CASE DISSECTION

IS BUSINESS READY FOR SECOND LIFE?

BY DAVID F. CARR

ILLUSTRATION BY JAMES GARY

Companies such as Toyota and American Apparel are setting up shop in the virtual world, but the site's operator, Linden Lab, must now scale its infrastructure to meet demand.

THEY STARTED GATHERING hours before the Town Hall meeting on Jan. 9 was scheduled to begin, anxious to grab a seat in the virtual auditorium: a lizard man, an armor-plated robot, a floating ball of energy, several dragons, and members of the Alliance armed forces in their best dress uniforms, along with many dozens of curvaceous women and preternaturally buff men. Some paced in front of the stage, while others hovered in mid-air or sat typing text chat at each other on invisible keyboards.

These Town Hall meetings are a tradition in Second Life, the virtual world operated by Linden Lab, a San Francisco startup, where users dress their avatars in clothes (or dragon getups) bought in virtual boutiques, participate in social dramas of their own making, and set up virtual businesses ▸

where they buy and sell virtual real estate or hawk virtual clothes, houses, vehicles and furniture.

With more and more avatars filling the same virtual space, the simulation software that tracks the movements and position of individuals and executes animation scripts starts to fall behind. Time seems to slow down, with avatars moving as if through molasses. Some people blink out of existence as the viewer software on their own desktops crashes. Others find themselves in odd predicaments as the laws of physics seemingly break down; while trying to grab a spot in the standing-room area at the back of the auditorium, they find themselves sinking through the floor up to their necks and getting stuck there—disembodied heads, unable to see what's happening onstage.

It's not the first time for such problems, but audience members grumble that this time the whole system may crash before the event even gets started. In fact, one of the four simulators that have been clustered together to support a bigger audience does go down, ejecting everyone within it.

These types of problems, however, don't seem to be deterring people—and businesses—from entering Second Life.

Indeed, real-world companies such as Toyota and American Apparel are exploring whether this 3D world can be adapted to serve real business purposes, similar to the way the Web evolved from a medium for academics and hobbyists to one that supports corporate commerce and marketing. Already, your avatar can test-drive a Toyota Scion or buy clothes in a virtual American Apparel store. So far, however, it's not clear how much these efforts are doing to sell real-world cars, clothes or any other merchandise.

But Chris Holdren, vice president of Web services at Starwood Hotels, who oversaw the construction of a hotel in Second Life—a prototype of the new Aloft brand hotels scheduled to appear in the real world in 2008—says Second Life presents enough opportunities that corporate technology leaders should pay attention to it. "I definitely think they should learn about it and understand it," he says. "Whether they invest in it is a more complicated question."

And if this really is the start of something big, those companies that explore the technology now may be in a better position later, much like the first companies to grasp the importance of the Web in the early 1990s—back when it was an immature technology trickling out of academia.

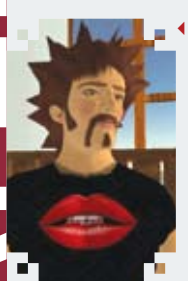
Sandy Kearney, director of the virtual worlds program at IBM, says the transition is coming, and "you may not have as much time as you had with the Web" to adjust to its impact. In addition to using it as part of a program for keeping employees connected with each other and with IBM alumni, and as a virtual meeting place to talk with customers, IBM has built a Circuit City and a Sears appliance store in Second Life as demonstration projects (which means IBM didn't charge them for the work).

"Based on the history of the Internet, we think this is a stabilizing period for the 3D Web," Kearney says. A true 3D Web would have to be based on open technologies, with some means of passing between virtual worlds hosted by different organizations. And just as new types of businesses were born on the Web, new businesses will be created around the 3D Web, she says. "But right now it's very early, and the technology is very, very young."

