Journal of
Virtual Worlds Research
jvwresearch.org ISSN: 1941-8477

Volume 3, Number 1
October 2010
The Researcher's Toolbox

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November 2010

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eLab City: A Platform for Academic Research on Virtual Worlds

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Abstract

The eLab City project in Second Life is a laboratory environment for the study of user behavior in virtual worlds. This paper describes the origin and development of the eLab City project, which includes virtual infrastructure constructed in Second Life, a panel of Second Life users who have agreed to participate in research studies, tools for observational data collection, and procedures for fielding research projects. The eLab City panel is described in detail, with discussion of the panel signup process, recruitment, and panelist demographics. Cooperation rates for a series of research studies that used subjects from the elab City panel are presented, comparing studies fielded in Second Life to Web-based studies. We conclude with a discussion of lessons learned and next steps for this research project.

Keywords: cooperation rates, online research, Second Life, virtual worlds

Acknowledgments. The eLab City project would not have been possible without the assistance of many individuals. The author thanks Mario Menti and Dietmar Walter for respectively providing panel programming support and access to the GMI Net-MR product, Nico Agosto for his LSL scripting and database support, Melah Carter, Khushbu Gokalgandhi, Erica Lopez, Tanya Manifold, and Mark Manalang for their research support, Andrea Godrey, Francesco Massara, Xing Pan, and Michael Trusov for their collaborative efforts on various research projects, Cezary Ostrowski for his design and development work in single handedly constructing eLab City, and Nadia Hennrich for her conceptual work and artistic direction.

eLab City: A Platform for Academic Research on Virtual Worlds

1. Overview of the eLab City project

The eLab City project was launched in Second Life in 2008 as a multi-faceted laboratory environment for studying user behavior in virtual worlds (Novak 2007, 2008). The objective of this paper is to describe the motivation for creating eLab City and to explain the various research components of the project, paying particular attention to the eLab City Panel. Over the course of a year, we have assembled a survey panel of over 5,000 Second Life users who have visited the eLab City project, many of whom have subsequently participated in a series of Web-based studies as well as experiments that were programmed and fielded in Second Life. The conception and development of the eLab City project and the eLab City Panel raised a host of methodological and operational issues which we identify and address. We trust that our experiences over the past two years in developing and launching eLab City will be valuable to other researchers who are contemplating using virtual worlds as a platform for academic research.

1.1 Virtual worlds as research environments.

Virtual worlds can arguably provide a sound basis for business study, given the ability of virtual worlds to simulate both the laws of physics as well as economic systems (Bloomfield 2007). These worlds are inhabited by virtual representations of real world consumers; considerable research has established that social, psycho-physical, and economic behaviors enacted in virtual worlds are consistent with real life behaviors (e.g. Miller 2007; Chesney et al. 2007; Gorini, Gaggioli and Riva 2007; Yee et al. 2007). Given behavioral consistency across real and virtual environments, virtual worlds can serve as laboratory environments for furthering consumer knowledge (Hemp 2006; Novak 2007; 2008) and more generally can serve as a platform for scientific research (Bainbridge 2007, Djorgovski et al 2009, Miller 2007).

Some authors have argued that it is important for research about virtual worlds to be conducted from within the virtual world itself, rather than, for example, by inviting respondents from a virtual world to complete a Web-based survey, since "moving out of the virtual world to answer a survey creates a break in immersion and thus potentially prevents accurate recall of the virtual environment" (Bell, Castronova and Wagner 2009, p3). Of course, if the virtual environment is not itself the topic of the research study, requesting that participants exit a virtual world and complete a survey in a Web browser would not necessarily pose such a dilemma. Furthermore, fielding research studies in Web browsers may offer significant advantages considering that current technology for implementing surveys in virtual worlds (i.e.Second Life) is extremely

crude by comparison to the available tools for Web-based surveys such as the two survey research tools we used in the eLab City project—Qualtrics[1] and GMI-Net-MR[2].

Still, there are many situations in which it is critical that research be conducted within a virtual world, rather than in the real world or in a Web browser. One such stream of research—which requires data collection occuring within a virtual world—focuses upon demonstrating that virtual world behavior mirrors real world behavior. For example, Slater et al (2006) replicated Milgram's (2006) obedience study in a projection based virtual reality environment; Yee et al. (2007) replicated findings from the physical world regarding interpersonal distance in the virtual world Second Life; and Eastwick and Gardner (2008) replicated physical world findings regarding the "foot-in-the-door" technique in the virtual world There.com. In such cases, since virtual world behavior itself is of interest, it is necessary for the research to be fielded and data collected within the context of a virtual world.

In other situations, it is equally critical that research *not* be conducted within a virtual world, but be conducted in the real world (outside the virtual world). Such situations include research on the impact of virtual world behavior on subsequent real world behavior. For example, Yee and Bailenson (2007) found that participants who were given taller avatars in a virtual environment negotiated more aggressively in the virtual environment, but also negotiated more aggressively in subsequent real world interactions. Similarly, Fox and Bailenson (in press) reported that participants who watched their own avatar run on a virtual treadmill were more likely to voluntarily exercise the next day, in the real world. In such settings, at least some data must be collected outside the virtual world, in the real world, from subjects who had some prior interaction with a virtual world.

Based upon the previous examples, we can reasonably conclude that academic research on user behavior in virtual worlds should allow for various data collection possibilities. Potential participants may need to be initially contacted either within a virtual world, or within the real world. The study itself may need to be fielded either within a virtual world, or within the real world (including a Web browser). Examples of virtual world participant contact include:

- Instant messages sent within a virtual world to a list of avatar names
- Intercept surveys in which an avatar—or an automated avatar "survey bot" (Menti 2007)—approaches another avatar, or
- Survey devices which can be placed around a virtual world and encountered by virtual world visitors as they explore the virtual environment (Bell, Castronova and Wagner 2009).

[1] http://qualtrics.com/
[2] http://www.gmi-mr.com/

Real world participant contact includes:

- Emails sent to an existing sampling frame of email addresses,
- Posts on Web pages, or
- Social networks informing and directing potential participants about a research study.

In the next section, we introduce the eLab City project and describe various modes of data collection in the eLab City project. From our discussion so far, we note that eLab City is intended as a virtual world research platform that allows flexibility in whether research subjects are contacted—in the virtual world or the real world (i.e. via email)—for participation in research studies—fielded either within the virtual world or the real world (i.e. via a Web browser).

1.2 eLab City concept and development

A concept plan for the eLab City project was released in November 2007, and bids were solicited from Second Life developers to construct a two-region academic build in Second Life.[3] Construction began in late 2007, was completed in Spring 2008, and the first research activities began in Summer 2008. Originally envisioned as a "live-work-play" community, eLab City was designed to provide a microcosm of many key social aspects of Second Life. However, eLab City's primary functions were to be a working laboratory and a mechanism for building a subject pool of participants for academic research studies.

Construction of eLab City was guided by three principles: form, function, and community. In hindsight, it became apparent that these three principles were ordered from least to most difficult to achieve. Form, in the sense of high quality design, was the first principle. Most academic builds in Second Life are not particularly inspired; the same can be said for much of the user generated content in Second Life itself. eLab City was designed to be a destination with strong design considerations and a compelling sense of place and we believe it is highly successful on the form dimension.

The physical infrastructure of eLab City includes, as mentioned above, live-work-play aspects. Figure 1 shows an annotated screenshot of the eLab City project. The "live" aspect includes a section of roughly one dozen pre-built unfurnished apartments intended for student workers and others involved with the eLab City project. As in other Second Life locations, residents quickly displayed a sense of ownership. For example, when the first set of student residents moved in, they changed the name from the non-descript "Building A" and "Building B" to "Oceanside Suites North" and "Oceanside Suites South," and they remain so today. The "work" section of

[3] The original concept plan for eLab City is available at: http://elabresearch.ucr.edu/novak/elabcity/eLab City Concept Plan (Nov 5 2007).pdf

