of the Game

• Players engage in this game for the following reasons:
  – **Adventuring**: involves a combination of questing, combating and socializing.
  – **Socializing**: involves meeting other players.
  – Fighting other Players (Player vs. Player)

• Although socializing can be part of adventuring, in terms of forming groups for combat, it is not strictly required.

• For this study, player vs. player combat was not permitted and thus were not included in the sample.
Rules of the Game

- Sample Player Travel/Activity Pattern
Player Game Engagement

• An exploratory analysis of online gaming activity engagement was conducted to **examine when and how long these gaming sessions lasted**.

• Although the activities and time use decisions of players are not known for non-game activities, examining the distribution of game sessions over the timeframe of a day or a week can provide **insight into the timing and relative time use distributions**.

• For this analysis the player event logs from the first week of August were used. A total of 5957 sessions were observed after the session stitching process (Huang et al. 2009) was completed.
To characterize the session start time choice, the percentage of players in the sample with start times falling within specific hours of the day are shown below.
Player Game Engagement

- A second characteristic examined in this exploratory analysis was the distribution of session durations across different hours of the day.
Player Engagement

• Overall looking at the distribution of session start and stop times, and their mean durations, the results indicate that the level of players in the environment varies cyclically over time, with low levels during the early parts of the day and rising later in the day.

• For Fridays and weekends, this peak starts earlier relative to weekdays, and is longer in duration.

• In general, there are more session finishes in the early part of a day (after midnight) than other portions.
Time Allocation for Combat

- Players’ time allocation can be conceptualized as a series of hierarchical decisions.

- This study considers three types of activities: i) combating; ii) non-combating and iii) travel.

- Within the game, combating is a means of winning or gaining experience points, and is thus, driven by the goal of maximizing the number of points gained. Players can decide to spend a certain amount of time in zone with different difficulty levels.

<table>
<thead>
<tr>
<th>Event</th>
<th>Event Type</th>
<th>Duration (min)</th>
<th>Location</th>
<th>Location Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Non-Combat</td>
<td>0.1</td>
<td>Qeynos City</td>
<td>City</td>
</tr>
<tr>
<td>2</td>
<td>Combat</td>
<td>1</td>
<td>Qeynos City - Village</td>
<td>City</td>
</tr>
<tr>
<td>3</td>
<td>Non-Combat</td>
<td>0.1</td>
<td>Qeynos City</td>
<td>City</td>
</tr>
<tr>
<td>4</td>
<td>Travel</td>
<td>4</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>5</td>
<td>Combat</td>
<td>1</td>
<td>Enchanted Lands</td>
<td>Field</td>
</tr>
<tr>
<td>6</td>
<td>Travel</td>
<td>7</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>7</td>
<td>Non-Combat</td>
<td>1</td>
<td>Halls of Fate</td>
<td>Dungeon</td>
</tr>
<tr>
<td>8</td>
<td>Combat</td>
<td>32</td>
<td>Halls of Fate</td>
<td>Dungeon</td>
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<td>9</td>
<td>Non-Combat</td>
<td>30</td>
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<td>Dungeon</td>
</tr>
<tr>
<td>10</td>
<td>Combat</td>
<td>19</td>
<td>Halls of Fate</td>
<td>Dungeon</td>
</tr>
</tbody>
</table>
Time Allocation to Combat: Cluster Analysis

• As an initial step to uncover these different strategies, a cluster analysis was used to identify regimes of players that allocate time similarly with respect to the three combating areas (city, field and dungeon), and other characteristics.

• Each combating area represents a different level of difficulty, with cities being the safest and dungeons being the most dangerous.

• A hierarchical clustering algorithm was used to generate and identify groups of players and four clusters were identified.
Time Allocation to Combat: Cluster Analysis

Average Combat Time Allocation

Average Proportion of Playtime for Combat

Cluster

Allocations:
- Dungeon
- Field
- City

Proportion (0-1)

Cluster

1
2
3
4
Time Allocation to Combat: Cluster Analysis

Average Character Level

Average Character Age (hrs)

Average Income (Millions of Coins)
Time Allocation to Combat: Cluster Analysis

- Based on the clustering analysis, there are similarities in the way players allocate their combating times.

- Players with low character levels spend more time in the cities, while players with high character levels spend more time in the dungeons, which is reasonable considering difference in the difficulty of these regions.

- However, with respect to coins and age of characters, the players with the lowest levels, in general, spend more of their time in the fields.
Time Allocation to Combat

• To gain further insight into this allocation and to relate the allocation to attributes of the characters, a nested-Tobit (N-Tobit) model of time allocation was used.