Yet the entry of businesses has created opportunities for experienced residents to set themselves up as consultants who help newcomers create their own Second Life experiences. Alyssa LaRoche entered Second Life as Aimee Weber while she was laid up with a torn knee ligament and couldn't do much other socializing. She became a regular at Second Life nightclubs, decked out in clubwear of her own design and a pair of butterfly wings.

A former computer consultant to financial services companies who was then working as a Web programmer,

PLAYER ROSTER



PHILIP ROSEDALE
Founder & CEO

Rosedale is a pioneer in the development of streaming media technology. After developing a low-bandwidth videoconferencing system called FreeVue in 1995, he sold his company to RealNetworks in 1996 and became its chief technology officer, overseeing the development of RealVideo and other products. In 1999, he joined venture capital firm Accel Partners as an entrepreneur-in-residence, and began researching ideas that led to the creation of Second Life.

MITCH KAPOR
Chairman

A computer industry leader for the past two decades, Kapor rose to prominence as the founder and CEO of Lotus Development. He was also an early investor in UUNet Technology and RealNetworks, and was a partner in Accel Partners when Rosedale was there. In an interview with Reuters, he characterized the market Linden Lab is pursuing as a $100 billion opportunity—but only in the long run, once the technology has a chance to mature.

CORY ONDREJKA
Chief Technology Officer

Ondrejka leads the team developing the Second Life platform, including simulation of the virtual world on distributed servers, 3D streaming media, and the in-world tools that allow avatars to customize their own appearance and collaboratively create objects. He championed the decision to allow users to retain intellectual property rights to their creations. He has been a computer game programmer for Pacific Coast Power and Light and for Acclaim, but has also programmed electronic warfare systems. A former lieutenant commander in the Navy, he earned degrees in computer science and weapons and systems engineering at the U.S. Naval Academy, graduated from the Navy Nuclear Power School, and worked at the National Security Agency.

JOE MILLER
Vice President, Platform & Technology Development

Since joining the company in April 2006, Miller has concentrated on extending the Second Life platform to reliably support very large member communities. His resume includes 30 years of experience at gaming companies such as Atari and Sega of America. In the computer learning field, he was a founder and CEO of

AVATARS COURTESY OF LINDEN LAB

LaRoche became proficient at designing items for sale to other avatars and soon established a clothing store called Preen. Other users bought her clothes with Linden dollars, or Lindens, the "in-world" currency, which trade on exchanges operated by Linden Lab and others at a rate of about 250 to 300 Lindens to $1US.

When American Apparel, a real-world clothing store, decided to create a parallel boutique in Second Life, Aimee was hired to design it. Her company, Aimee Weber Studios, a Second Life development company, now employs 11 full-time employees and another 10 part-timers. But she also continues to operate in-world businesses such as her clothing stores, and to develop her own real estate in areas such as Midnight City, where she rents out storefront locations and lofts.

The Second Life system runs on 1,800 Debian Linux servers dedicated to simulating activities in the virtual world, with multiple copies of the simulation software on each server. As of mid-February, there were 6,400 simulators—software devices that track activity—in production, with each of them representing 16 acres of land. Linden has another 200 servers for supporting systems, including MySQL databases, Web servers and test simulators. These numbers come from vice president of technology Joe Miller, who notes that Linden is currently adding three racks of servers per week, with 41 servers per rack, in an effort to get ahead of a backlog in orders for new land.

Meanwhile, Linden's viewer software—effectively, the equivalent of a browser for this version of the 3D Web—must download all the object geometries and the images used to provide them with "texture," and display them and their movements on screen.

But there are limits to how much the simulators can simulate and the viewers can display. As the January Town Hall meeting demonstrated, Second Life events often turn into inadvertent stress tests.

Ultimately, whether Linden Lab ▸

LINDEN LAB BASE CASE

HEADQUARTERS: 1100 Sansome St., San Francisco, CA 94111

PHONE: (415) 243-9000

BUSINESS: Develops and operates the software simulation system behind the Second Life virtual world.