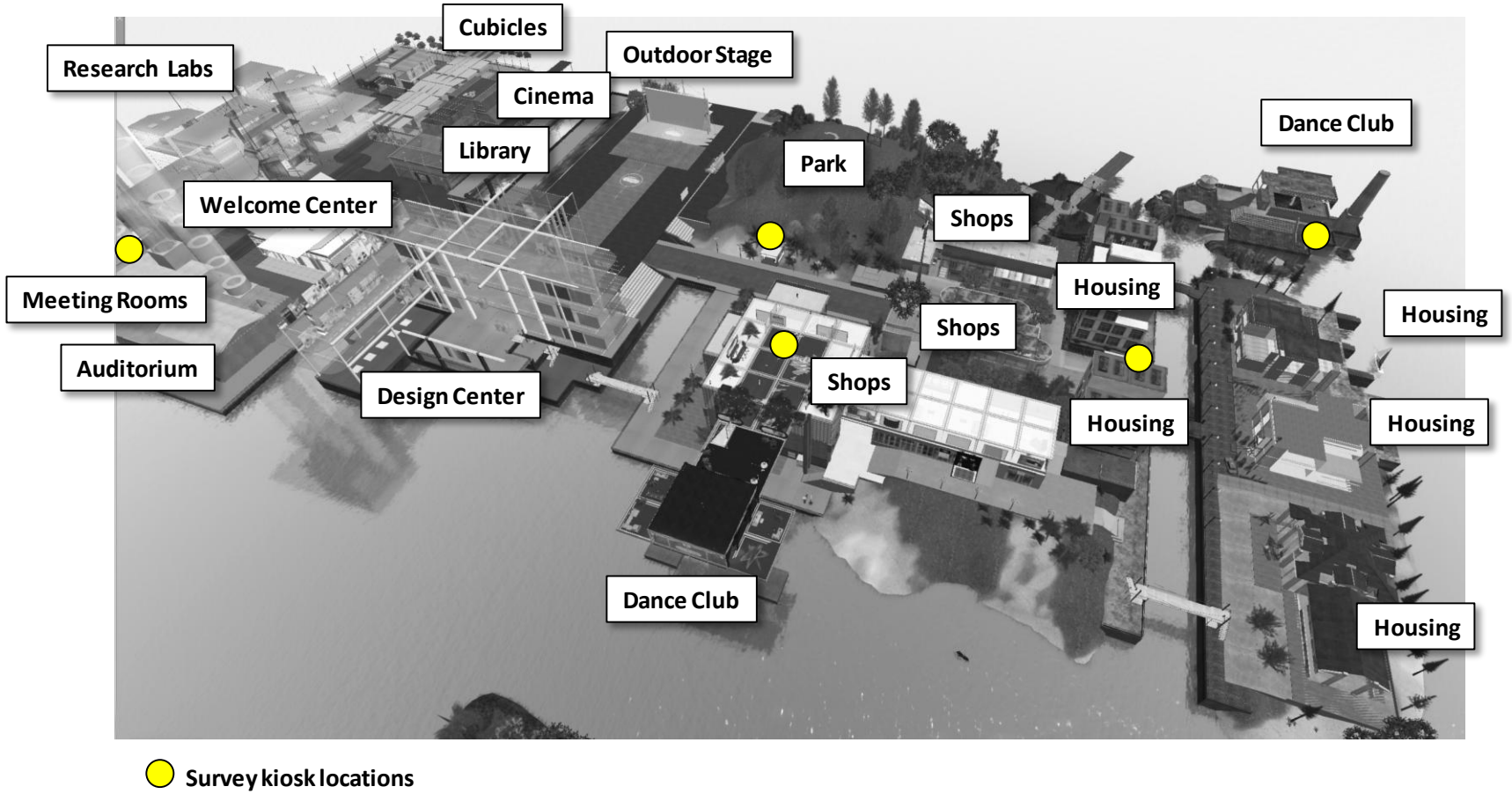

Figure 1. The eLab City Project

eLab City is a complex of research-related buildings. These include 14 cubicles in a virtual behavioral lab that can be configured for experimental studies and mapped to parallel physical world research cubicles in our department's real-world behavioral lab. There is also a large office building intended for use by faculty researchers, an auditorium, several conference rooms, library, visitor's center, and survey sign-up kiosks. The "play" section includes two dance halls, a multipurpose exhibition hall, resident-run shops, a cinema, outdoor stage (later converted to a drive in movie screen), and garden and park space.

Function, the second principle, focuses on the role of eLab City as an environment for academic research. As an academic research facility and platform, eLab City combines a panel of Second Life users, survey and experimental research capabilities, and tools for unobtrusively tracking user visit behavior. This functional aspect of eLab City as a means to support academic research is described in detail in subsequent sections. Again, we have found eLab City to be highly successful on the function dimension.

The third principle is community. At the most basic level, eLab City needs people to agree to participate in research studies for the project to succeed. As described below, we have been very successful in building a research panel of over 5000 Second Life users who have agreed to be contacted when research studies are available. However, beyond this rather narrow definition of community, we hoped to encourage a core group of Second Life users to make eLab City one of their primary destinations in Second Life, and to bring others to this destination. By providing modest financial support to Second Life residents who operate two dance clubs on eLab City, we have attracted a loyal group who visited the project for the purpose of socializing with their friends at these clubs. However, as discussed later, we are not as satisfied with the community building aspect of eLab City as we are with its form and function. Given limited resources, we found most of our time consumed with the research function, and found the task of building a real community to be especially challenging.

1.3 eLab City research process

The eLab City research process consists of three main functions – the eLab City panel, a base for fielding research studies, and a means for collecting observational data. Figure 2 provides an overview of these three functions. Section 2 describes the eLab City panel signup process, recruitment, and demographics of panelists. Section 3 provides a brief discussion of the observational data that is collected at eLab City, and Section 4 presents information on cooperation rates for eLab City research studies that have been fielded with either email or Second Life IM invitations, and that have been fielded either with a traditional Web browser or within Second Life. Some comparisons of cooperation rates for the eLab City panel of Second Life users with a more general global panel of Web users, for the same research study, are also made.

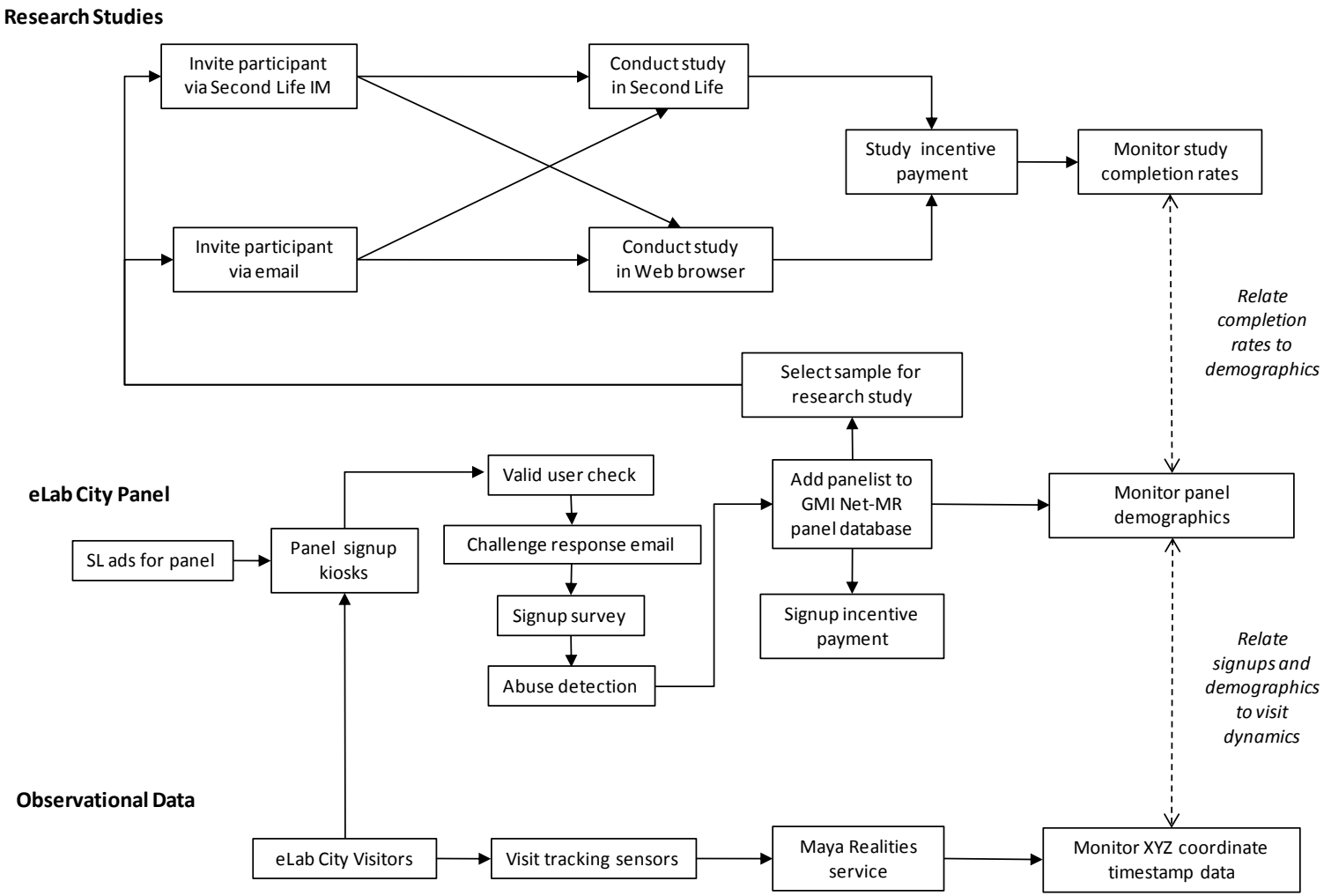

Figure 2. eLab City Research Process

The purpose of Figure 2 is to provide a high-level overview of the steps involved in running eLab City from a research perspective. The eLab City panel lies at the heart of the research process. We directed much of our initial attention toward obtaining and identifying high quality panellists. The data reported in the following section represent 5265 panel signups in a one year period from August 14, 2008 through August 30, 2009.