• Unlike the Tobit model, the nested-Tobit allows more than one level of choice to be arranged in a sequential hierarchy, as in a nested Logit (Amemya 1984; Lee 1992; Howe et al. 1994; Meloni et al. 2004).

• In general, an N-Tobit model allows the estimation of two or more equations of the following type:

\[ y_1^s = x_1^i \beta_1 + u_1 \quad \text{and} \quad y_2^s = x_2^i \beta_2 + u_2 \]

where

\[ u_i = [u_{1i}, u_{2i}]' \sim N(0, \Sigma) \quad \Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{12} & \sigma_2^2 \end{bmatrix} \]
Time Allocation to Combat

• The first endogenous variable is the same as that defined in Kitamura’s model of time allocation to discretionary activities (1996). The second endogenous variable is the same as the one additionally adopted by Meloni et al. (2004 and 2007).

• These endogenous variables are related as follows:

\[
\begin{align*}
  y_1 &= \begin{cases} 
  y_1^* & \text{if } x_1' \beta_1 + u_1 > \Delta \\
  y_1 = \Delta & \text{otherwise}
  \end{cases} \\
  y_2 &= \begin{cases} 
  y_2^* & \text{if } x_2' \beta_2 + u_2 > \Delta \\
  y_2 = \Delta & \text{otherwise}
  \end{cases}
\end{align*}
\]

\[
y_1 = \ln \left( \frac{T_{\text{field}} + T_{\text{dungeon}}}{T_{\text{city}}} \right) \quad \quad y_2 = \ln \left( \frac{T_{\text{dungeon}}}{T_{\text{city}} + T_{\text{field}}} \right)
\]
Time Allocation to Combat

- $y_1$ and $y_2$ are observed only if the corresponding $d_1$ and $d_2$ are greater than the threshold $\Delta$. This model can be estimated using maximum likelihood estimation:

$$L = \prod_{d_1=0} Pr(y_1^* < \Delta) \times \prod_{d_1=1} \left[ \prod_{d_2=0} Pr(y_2^* \leq \Delta | y_1^* = y_1) \times \prod_{d_2=1} Pr(y_1^* = y_1, y_2^* = y_2) \right]$$
# Time Allocation to Combat

## Estimation Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>T-statistic</th>
<th>Coefficient</th>
<th>T-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>5.3239</td>
<td>41.54</td>
<td>-7.7259</td>
<td>-27.76</td>
</tr>
<tr>
<td>Character Level</td>
<td>0.1020</td>
<td>18.10</td>
<td>0.1020</td>
<td>11.96</td>
</tr>
<tr>
<td>Age Character (s)</td>
<td>-6.1111E-08</td>
<td>-3.68</td>
<td>-9.1617E-08</td>
<td>-3.76</td>
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<tr>
<td>Travel Time/ Per unit PlayTime</td>
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<td>2.85</td>
<td>3.8228</td>
<td>8.08</td>
</tr>
<tr>
<td>Social Membership (1/0)</td>
<td>5.5982</td>
<td>54.31</td>
<td>8.3535</td>
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</tr>
<tr>
<td>Coins (start)</td>
<td>3.5899E-09</td>
<td>4.30</td>
<td>3.8383E-09</td>
<td>1.97</td>
</tr>
<tr>
<td>Home (1/0)</td>
<td>0.3731</td>
<td>3.81</td>
<td>0.6236</td>
<td>4.56</td>
</tr>
<tr>
<td>Guild Member (1/0)</td>
<td>-0.2604</td>
<td>-2.35</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Strength (start)</td>
<td>-0.0065</td>
<td>-4.45</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Stamina (start)</td>
<td>0.0020</td>
<td>1.48</td>
<td>0.0024</td>
<td>1.57</td>
</tr>
<tr>
<td>Agility (start)</td>
<td>-0.0034</td>
<td>-2.55</td>
<td>0.0058</td>
<td>3.28</td>
</tr>
<tr>
<td>Wisdom (start)</td>
<td>-0.0066</td>
<td>-7.66</td>
<td>0.0017</td>
<td>1.47</td>
</tr>
<tr>
<td>Intelligence (start)</td>
<td>-0.0020</td>
<td>-2.57</td>
<td>0.0036</td>
<td>3.72</td>
</tr>
</tbody>
</table>