CHIEF TECHNOLOGY OFFICER: Cory Ondrejka

FINANCIALS IN 2006: The privately held company expects to record revenue of $10 million to $12 million for 2006, up from $4 million in 2005. The company said it posted its first profitable month in December, but did not release figures.

CHALLENGE: While continuing to grow and improve its own virtual world platform, Linden Lab is pursuing an open-source initiative that it hopes will set the standard for the 3D Web, which it sees as "a $100 billion opportunity" (only part of which Linden will be able to capture for itself).

BASELINE GOALS:

- Support a peak load of 150,000 concurrent users by the end of 2007, according to an unofficial prediction from Cory Ondrejka's blog. The peak number of concurrent users surpassed 33,000 in mid-February.
- Achieve profitability for full-year 2007.
- Grow the number of Second Life residents. The 2006 goal was 1 million. Although no specific target has been set for 2007, the company surpassed its 2006 goal of having 1 million residents by more than a million; in the first quarter of 2007, the virtual world had surpassed 3 million residents (although the number includes inactive accounts, as well as multiple avatars controlled by a single user).

PROMINENT RESIDENTS

◂ GWYNETH LLEWELYN

(real name withheld "for personal reasons")

In real life, Gwyneth is a veteran of Internet startups who sees some of the same potential in Second Life that she saw in the early days of the Web, when the technology was clumsy, connections were slow and it took some imagination to see what the future would bring. She is an active Second Life citizen, promoting experiments in democratic governance within the virtual world, and keeps a blog at Gwynethllewelyn.net.

TIMELESS PROTOTYPE ▸

(real name withheld "for personal reasons")

A programmer working in scripting language used to manipulate objects within the Second Life world, Timeless created a software distribution system to support updates to his creations. He's the creator of the MultiGadget (effectively a bundle of several useful scripts, such as one that makes a chair and table set materialize out of thin air) and proprietor of the Timeless Gadget Shop. While he prefers to protect his identity, he identifies his employer as British digital media company Graphico (*graphico.co.uk*), which is starting to do Second Life consulting.

PROKOFY NEVA

(real name: Catherine Fitzpatrick)

Prokofy is a Second Life political activist, often challenging Linden Lab on its policies and campaigning for more democratic governance of the virtual world. "I take them seriously when they say it's a country," says Fitzpatrick, the woman behind Prokofy, who in real life is a Russian translator and human rights activist from New York City. As a dealer in Second Life real estate (sort of the equivalent of being a reseller of server space for Web sites), she has also protested Linden's move toward open sourcing its system, which could in the future undermine "land" values if the number of servers operated by other organizations grows too rapidly.

ROBIN HARPER ▾

Vice President, Community and Support

Harper is responsible for shaping the evolution of the rapidly growing community of Second Life users, working to resolve social and economic issues that arise within the virtual world as well as listening to concerns about Second Life technology. Before joining Linden Lab in 2002, Harper was vice president of marketing at Maxis, a division of Electronic Arts, where among other things she helped establish SimCity as one of the most recognized brands in entertainment software.

the Knowledge Universe Interactive Studio and president of MindQ Publishing, two companies focused on lifelong learning services and applications. Perilux Group, which he founded prior to joining Linden Lab, designed products now offered by LeapFrog, Bright Things, Apple and Fitniks.

GROWING PAINS

The news that drew a crowd to Second Life's Town Hall meeting on Jan. 9 was the announcement from Linden Lab, the company that runs the virtual world, that it would release the Second Life viewer as open-source software. This means programmers outside the company's employ will have a chance to improve the graphics rendering, fix bugs, improve performance and develop specialized versions of the viewer for specific audiences, such as professors teaching courses within the virtual world. If that goes well, Linden is talking about also open sourcing the server software that simulates the existence of the world these avatars share.

Now Second Life "residents," as users of the system are called, want to know exactly how the open source plan is going to work. Many are excited. Some are upset. Prokofy Neva (the creation of Catherine Fitzpatrick, a Russian translator and human rights activist), who's in the virtual real estate business, is concerned about the long-term impact of open sourcing, particularly the idea that it could undermine land values and property rights.