2. eLab City panel

2.1 Overview description

The eLab City panel is a group of Second Life users who have agreed to participate in academic research studies fielded by the Sloan Center for Internet Retailing at the University of California, Riverside. Users who opt-in to the panel are contacted a few times a year and invited to participate in research studies related to virtual worlds. Incentives of L$250 (approximately $1 US) are provided to those who join the panel, and additional incentives of L$250-$L500 (approximately $1-2 US) are paid for each study completed after joining the panel. There are a number of similar panels in Second Life; for example the Second Life research panel maintained by Market Truths[4], the First Opinions Panel maintained by the Social Research Foundation[5], and the Repères Second Life Panel[6]. While the eLab City panel is similar to these other panels, it is unique in that it is devoted to non-commercial, academic research, and that it is only used for research studies fielded by university researchers affiliated with the eLab City project. All research studies that use participants from the elab City panel have filed University human research review board (IRB) protocols.

Setting up and maintaining a research panel is a substantial undertaking. Owning one's own research panel provides researchers with much greater control over the signup and research process, but the trade-off is in the time and financial cost required to build and maintain the panel. Maintaining a research panel, however, does allow researchers to investigate problems involving the operation of the panel itself, such as methodology for devising optimal contact strategies that maximize survey cooperation rates of panel members (Neslin, Novak, Baker, and Hoffman 2009). The basic operation of the eLab City Panel is described in the next section.

2.2 Panel process

Signup Kiosks. Five panel signup kiosks are located throughout eLab City, with locations shown in Figure 1. Each kiosk contains a main "click to join" sign describing the basic terms of the panel. An FAQ sign, when clicked, delivers a Second Life notecard with detailed information about why and how to join the panel, what information is collected, how to remove yourself from the panel once you've joined, privacy considerations, and contact information for the human research review board.

[4] http://sl.markettruths.com/panel/default.asp
[5] http://www.socialresearchfoundation.org/terms_conditions.html
[6] http://www.reperes-secondlife.com/privacy.asp

Adding New Panelists. Clicking the main kiosk sign triggers a set of steps summarized in Figure 2. To minimize the possibility of Second Life users creating multiple avatars (alts) for the purpose of joining the panel and receiving a signup payment, a Linden Scripting Language (LSL) script checks to see if the Second Life avatar who is trying to join the panel has been in Second Life for at least 30 days. A check is also made to verify that the avatar has not previously joined the panel. All panelist data is stored in the GMI Net-MR 5.5 panel management system. Communication between LSL scripts and Net-MR through HTTP requests allows the Net-MR database to be accessed within Second Life, an example being a query of whether a potential panelist is already in the panel. If the avatar is at least 30 days old and not already enrolled in the panel, the avatar is considered a valid user and asked if they would like to receive an invitation to join the eLab City panel. If they answer yes, a form opens in a browser window with the avatar's own name supplied and asking for an email address. Submission of this form triggers a challenge response email; an email is sent to the email address that was entered; the responder clicks a URL in this email to open the panel signup form in a Web browser. A check is made at this point to ensure that the email address is not already in use in the panel. The signup form asks for basic demographic information – respondent gender, avatar gender, and respondent birth year, education level, country, and native language. Although the signup form is Web-based, the signup process can only be initiated by an avatar within Second Life. The new panelist is requested to provide a password, which can be later used to sign into a panelist portal to change personal information or opt out of the panel.

Abuse detection and payment. One of the problems with any online panel is the possibility of abuse. The likelihood of abuse increases when panelists are provided financial incentives for joining the panel. eLab City panel policies specify only one signup is allowed from a given real life person or IP address. Of course, Second Life users maintain multiple identities or "alt" accounts, and when one is awarded Linden dollars for joining a survey panel, the temptation to sign up multiple alts is sometimes too much for some users to resist. In the initial days of the eLab City Panel, scripts automatically paid a signup incentive immediately after an avatar name was added to the panel. After a few days, we discovered that one individual had signed up—and had been paid—over 20 times, using 20 different accounts. A number of clearly suspicious patterns made this abuse obvious. First, in a short period of time there were over 20 emails from the same domain, with user names "a," "b," "c" and so on. Second, most passwords for these suspicious signups were identical. Third, the signups all came from Second Life avatars with identical first names that ended in digits "1," "2," "3," etc.

This abuse incident was reported to Linden Lab, but as with all abuse reports, the reporter of the incident is not notified as to how the situation was handled, as per the rather abrupt notice supplied by Linden Lab as a "solution" to this case: "For reasons of privacy, the outcome of reported incidents will not be public. Please do not expect any update on the situation. If you are

still experiencing abuse, please report it via in-world tools."[7] In response to a question about whether this situation was considered a violation of Linden Lab's Terms of Service (TOS), Linden Lab responded, "if someone is attempting to fraudulently obtain linden – by whatever means, that is against TOS."[8] While one would hope that such a violation of TOS would result in negative consequences for the perpetrator of the abuse, a year and a half after this incident, every one of the suspicious avatar names that fraudulently joined the panel is still listed as an active Second Life user when searched for in Second Life. It is clear that the researcher must bear responsibility for being alerted to such cases of abuse; it is equally clear that Linden Lab maintains a hand-off approach in such cases.

Following this incident of abuse, we began collecting IP address, limited signups to one per IP address, and modified Net-MR programming to flag all signups which had an IP address identical to that of someone who was already in the panel. If there are multiple signups from the same IP address, then only the first of those signups is enabled as a valid panelist, and all subsequent signups from that IP address are disabled. As a result, multiple unique individuals from the same household who share a router are not allowed to join the eLab City panel. One advantage of limiting signups to one per household is preventing panelists who have been invited to the same study from comparing notes face to face.

We also instituted a procedure of manually reviewing and approving new signups before payment, and disabling those signups suspected of abuse. Payments are now made about 3 times a week, and panelists are told to expect payment 24 to 48 hours after joining the panel. An avatar key is collected as part of the signup process, and used by a GMI Net-MR script to pay L$250 signup payments to approved new panelists. Of 5950 signups from August 2008 through August 2009, the percentage disabled and not paid because of suspected abuse was 11.5%. While is not insignificant, neither is it an alarmingly large concern. However, we should note that our current screening procedures do not eliminate all cases of multiple signups from a single individual.

2.3 Recruitment

We used Second Life classified advertising as the primary method for building our panel. Second Life maintains a classified advertising system which can be accessed either through a Web browser, or by the Second Life client while the user is logged into Second Life. Page position in both Web and in-world classified ad listings is determined by the amount that a user pays per week to place an advertisement. We placed advertisements in two sections, Employment (L$3500/week) and Wanted (L$1300/week), paying placement fees that assured our ads remained in the top five ads for that section. The ads described the eLab City panel, noted that we paid a L$250 incentive for answering a brief signup questionnaire, and provided a teleport to a signup kiosk location in eLab City.

[7] Solution provided to Linden Lab support ticket #4051-5096926, August 6, 2008.
[8] Belinda Linden, Second Life concierge support live chat log, August 1, 2008.

The ads, as described above, ran from November 1, 2008 through August 30, 2009. The ad in the Employment section produced 4524 teleports, and the ad in the Wanted section produced 1076 teleports. Note that we had a total of 5265 panel signups from August 14, 2008 through August 30, 2009. Over the 42 weeks the ads ran, this translates to a cost per teleport of L$38 (approximately 15 cents, US). This is a very reasonable pay-for-performance rate for delivering potential panelists to the signup kiosks. The total number of panel signups tracks closely with the number of teleports from the classified ads, though we cannot determine whether a teleport directly resulted in a signup. Prior to November 1, we experimented with various advertisements. Figure 3 displays the number of new signups per week. Once the classified ads were put in place, the number of new signups was reasonably constant from week to week.

2.4 eLab City Panel demographics

Basic demographic characteristics collected when Second Life visitors join the eLab City panel are reported in Table 1. Column a shows demographics for the 5265 valid enabled eLab City panelists. There is a skew toward more female panelists (55% female), and even more reporting using female avatars (57% female avatars). Instances of reported gender switching are relatively rare and are more likely for men than for women. Of those who reported their gender as male, 7.3% reported using a female avatar, while of those who reported their gender as female, only 2.2% reported using a male avatar.

Education is roughly uniformly distributed, with fairly equal proportions of high school, some college, and college education, and slightly fewer reporting at least some post-graduate education. Avatar age is evenly divided between three groups: a third have been in Second Life for three months or less a third from 3-12 months, and a third a year or more. Age skews young, with a third of the panel between 18-24, 40% between 24-34, and only 10% age 45 or older. The eLab City Panel has a similar age distribution to previous surveys of Second Life users. A 2007 Global Market Insite survey of 10,000 Second Life users[9] found that 51% were 29 or younger, as compared to 55.8% of eLab City panelists. Mean age of eLab City panelists is 30.7 years, compared to a mean age of 32 reported by Linden Lab in 2006.[10]

Column (b) of Table 1 reports demographic statistics for avatars whose accounts were disabled because of suspected abuse. While the differences between enabled and disable accounts are not too striking, Second Life visitors whose panel membership was disabled because of suspected abuse were slightly more female, slightly less educated, more likely to be from 25-34 (although mean age is the same: 30.8 years for disabled vs. 30.7 years for enabled), and more likely to have joined Second Life recently (217.5 days for disabled vs. 304.2 days for enabled).