Loglikelihood Value: -36302.84

LL(constants only): -39623.33

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>T-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Deviation Eq1</td>
<td>3.97478665</td>
<td>104.804</td>
</tr>
<tr>
<td>Standard Deviation Eq2</td>
<td>5.34588462</td>
<td>82.746</td>
</tr>
<tr>
<td>Covariance</td>
<td>0.43222781</td>
<td>36.334</td>
</tr>
</tbody>
</table>

N=7535
Time Allocation to Combat

(field + dungeon) vs. city

- Social Membership
- Home Ownership
- Guild Membership

dungeon vs. field

Coefficient Value
Time Allocation to Combat

(field + dungeon) vs. city

dungeon vs. field

Coefficient Value

-0.0080
-0.0040
-0.0020
0.0000
0.0020
0.0040
0.0060

Coefficient Value

-0.0060
-0.0020
0.0000
0.0020
0.0040
0.0060

-0.0080
-0.0060
-0.0040
-0.0020
0.0000
0.0020
0.0040
0.0060
0.0080

Strength
Stamina
Agility
Wisdom
Intelligence

(field + dungeon) vs. city

dungeon vs. field
Time Allocation to Combat

• Overall the results suggest the following three issues related to examining time use behavior in virtual worlds:

  – **Social memberships play an important role in time allocation**, both small social groups for combating and larger groups, such as guilds which encompass several hundreds of members.

  – With respect to the status of players, the time allocation to different zones of varying difficult seems to favor more experienced players allocating more time to more difficult areas.

  – The estimation results further suggest the existence of different playing regimes that behave differently from each other.
Time for Traveling

- To examine different player regimes in relation to how players are experiencing travel times, a switching regression model was estimated (Maddala 1983).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regime 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>224.4013</td>
<td>8.309</td>
</tr>
<tr>
<td>Combat Time - City</td>
<td>0.0798</td>
<td>2.156</td>
</tr>
<tr>
<td>Combat Time - Field</td>
<td>0.0380</td>
<td>2.776</td>
</tr>
<tr>
<td>Combat Time - Dungeon</td>
<td>0.0998</td>
<td>9.233</td>
</tr>
<tr>
<td>Character Level</td>
<td>-2.0803</td>
<td>-3.519</td>
</tr>
<tr>
<td>Guild Membership</td>
<td>-29.8473</td>
<td>-3.211</td>
</tr>
<tr>
<td><strong>Regime 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>311.0852</td>
<td>2.833</td>
</tr>
<tr>
<td>Total Combat Time</td>
<td>1.0378</td>
<td>5.422</td>
</tr>
<tr>
<td>Character Level</td>
<td>5.9227</td>
<td>2.151</td>
</tr>
<tr>
<td>Loglikelihood Value</td>
<td>-36302.84</td>
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<tr>
<td>LL(constants only)</td>
<td>-54301.99</td>
<td></td>
</tr>
<tr>
<td>Number of Observations</td>
<td>7535</td>
<td></td>
</tr>
</tbody>
</table>
Time for Traveling

• Based on the significance of variable in the equations for both regimes, the results suggest two regimes of players.

• In the first regime, the results show that there are different impacts depending on where this combat time is allocated.

• Looking at character level, there seems to be opposite effects for both regimes.

• Furthermore, in the first regime, guild memberships showed to be significant, illustrating the different impact social memberships can make.
Conclusions

• The recent popularity of virtual world applications means that increasingly there is more engagement; this suggests that either substitution between activities is occurring (where activities that occur in the physical world are substituted for their virtual world counterparts), or that there is a gradual convergence of these two worlds where there is an increasing overlap.

• The results show that there is strong clustering of players into regimes, based on their time allocation pattern across combat zones of different difficulty levels.

• Additionally, players’ time allocation decisions for combating differ on the basis of social memberships and indicators of status and success in the game, such as home ownership or rental.

• Overall, the statistical results suggest the existence of player regimes within a game that differ by allocation of combat time and subsequently in explaining overall travel levels within the game.
Future Research

• SHORT TERM
  – Consider the dynamics of time use.
  – Closer examination of latent player regimes.
  – Integration of the “spatial” aspects the virtual world into behavior models.
  – A more detailed account of social network dynamics and their implications for group behaviors.
  – Examine the coordination among players both online and offline.

• LONGER TERM
  – Impact of mobility on virtual engagement: the mobile internet, telemobility.
  – Comparison of gaming activities in relation to other virtual and real-world activities—interaction and complementarity.
  – Here, Now and Everywhere: virtual social networks