That is, if anyone can run their own Second Life simulation server, won't that mean that the supply of land will explode and prices will plummet? And even before that happens, the open sourcing of the client raises the possibility of alternate viewers that won't respect the restrictions that content creators place on whether their objects can be copied, modified or transferred to other users. Protecting property rights is important because some residents have learned how to make money selling their digital creations.

Others are worried that releasing the source code will make it easier for hackers to create rogue viewers indistinguishable from the official one. Such a tool would allow them to create robot avatars that pose as real users, undermining the online society, or to overload servers with denial-of-service attacks.

When the event begins. Cory Linden, a.k.a. chief technology officer Cory Ondrejka, explains that releasing the client software as open source was a surrender to the inevitable, since independent developers had already created a series of software libraries that duplicate functions of the official Second Life client. That software was created independently, without the use of Linden source code, through a process of reverse engineering (working backward from the known functionality of the official client to produce software that behaves similarly), Ondrejka says.

That's exactly why some are wary. In November, a program called CopyBot was released into Second Life that demonstrated the ability to create multiple clones of avatars, including all their clothing. Among other things, that demonstrated how the copy protection that normally applies to digital objects could be undermined.

Ondrejka doesn't deny that there will be problems, but says the challenge of preventing unauthorized copies of digital content is no different than the situation that exists on the Web, where users can easily swipe articles, source code and images. And he says the company is looking at the future and taking it step by step. "We've only open sourced the client, so fully [open source] discussions are premature," he says.

The server-side component of the Second Life system that would make sense to open source is the simulator software used to host regions of the virtual world and track the actions of avatars within it. Linden Lab senior developer Andrew Meadows says the main challenge here will be to create a clear separation of responsibilities between simulators and other components of the system. For example, additional security barriers will have to be erected so that simulators hosted by outsiders are treated with a healthy degree of distrust, preventing them from gaining inappropriate access to the database systems that run the virtual economy, Meadows says.

Second Life residents come decked out to Linden Lab's virtual Town Hall meetings—they're the place to be seen.

COURTESY OF LINDEN LAB

And yet, within a couple of weeks after Linden announced an open-source client, a primitive, independently developed server compatible with that client was released. So, the future may be coming quicker than Ondrejka expected.

After the Town Hall meeting, Linden Lab CEO Philip Rosedale materializes as spiky-haired avatar Philip Linden. He tells his admirers, "The most rewarding thing is just that at this point, the fire is lit. Whether Linden continues to lead or not, we got things started." *—D.F.C.*

can turn Second Life into a successful economic platform for itself and its customers also hinges on whether the virtual world can survive its current growing pains. "Scalability? Absolutely, that's the question," says Aimee Weber Studios' LaRoche.

NOT QUITE *THE MATRIX*

Entering Second Life today is not quite the immersive virtual reality experience of science fiction books or movies like *The Matrix*, where the computer plugs directly into the human nervous system. Instead, Second Life users watch over their avatar's shoulder on a PC screen, direct its movements with the keyboard and mouse, and generally talk to each other via text chat (although a version of the client that includes integrated voice chat was expected to be made available soon).

And yet, with a little imagination, users do get the sense of "being there," in the same space with other users. That's why the Town Hall attendees cared about being there "in person"—to see and be seen—even though they could have listened in and submitted questions by text chat from anywhere in the virtual world.

Second Life is the brainchild of Linden Lab. The company was founded in 1999 by chief executive officer Philip Rosedale, formerly the chief technology officer of Real Networks, a vendor of Internet audio and video software and services. An early Second Life prototype called Linden World was shown to attendees at Demo 2002, a conference that showcases information-technology startups. In October of that year, Linden announced a beta of the system, now renamed Second Life. The official release of Second Life took place in June 2003.