[9] http://nwn.blogs.com/nwn/2007/04/second_life_dem.html#more
[10] http://www.secretlair.com/index.php?/clickableculture/entry/second_life_stats_early_2006/

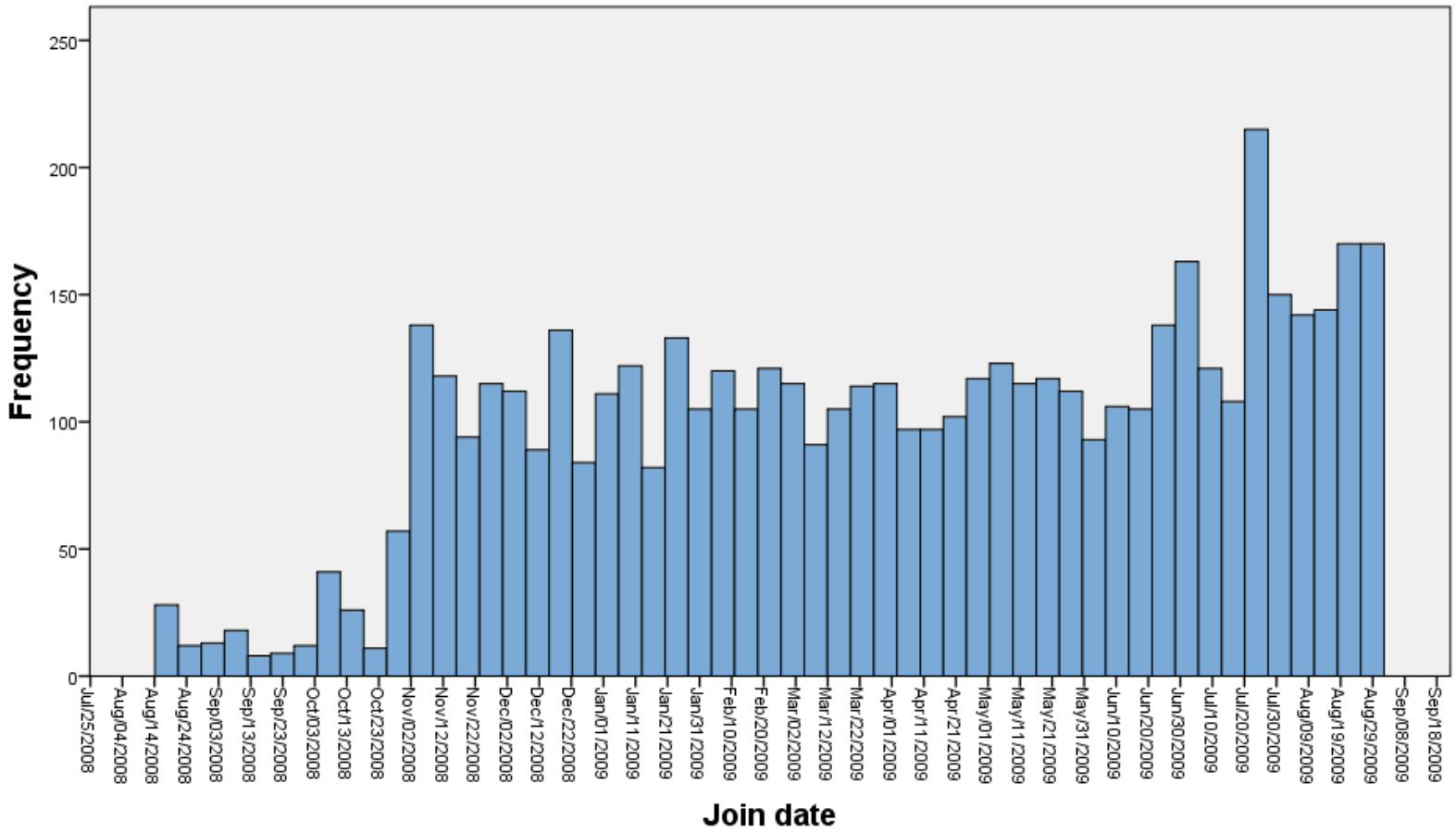

Figure 3. Distribution of Join Dates for eLab City Panel

Table 1 – eLab City Panel Demographics

	(a) eLab City Panel Enabled (n=5265)	(b) eLab City Panel Disabled (n=685)	(c) eLab Global Panel (n=5460)
GENDER			
Female	55.5%	58.1%	58.9%
Male	45.0%	41.9%	38.8%
Not stated	n/a	n/a	2.3%
AVATAR GENDER			
Female	57.0%	58.2%	n/a
Male	43.0%	41.8%	n/a
EDUCATION			
Less than High School	4.3%	6.4%	1.0%
High School	25.5%	27.6%	13.2%
Some College	24.3%	19.3%	23.8%
College	27.6%	27.6%	30.2%
Some Post-Graduate	7.3%	9.8%	10.8%
Post-Graduate	11.0%	9.3%	15.9%
Not stated	n/a	n/a	5.2%
AGE			
18-24	33.5%	27.9%	9.1%
25-34	40.2%	48.3%	26.9%
35-44	16.7%	15.5%	24.7%
45-54	6.7%	5.0%	22.7%
55-64	2.2%	1.6%	12.8%
65+	1.2%	1.8%	3.7%
Mean age	30.7	30.8	41.1
AVATAR AGE WHEN JOINED ELAB CITY PANEL			
< 3 months	33.6%	40.9%	n/a
3-6 months	15.1%	20.6%	n/a
6-12 months	17.8%	17.7%	n/a
1-2 years	22.6%	16.6%	n/a
2+ year	10.8%	4.2%	n/a
Mean avatar age	304.2	217.5	n/a

How does the eLab City panel compare demographically with a panel of general Web users? We also maintain a separate eLab global panel, which consists of Web users (likely not Second Life users) who opt in to receive email invitations to Web based research studies. Column c of Table 1 reports demographic statistics for the eLab global panel. Compared to the eLab City panel (column a), the global panel of Web users (column c) is more likely to be female, more likely to have higher education, and more likely to be older.

Table 2 reports the top 10 native languages and the top 10 countries for enabled eLab City panelists (column a), disabled eLab City panelists (column b), and eLab global panelists (column c). For the eLab City panel, Table 2 also reports country as determined by geolocation of IP address using the WorldIP free geolocation database.[11] Of enabled panelists, 62.7% report English as their native language, which is 10 percentage points higher than for disabled panelists (52.7%), and almost 10 percentage points lower than the eLab global panel (71.6%). Comparing disabled vs. enabled panelists, those whose accounts were disabled for suspected abuse were more likely to speak Portuguese, Spanish and Russian. Results for the top 10 countries largely parallel native language, with four English speaking countries (US, UK, Canada, Australia) listed in the top 10 among enabled eLab City panelists.

Comparing the top 10 countries obtained by panelist self-report with the top 10 countries as determined by geolocation of IP address shows some discrepancies. For enabled panelists, 44.7% report their country as United States, but only 39.5% of their IP addresses return a US country code. The pattern is much more extreme for disabled panelists, of whom 39.4% report their country as United States, but only 25.7% of their IP addresses return a US country code. This discrepancy could be because some international individuals are using proxy servers hosted outside the United States, or because some expatriate US citizens living in other countries report their country as United States. However, a portion of the discrepancy can also simply be from people lying about their true country, an explanation which seems likely given the discrepancy is greater for those panelists whose accounts were disabled because of suspected abuse.

Further analysis of enabled panelists identified countries which had the greatest mismatch between self-reported country and country as determined by IP address. Russia was the most problematic, in that only 76% IP addresses with a Russian country code were from panelists who said their country was Russia (18% of IP addresses with Russian country codes were from panelists who said their country was the United States). Again, while it is possible there is a large expatriate US Second Life community living in Russia, this discrepancy may point to suspect accounts. Other IP addresses with low percentages of geolocated country codes matched self-reported country are Germany (81.9%), Turkey (82.45), Portugal (82.5%), Argentina (85.2%), and Brazil (87.9%). In contrast, 99.5% of IP address with a United States geolocated country code were from panelists who self-reported their country as the United States.

[11] http://www.wipmania.com

Table 2 – eLab City Panel Native Language and Country

(a) eLab City Panel Enabled (n=5265)		**(b) eLab City Panel Disabled (n=685)**		**(c) eLab Global Panel (n=5460)**	
TOP 10 NATIVE LANGUAGES					(n=2458)[12]
English	62.7%	English	52.7%	English	71.6%
Portuguese	12.4%	Portuguese	21.5%	Spanish	3.1%
Spanish	3.6%	Spanish	7.0%	Russian	2.3%
Russian	3.6%	Russian	6.1%	Chinese	1.6%
French	2.9%	French	2.8%	Tagalog	1.6%
Romanian	2.0%	Turkish	2.2%	Indonesian	1.1%
German	1.9%	Czech	1.6%	Romanian	.7%
Turkish	1.4%	Romanian	1.2%	Portuguese	.7%
Italian	1.4%	Italian	.6%	Arabic	.6%
Dutch	1.3%	German	.4%	German	.6%
35 other languages	6.8%	19 other languages	3.9%	30 other languages	16.1%
TOP 10 COUNTRIES (AS REPORTED BY PANELIST)					
United States	44.7%	United States	39.4%	United States	56.5%
Brazil	10.0%	Brazil	18.5%	India	9.0%
United Kingdom	6.7%	United Kingdom	4.4%	Canada	7.9%
Canada	4.4%	Russia	4.1%	Australia	3.0%
Russia	2.8%	Canada	3.8%	United Kingdom	2.2%
France	2.5%	Argentina	3.6%	South Africa	1.8%
Portugal	2.4%	Turkey	3.4%	Malaysia	1.1%
Romania	2.0%	Portugal	2.3%	Philippines	1.0%
Germany	1.9%	France	2.0%	Singapore	.7%
Australia	1.7%	Ukraine	1.9%	Ukraine	.7%
108 other countries	20.8%	47 other countries	16.5%	110 other countries	13.4%
TOP 10 COUNTRIES (IP LOOKUP)					
United States	39.6%	United States	25.7%		n/a
Brazil	11.3%	Brazil	23.2%		n/a
United Kingdom	6.3%	United Kingdom	5.0%		n/a
Canada	4.9%	Canada	4.8%		n/a
Russia	3.5%	Russia	4.8%		n/a
Portugal	2.6%	Argentina	4.7%		n/a
France	2.4%	Turkey	4.1%		n/a
Romania	2.4%	Czech Republic	3.8%		n/a
Germany	2.2%	Portugal	3.8%		n/a
Romania	2.1%	Ukraine	3.8%		n/a
92 other countries	22.8%	32 other countries	16.4%		n/a

[12] Native Language was not asked of 3002 panelists

3. Avatar location data

Description of location data. An additional source of input is avatar location data, consisting of minute-by-minute observations of XYZ location coordinates and timestamps, together with avatar names. Locations in each 256x256 meter region in Second Life correspond to X and Y coordinates between 0 and 256, with the Z coordinate indicating the distance in meters from a zero elevation. The Maya Realities service was used to collect these data for the two eLab City regions, using a set of sensors placed throughout the eLab City property in Second Life. Each minute, the sensors scan to detect the presence of avatars within a fixed radius of each sensor. Sensors are located in an overlapping array that permits coverage of the entire area of eLab City. This paper reports avatar location data for the time period from August 14, 2008 through December 31, 2008. A total of over 250,000 location observations were recorded during this time period from 7423 distinct avatars who visited eLab City during this time period. Of the 5265 enabled eLab City panelists who joined by August 31, 2009, avatar location data is available on a subset of 1275 panelists who joined through December 31, 2008.

Figure 4 plots the XY coordinates for over 250,000 avatar location observations between August and December 2008. Labels from Figure 1, identifying key eLab City landmarks, are overlaid on the plot. The location observations concentrate in certain key areas, especially the two dance clubs. Shopping areas, housing, and survey kiosk locations also display visible concentrations of traffic. While avatars can fly in Second Life and are not constrained in terms of where they can go, the locations chosen by visiting avatars tend to conform to the physical structures or walkways in eLab City.

Location statistics. Of the 7423 avatars who visited eLab City sometime between August and December 2008, a total of 1275, or 19% of all visitors, successfully joined the eLab City panel. An additional 134 avatars attempted to join the panel during this period, but had their accounts disabled because of suspected abuse. Using the Maya Realities avatar location data, we can determine the total number of minutes each visiting avatar spent in eLab city between August and December 2008, by summing up the number of per-minute scans in which an avatar's presence was detected. Enabled panelists spent 49.0 minutes on average in eLab City (n=1275), disabled panelists spent 15.8 minutes (n=134), and those visitors who never joined the panel spent a mean of 23.0 minutes (n=6014) in eLab City. The differences among the means of these groups was statistically significant (p=.007).

Mean differences are somewhat misleading, however, since the distribution of time spent in eLab City is highly skewed. While just over half of all visitors spent five minutes or less in eLab City, a relatively small number of individuals spent a very long time there. One avatar alone spent 190 hours in eLab City, while 12 other avatars each spent over 50 hours in eLab City, during this four

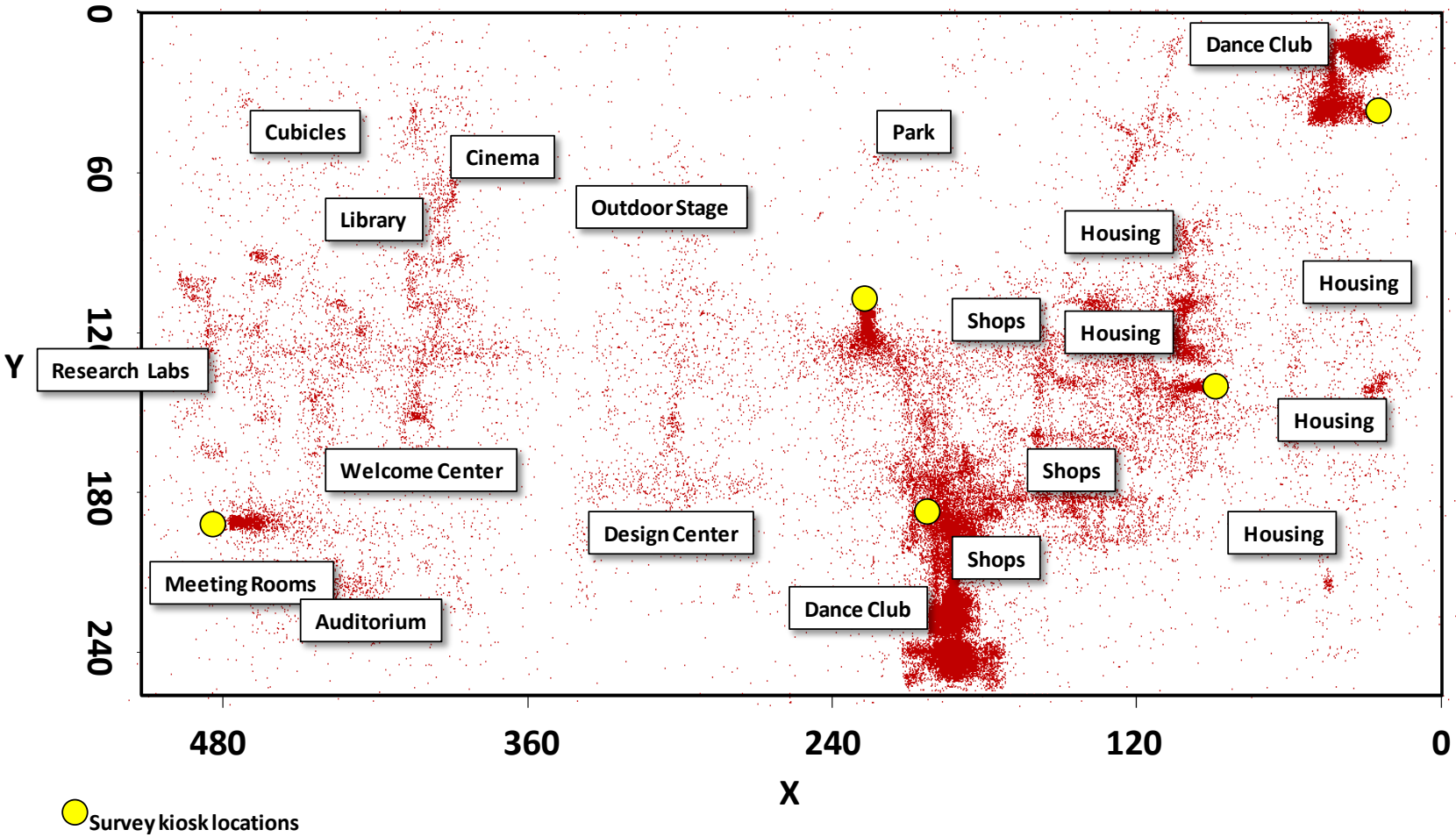

Figure 4. eLab City Visiting Avatar Locations from August 2008 – December 2008

and a half month period. Table 3 categorizes the time spent in eLab City and compares enabled panelists, disabled panelists, and those who never joined the eLab City panel. The mean time for those who never joined the panel is inflated from having a few avatars who spent a long time in eLab City, but who never joined the panel. The frequency distributions show a clear progression, where 26.6% of enabled panelists spent less than 5 minutes, 41% of disabled panelists spent less than 5 minutes, and 59.2% of those who never joined the eLab City panel spent less than 5 minutes.