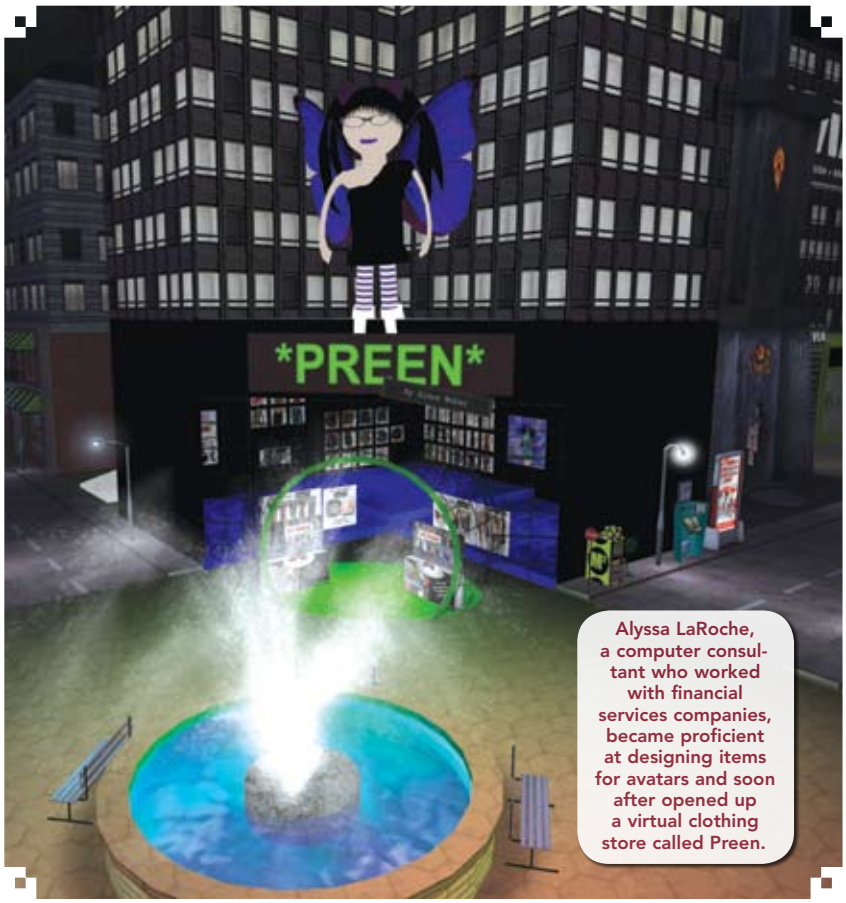
Originally, Rosedale was looking for a way to apply his experience pioneering streaming media technologies such as RealVideo to virtual reality. The advantage of watching a movie over a streaming media system, rather than downloading the entire video file, is that your computer can begin displaying the first frames of the video almost as soon as they are received over the Internet. Streaming video also makes it possible to broadcast a live event. Similarly, for Second Life, the advantage of streaming 3D graphics is that it makes it possible to depict an ever-changing world.

That's in contrast to the experience delivered by the popular massively multiplayer online role-playing games (MMORPGs) conducted over the Internet, a category currently dominated by World of Warcraft. Those worlds are created by professional game designers, and much of the graphical content comes into the user's home on a CD-ROM. Internet servers track the position and actions of players in the fantasy world and enforce the rules of the game, but the amount of graphical content they must transmit is limited because most of the background scenery is stored locally on the player's desktop computer.

In Second Life, users create everything, including the background scenery. Land owners "terraform" their properties, sculpting hills, planting trees and creating animated waterfalls, and then they fill in tree houses, shops, beach bars and bordellos. And since these scenes can change at any time, the Second Life desktop software must download and re-create each area the user enters at every visit.

The software uses OpenGL, a standard originally defined by Silicon Graphics, to represent geometric shapes, and bitmapped images to represent textures (wood, stone, metal, skin) that wrap around those objects. The viewer requires a high-end PC graphics card to accelerate 3D rendering.