Table 3 – Time Spent in eLab City between August 2008 and December 2008

Time spent:	**Enabled Panelists (n=1275)**	**Disabled Panelists (n=134)**	**Never Joined Panel (n=6014)**
1-2 minutes	6.4%	21.6%	30.8%
3-5 minutes	20.2%	19.4%	28.4%
6-10 minutes	24.0%	25.4%	17.3%
11-15 minutes	15.0%	13.4%	7.7%
16-30 minutes	19.7%	12.7%	7.9%
31-60 minutes	9.2%	3.7%	4.5%
1-6 hours	4.3%	3.0%	2.7%
6+ hours	1.3%	.7%	.6%
	100%	100%	100%
Mean time spent	49.0	15.8	23.0

Avatar location data can also be used to compare the exact locations in eLab City that these three groups visited. The XYZ coordinates were coded into various specific areas in eLab City. Five of these areas define panel signup kiosk locations and 15 areas correspond to major buildings or outdoor areas in eLab City. Table 4 reports the percentage of enabled panelists, disabled panelists, and non-joiners who visited each of these 20 specific areas at least once between August 2008 and December 2008. The majority of the signups to the panel seem to be coming from visits to the central and east kiosks, which corresponds with the fact that Second Life advertising directed visitors to these two kiosk locations. Since a greater proportion of the disabled panelists visited the east kiosk, we might hypothesize that the classified ads placed in the "Wanted" classifieds which directed panelists to the east kiosk attracted avatars more prone to abuse than the classified ads places in the "Employment" classifieds which directed panelists to the central kiosk. Very few panelists who joined at either of the two signup kiosks located at one of the eLab City clubs wound up being disabled due to suspected abuse.

The percent of avatars visiting the 15 non-kiosk locations show a very interesting result. In most cases, enabled panelists were more likely to have visited eLab City locations than those visitors who never joined the panel. For example, 56.4% of all enabled panelists visited the main

walkway in eLab City at least once, compared to only 28.2% of those visitors who never joined the panel. There are, however, three key exceptions. Non-joiners were more likely than enabled panelists to have visited Club Sky (21.1% vs. 6.9%), Club Alcatraz (15.6% vs. 6.4%), and the main shopping mall (28.5% vs. 13.6%). Since the two dance clubs and the mall shops were intended, at least in part, to drive traffic to the eLab City panel, we can conclude that they were not very successful in doing so.

Table 4 – Percent Visiting Selected eLab City Areas between August 2008 and December 2008

eLab City Area	Enabled Panelists (n=1275)	Disabled Panelists (n=134)	Never Joined Panel (n=6014)	p-value
Kiosk - Central	54.2%	43.3%	24.1%	.000
Kiosk - East	40.9%	47.8%	12.1%	.000
Kiosk - West	14.8%	10.4%	3.1%	.000
Kiosk - Club Sky	4.4%	0.7%	3.0%	.009
Kiosk - Club Alcatraz	2.1%	0.0%	1.2%	.013
Walkway - Mall	56.4%	44.8%	28.2%	.000
Walkway - Residential District	43.8%	49.3%	17.3%	.000
Shops - Old Town	20.7%	15.7%	11.7%	.000
Shops - Mall	13.6%	10.6%	28.4%	.000
Club Sky	6.9%	3.7%	21.1%	.000
Club Alcatraz	6.4%	0.7%	15.6%	.000
Walkway – Design Center	6.2%	4.5%	4.0%	.002
Welcome Center	5.8%	3.0%	3.4%	.000
Residential District	5.4%	4.5%	5.3%	.899
Auditorium	5.3%	3.7%	2.3%	.000
Research Labs	4.5%	1.5%	2.0%	.000
Design Center	4.2%	1.5%	3.0%	.043
Cinema/Library	3.5%	0.7%	1.8%	.000
Great Lawn	3.5%	3.0%	2.2%	.021
Capital Hill Park	3.3%	0.7%	2.8%	.219

Location data caveats. While avatar location data is extremely useful, there are some caveats regarding its collection and use. Multiple overlapping sensors may pick up an avatar within the same one minute scan, so the data needs to be cleaned to eliminate such duplicates. To minimize lag, scans are conducted at one minute intervals; however, during the period between consecutive one minute scans, any additional movement of an avatar cannot be detected. To capture real-time interaction, fixed interval location scans can be supplemented by object

interaction sensors, which record the exact time of interactions with an object (touches, collisions, sits, etc.) at the time the interaction occurs. Object interaction sensors were installed in panel signup and FAQ signs. They provide useful additional information – for example, for every enabled panelist who touched the "click to join" sign in a signup kiosk, there is almost exactly one non-joiner who also touched the sign. While only half of those who touch the kiosk signup signs join the panel, many of those who touch and do not join are informed by the script in the signup kiosk that their avatar is less than 30 days old and thus not eligible to join. Last, sensors are only useful if they are in place and active. In Second Life, the Maya Realities sensor must be deeded to the group that owns the parcel of land on which the sensor is placed. In practice, however, sensors have unfortunately been mistakenly deleted by members of the group who did not know what they were.

4. Research studies

Fielding studies within virtual worlds offers the potential to solicit panel members either via traditional email or via instant messaging within the virtual world itself. We consider the merits of both methods and provide empirical evidence of difference in cooperation rates. Based upon comparable studies fielded to both our Second Life and our global Web panels, we also compare cooperation rates and data quality between Web-based studies administered to virtual world and web-based users. We begin, however, with a more general discussion of the types of research studies in progress and planned for eLab City.

4.1 Types of research studies

As noted earlier, Web based surveys offer advantages of sophisticated pre-existing systems for data collection, such as the Qualtrics product used to field eLab City research studies. Samples of email addresses drawn from the eLab City panel are uploaded into Qualtrics, which is used to email the sample. Avatar name can be uploaded as well and used to customize the solicitation email. Those who complete a Web-based survey are paid an incentive, typically L$250-L$500. This payment is made in Second Life using a script that pays a list of avatar names, using the avatar key collected during initial signup to the eLab City panel.

A series of in-world studies have been fielded in eLab City. These are still in progress, and only general details are provided here. One series of studies involves "choice tasks"—described below—in which the participant inspects a series of stimuli and is asked to select which stimulus they like best. Versions of the study have included 2, 4, and 16 stimulus options. The stimuli are presented as images which can be clearly seen only when the participant stands on a mat in front of the image. Stepping onto the map triggers an LSL script which swaps in a high resolution version of the image that clearly shows the stimulus; stepping off of the map swaps in a blurry unclear version of the image. Various events, with timestamp and avatar name, are transmitted to a MySQL database: study start, step on to mat, step off of mat, choice, study completion. In

addition, following the choice, a short survey is administered in Second Life through a dialogue menu, and these responses are also sent to the MySQL database.

Another series of studies present a slideshow of stimuli in Second Life, and then re-present the stimuli one at a time, together with false stimuli that have not been presented, and ask participants if they recognize a stimulus from the original slideshow. This is a classic signal detection task, and we have used this in a series of ongoing studies that look at recall accuracy (Massara and Novak 2010).

An additional study in progress uses student research assistants as in-person interviewers in Second Life. These studies involve a precise way that questions are to be asked in different experimental conditions. To ensure these questions are asked in a uniform manner, we have developed "interview HUDs" (heads-up displays) that allow the interviewee to click a series of buttons that triggers avatar movement and questions that are asked. The timing of individual questions, and responses provided by the interviewee, are passed into a MySQL database. The interviewer HUD also scans the environment and passes information about key events, such as the presence of other avatars, and the location of the interviewer and interviewee, to the MySQL database as well.
In the next section, cooperation rates for a set of Web-based and in-world studies are reported.

4.2 Cooperation Rates

One can build a panel of Second Life users, but to what extent will panelists actually participate in research studies? To date, we have fielded three substantial research studies using the eLab City Panel. Because these studies are still in progress, we refer to them here as "Study A," "Study B," and "Study C." Study A is a choice experiment, Study B is a survey of avatar personality, and Study C uses a signal detection task to test recall accuracy. In this section we report cooperation rates for these studies. In addition, as some of the studies were administered in different ways (i.e. with email invitations vs. Second Life instant message used as invitations), and with different panels (i.e. eLab City panels vs. eLab global panel), we can see if the mode of administration or nature of panel seem to influence cooperation rates.

Study A. Study A was administered in four different formats: 1) email invitations to a Web-based study were sent to 1041 eLab City panelists, 2) email invitations to a Second Life (in-world) study were sent to 155 eLab City panelists, 3) Second Life IM invitations to a Second Life study were sent to 1281 eLab City panelists, and 4) email invitations to a Web-based study were sent to 2270 eLab global panelists. Study B was administered in one format, where email invitations to a Web based study were sent to 976 eLab City panelists. Study C was administered in two formats: 1) email invitations to a Second Life study were sent to 1548 eLab City panelists, and 2) email invitations to a Web-based study were sent to 1006 eLab Global panelists.

Table 5a reports completion rates for all studies that used email invitations. Across the six variants of Studies A, B and C, completion rates (defined as number of completes divided by number of email invitations) ranged from 15% to 32%. These cooperation rates are in line with other recent studies using email invitation to Web based studies, using similar panels. For example, of the most recent 20 studies reported by Neslin, Novak, Baker and Hoffman (2009, p. 730), seven studies had completion rates between 10-20%, eight studies had completion rates between 20-30%, and five studies had completion rates between 30-40%. Considering Study A, we see very similar completion rates for email invitations to a Web based study sent to the eLab City panel (32%, Study A.1) and to the eLab global panel (30%, Study A.3). When email invitations to an SLURL for a Second Life study were sent to the eLab City panel (Study A.2), completion rates were unchanged at 30%. For this study, completion rates were not affected by the sample, or whether the study was administered in a Web browser or in an experimental setting in Second Life itself.

Table 5a – Cooperation Rates for Email Invitations

	# of email invites	**# of completes**	**Complete rate** # completes / # email invites
eLab City Panel Study A.1 Email Invite + Web Study	1041	335	32%
eLab City Panel Study A.2 Email Invite + SL Study	155	47	30%
eLab City Panel Study B: Email Invite + Web Study	976	189	19%
eLab City Panel Study C.1 Email Invite + SL Study	1548	234	15%
eLab Global Panel Study A.3 Email Invite + Web Study	2279	685	30%
eLab Global Panel Study C.2 Email Invite + Web Study	1006	202	20%

Table 5b reports one additional mode of administration for Study A (see Study A.4). Here, we sent instant messages in Second Life to invite member of the eLab City panel to complete a study in Second Life. There was one additional step in this mode of administration. A script went, in sequence, through each name on a contact list of 1281 panelists. The script first determined if the target panelist on the list was currently logged into Second Life. If the target panelist was logged into Second Life, an IM invitation was sent, and the script paused for 10 minutes and then continued with the next target name on the list. The 10 minute pause was designed to allow the recipient time to teleport to the experiment location and complete the study. In effect, we attempted to regulate the number of panelists receiving IM invitations so that

not many would be at the experiment site at any given time. If the target panelist was not logged into Second Life, the script proceeded to the next name on the list. Once the script reached the bottom of the list, it returned to the top and repeated the processes, ignoring anyone who had already been sent an IM invitation. The script ran for approximately two weeks, until it was consistently unable to find names remaining on the contact list who were logged into Second Life.

Table 5b – Cooperation Rates for IM Invitations

	# on IM contact list	**# of completes**	**Complete rate** # completes / # on IM list	**Reach rate** # reached / # on contact list	**Conditional Complete rate** # completes / # reached
eLab City Panel Study A.4 IM Invite + SL Study	1281	245	19%	42%	45%

note: Study A (IP), Study B (GT), Study C (RA)

The overall completion rate for Study A.4, defined as the number who completed the study divided by the number of names on the IM contact list, is 19%, which is appreciably lower than the 30% - 32% completion rates found for Studies A.1 through A.3. This suggests that email may be a more efficient way to reach eLab City panelists than instant messages in Second Life. However, while email invitations were used in Study A.2, one problem is that it is much more difficult to control when the email recipient will choose to respond to the invitation and proceed to the SLURL. Thus, the lower overall completion rate is offset to some degree by greater experimental control over the timing of when the participant arrives to begin the study in Second Life.

For the IM invitation method, however, completion rate is not the only story. From Table 3b, we see that during the two weeks the script was running, only 42% of the names on the contact list were found to be logged into Second Life. This does not mean that the remaining names were not logged into Second Life at all during these two weeks, but that these names were not logged in at those points in time the script attempted to locate them. If we consider those names the script was able to reach and IM because they were logged in to Second Life, the conditional completion rate is 45% (defined as number of completes divided by number of IMs sent). This presents a more favourable picture. When we sent an IM to someone who was logged into Second Life, the completion rate was 45%, compared to 30-32% using email invitations.

Studies B and C. A second study, Study B, was only fielded with email invitations sent to the eLab City panel for a Web based study. This was a more involved study than Study A and

completion rate for this study was only 19%. Study C was fielded in two different formats. Completion rate was 15% for email invitations to the eLab City panel sent to a Second Life study, and was 20% for email invitations sent to the eLab Global panel for a Web based study. The Second Life version of the study required more of the participant, in that they needed to navigate a series of lab rooms and operate a virtual slideshow, while the Web based version was a relatively straightforward survey. Thus, the difference in completion rates is not surprising.

4.3 Factors Affecting Cooperation Rates

One question is whether completion rates can be predicted by demographic characteristics of panelists, and whether there may be differences in which demographic characteristics predict completion rates for different types of study administration, or different panels. Table 6 reports results of a series of multiple regression models, predicting a binary dependent variable of whether the study was completed or not completed from a set of demographic variables.

Table 6 – Factors Affecting Cooperation Rates

note: dependent variable is complete/not complete study

	eLab City Panel										**eLab Global Panel**			
	(a) Study A.1 Email Invite Web Study (n=1041)		(b) Study A.2 Email Invite SL Study (n=155)		(c) Study A.4 IM Invite SL Study (n=1281)		(d) Study B Email Invite Web Study (n=976)		(e) Study C.1 Email Invite SL Study (n=1548)		(f) Study A.3 Email Invite Web Study (n=2279)		(g) Study C.2 Email Invite Web Study (n=1006)	
	Std Beta	p	Std Beta	p	Std Beta	p	Std Beta	p	Std Beta	p	Std Beta	p	Std Beta	p
Gender	-.055	.073	.101	.208	**-.067**	**.017**	**-.088**	**.006**	-.021	.406	-.003	.900	.023	.524
Education	.028	.393	-.075	.382	-.043	.151	.061	.061	**.056**	**.035**	**.077**	**.000**	.058	.108
Age	**.102**	**.002**	**.214**	**.012**	**.059**	**.046**	**.139**	**.000**	**.065**	**.015**	**.057**	**.010**	.005	.881
Avatar Age	**.136**	**.000**	.052	.527	-.032	.256	.051	.107	**.075**	**.003**	n/a	n/a	n/a	n/a
Country 1[a]	.032	.297	-.146	.071	-.013	.653	**.073**	**.023**	-.021	.423	-.001	.974	-.002	.962
Country 2[b]	-.031	.319	-.101	.209	.040	.162	**.095**	**.004**	.022	.393	-.006	.790	-.074	.051
	R^2	p	R^2	p	R^2	p	R^2	p	R^2	p	R^2	p	R^2	p
Full Model	**.040**	**.000**	**.095**	**.021**	**.011**	**.032**	**.051**	**.000**	**.017**	**.000**	**.009**	**.002**	.008	.249

[a]from Canada, UK, Australia, New Zealand

[b]from any country *except* USA, Canada, UK, Australia, New Zealand

Table 6 reports standardized regression coefficients (Beta) together with the p-value for each demographic term in the model. R^2 statistics for most models are quote low, although R^2 is .095 in column b (Study A.2). With the exception of column g, where R^2 is not significant, panelist age is a significant predictor of study completion, with older panelists more likely to complete. In two cases, each of the following predictors is significant: women are more likely to complete (columns c and d), older avatars are more likely to complete (columns a and e), and those panelists with a higher education are more likely to complete (columns e and f). The weak prediction of study completion by demographic characteristics is not surprising, as completion of previous studies and time since last invitation have been found to be stronger predictors of completion rates than user demographics (Neslin, Novak, Hoffman and Baker, 2009).

5. Lessons Learned and Next Steps

In this final section, we consider a range of broader issues related to the eLab City project ranging from lessons learned during the course of development, to thoughts about conducting research in virtual worlds and next steps

Sustainability. We learned a number of lessons during the development and subsequent use of the eLab City project in Second Life. We began with a detailed set of specifications for eLab City, but construction in Second Life is an iterative process and it is very difficult, if not impossible, to completely describe in advance all objects and structures that are to be built and the scripting functionally of each item. Learning to build and script in Second Life is not terribly difficult if one is willing to spend the time learning and practicing; learning to build in an aesthetically pleasing manner, though, is much more difficult. While building skills can be learned, artistic and design talent is less readily acquired, and it is here that a suitably chosen developer can make a major difference.

Once a build is constructed, however, it is time consuming and challenging to sustain human presence in Second Life. As has been noted by many commentators, Second Life often feels empty and deserted (Rose 2007). From Figure 4, it can be seen that while some sections of eLab City were well visited, such as the two dance clubs, many other areas were thinly visited and many areas were underutilized. The reason the dance clubs were heavily visited is that they were effectively managed in Second Life by an avatar hired as club manager who employed two assistant managers and a dozen hostesses/hosts. The manager, assistant managers, and hosts/hostesses were paid wages in Linden dollars. Total combined hours worked/week by club staff were about 100 hours, with a combined payroll of approximately L$15,000/week (just under $60 US). While $60 goes a long way in paying wages in Second Life, over the course of months these expenses add up. While the work-for-hire model could, in theory, have been used to also support other areas in eLab City such as the library, cinema, auditorium, outdoor events, and so on, the cost would have diverted funds away from resources for supporting academic

research. Because of cost considerations, financial support for the clubs was terminated in the summer of 2009, and visits to eLab City dropped accordingly.

A natural alternative to hiring staff is to rely on user generated content and volunteer labor. While we attempted to do this, there is a significant time cost to identifying and maintaining oversight over volunteer workers to ensure that the project is meeting its academic objectives. Nothing runs itself in Second Life – human intervention is required to nurture social interaction. Over a year into the eLab City project, we are now rethinking the original purpose of much of the construction. One of the motivations for writing this paper, in fact, is the hope that some interested readers may contact the author with ideas for academic collaboration that utilize the eLab City infrastructure in a way that creates sustainable visitor traffic and real community.

Object permissions. All objects in Second Life are built from basic building blocks called "prims." Each region supports a maximum of 15,000 prims. This may sound like a lot, but major structures in eLab City, such as the design center or the main research lab building consist of over 2,000 prims. This is a well-known limitation of Second Life, but a bigger problem is the permission structure. Each prim has user-specified permissions associated with it that specify whether the prim, as well as objects created from a set of prims, can be 1) modified, 2) copied, or 3) resold/given away. Each of these permissions is a binary switch that can be set to yes or no. For example, with all permissions set to "yes" we have a "full perm" object can be freely modified, copied, or resold or given away.

Developers typically charge more for full perm construction because the creator relinquishes control and a full perm object represents profit potential for whoever owns it. Consider, for example a building in eLab City that avatar A constructs and sells to avatar B as full perm. Avatar B could then sell copies of the building, with permissions changed to no modify/no copy/no resell, to other avatars for profit, without any compensation to avatar A. Since the developer would have no way to profit from subsequent reselling of the building by avatar B, the developer would typically want a higher price for a full perm item than for an item that that could not be resold or given away.

Because of such cost considerations, all objects created by the eLab City developer were received with permissions set to modify/copy/no resell. In retrospect, this was not ideal, and we would recommend that academic researchers only receive full permission objects from Second Life developers, and negotiate up front to ensure this. The problem with objects having less than full permission comes up with collaborative work, in that it is significantly more difficult for multiple people to work on a project if items can't be copied and given from one person to another. In addition, full permission on objects is also required to transfer items from Second Life into OpenSim, which as we discuss later in this section, is a cost-effective alternative to Second Life.

Even with full permission objects, Second Life itself presents major limitations that get in the way of true collaborative work. Even though an object has full permissions, only the owner of the object can make changes to it. It is possible to deed objects to a group so that multiple people can work on it, but this approach has its own problems and what is really needed is a more flexible system that allows the owner of an object to specify the exact permissions for a list of avatar names that are authorized to work on the object.

Value of research in virtual worlds. Things take longer in Second Life. Virtual construction and scripting take longer than expected. Communication via IM is less efficient than talking by phone or email. I recall my first experience renting real estate in Second Life. An avatar working as a real estate agent took me to view several properties she thought I might like. The process of finding an apartment took about three hours and I recall thinking that if I were driving around with a real estate agent in the real world, I would have been done by now. I've lectured in eLab City on a number of occasions to various student groups from other universities. Again, things took longer than expected, there were difficulties with audio connections, and the experience of trying to get a group of a two dozen avatars to move in tandem throughout eLab City on a tour was akin to herding cats. I've expressed this frustration to various people I've talked to, that things just seem to take longer in Second Life than in the real world. At a recent conference, I mentioned this again, and was asked, "so why do you do it if it's so hard?"

Despite the difficulty of doing research in an environment like Second Life, the challenge alone is part of the appeal, as the challenges themselves raise research questions. In the real world, things may go more quickly, but what happens when the communication process is interrupted – for example when the user talks with an avatar real estate agent who is likely trying to simultaneously juggle multiple clients and keep them all satisfied? How do we communicate effectively with students in a classroom setting in a virtual world when we don't have any real idea what the person behind the avatar is actually doing – or even if they are at their computer? How do sellers and buyers of virtual goods value objects which have permissions that vary on the dimensions of modify, copy and resell? All of the quirks of Second Life get us to think about research in a different way, and often suggest important research questions to be answered.

Experience with eLab City also raises research questions. Beyond sample composition and cooperation rates for studies conducted within virtual worlds vs. traditional Web environments, how might the environment within which a study is administered affect data quality as well as the way participants respond to the study itself? What factors impact data quality and validity of results in virtual worlds?

It was noted that avatar locations in Figure 4 largely correspond to physical structures and walkways in eLab City. eLab City is a highly realistic virtual environment. In a less realistic

environment, would avatar visit locations also correspond to structures and walkways? More generally, what impacts navigation and wayfinding in virtual worlds, and how can navigation be influenced? A practical application of influencing navigation would be direct eLab City club visitors who didn't join the panel to signup kiosk locations. This was unsuccessfully attempted by placing ads in the clubs, but what appeal would be successful?

Conducting academic research in virtual worlds such as Second Life involves significant programming effort, since the tools for fielding research studies in Second Life are not native to the Second Life platform and must be developed. The development of toolkits to facilitate academic research in Second Life and other virtual worlds would be very useful. As an example, Yee and Bailenson (2008) have provided LSL/PHP scripts and MySQL database schemas for a system for longitudinal tracking of a broad range of avatar-related variables, collected every 30 seconds, as an avatar wearing a device containing these scripts moves about and interacts with Second Life. In addition to such tools for real-time observation of avatar behavior, a reasonably complete toolkit for fielding academic research studies in Second Life would include:

- Scripts for inviting avatars to studies using IM invitations and controlling the number of avatars present at the site of the research study in-world,
- Systems for fielding surveys within Second Life (e.g. Bell, Castronova, and Wagner 2009),
- Payment scripts for awarding incentives in Linden dollars upon completion of a research study,
- Scripts for tracking object interaction, avatar location, and avatar behavior during in-world studies, and
- Scripts for random assignment to experimental conditions, and for rezzing different versions of a study corresponding to a different experimental conditions.

What's next? What is the future of eLab City? Given that initial purchase and development costs during the first year are significantly higher than the cost to maintain the eLab City project subequent years, it is relatively cost-effective to maintain the project once it has been developed. We expect to maintain eLab City at least through 2011, and possibly beyond. The future of eLab City is largely tied with the future of Second Life. While usage of Second Life increased dramatically from 2006 to 2007, Table 7 shows that since 2007 the number of users actually logged into Second Life has been relatively flat, with the number of users logged in over the two month period from October to November decreasing from 2007 to 2009. At the same time, the number of users logged in during a one week period increased from 2007 to 2009, suggesting that those people who are using Second Life are using it a bit more frequently. While the overall picture suggests growth in usage is flat, there appears to be a core group of loyal users providing a more than sufficient critical mass for academic research purposes.

Table 7 – Number of Users Logged Into Second Life

Residents Logged-In During Last 7 Days	Residents Logged-In During Last 14 Days	Residents Logged-In During Last 30 Days	Residents Logged-In During Last 60 Days	Date:
571,652	738,872	1,000,468	1,378,079	December 1, 2009
538,373	729,293	1,039,501	1,426,294	December 3, 2008
475,383	616,591	981,494	1,498,415	December 1, 2007
169,272	273,824	452,222	690,800	December 4, 2006

Source: http://secondlife.com/statistics/economy-data.php

From an academic research perspective, the OpenSimulator Project (OpenSim) provides an alternative to Second Life and possible future migration path for eLab City, although the largest public grid currently has only 21,000 users.[13] OpenSim supports LSL scripting, with some limitations, but currently lacks a large centralized user base and a built-in economy that enables building a research panel and making incentive payments as was done in Second Life with eLab City. However, OpenSim is considerably less expensive than Second Life. Educational pricing for a Second Life region is $147.50/month, plus a one time setup fee of $700. In contrast, educational pricing for an OpenSim region hosted by ReactionGrid is only $25/month, plus a one time setup fee of $50.[14] The lower cost, plus the ability to upload content created on the OpenSim platform to Second Life, make OpenSim an attractive development platform for academic research on virtual worlds.

Academic researchers interested in fielding research studies in virtual worlds may also want to explore new next generaton platforms, such as Blue Mars, that are much more visually compelling than Second Life and which support significantly larger numbers of avatars. While a Second Life region is 256 by 256 meters in size, and supports approximately 40 simulanous avatars, the largest unit of land that can be purchased in Blue Mars, a "city," can be up to 16 by 16 *kilometers* in size, and can support up to 1500 concurrent users.

Despite the emerging alternatives, Second Life currently remains the most fully realized example of a general purpose virtual world, with a substantial loyal user base, a functioning economy, social and cultural nuances, and user-created infrastructure. While real-world businesses have experimented with and largely abandoned Second Life, from the perspective of a platform for academic research, Second Life remains a very attractive environment.

[13] http://opensimulator.org/
[14] http://www.reactiongrid.com/

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