Even with a fast Internet connection, however, the display of the world around you at log-in, or upon arrival at a new location, can be reminiscent of accessing a Web page with heavy graphics using a slow dial-up modem. That is, the volume of data to be downloaded, decoded and displayed often leads to an annoying delay Second Life users call "lag." If you materialize in a nightclub, you watch the tables, bar, barstools and other customers pop into existence one by one around you, sometimes painted a ghostly gray because the bitmapped textures that should decorate them haven't yet arrived. Some avatars may even show up with the words "image not found" painted across their clothes like graffiti. So, the trade-off of streaming all content over the Internet, with the vagaries of network congestion and packet loss, is that the Second Life experience is nowhere as slick as that of World of Warcraft, let alone a PlayStation 3 game.



Alyssa LaRoche, a computer consultant who worked with financial services companies, became proficient at designing items for avatars and soon after opened up a virtual clothing store called Preen.

COURTESY OF AIMEE WEBER STUDIOS

Second Life champions are quick to point out that it should not be compared to a game because it's not a game, not in the sense of having a clearly defined winner or built-in rules for how players advance in power or stature, as in the many fantasy role-playing games modeled after Dungeons & Dragons.

Its world started as a tiny land mass with a few thousand residents, powered by a rack of commodity Linux servers, and organically grew into a simulated area measuring about 139 square miles. That's six times the size of the island of Manhattan, or just about the size of Detroit.

To bring a new avatar into this world, all anyone has to do is sign up at the Second Life site, create a password and then download the viewer software. From there, people, with a few mouse clicks, can pick their avatar's sex, body type and clothes.

In general, the people who are having the most fun in the Second Life virtual world are those who enjoy creating things to show off, share, or sell to others.

Later, users can easily change from male to female or adjust their avatar's height and hair color with the "edit my appearance" utility built into the software. But if they really want to look good, they'll want to ditch the generic look and go shopping.

A Second Life designer dress is essentially a bitmapped texture, created using a program like Photoshop, uploaded onto Linden's servers and overlaid on an abstract object in the shape of a dress. The art of it is styling the image with light, shadow and transparent regions so that the dress seems to fit naturally and attractively on its owner.

In addition to clothes, users may want to buy some sparkling eyes and (particularly if they want to look good naked) more richly textured skin. And if they want to cuddle up with a virtual sweetie, they'll need to obtain some additional animations beyond the handful that are built-in by default.

Second Life avatars have the innate ability to create all sorts of objects, using the viewer's built-in 3D modeling tools. While new users often complain about the learning curve, experienced Second Life designers can use those tools to rapidly sketch a series of objects in midair and join them together to create whatever they wish. Just click the Build button at the bottom of the screen, choose from the menu of basic geometric "primitives," or "prims," and you'll soon find yourself creating plywood cubes, spheres and cones. Through a process of stretching, cutting and twisting, you can, say, reshape your plywood cube into a flat panel, then change the default texture to fabric, and you have a carpet.

Want to make the carpet fly? With a script written in the Linden Scripting Language (LSL), an object can be made to fly, bank and turn in response to keyboard commands. LSL code looks a little like C, JavaScript or the ActionScript language used in Flash animation. Similar to the way JavaScript can detect that a user has clicked a button, and change the content of a Web page in response, LSL can detect a mouse or keyboard action as a trigger to change the buoyancy, height, speed or direction of your flying carpet. Avatar animations can also be triggered by an LSL script, although the animations themselves are created using a third-party animation software tool, Poser, from E Frontier of Santa Cruz, Calif. Developers use Poser to manipulate the movements of an abstract humanoid shape. Once uploaded into Second Life, those animations can be applied to any humanoid avatar.

Anyone can do it, but doing it well takes skill. LaRoche (a.k.a. Aimee Weber) says the best Second Life designers learn how to create buildings and scenery that look attractive but download quickly. Much like a Web page, a "build" in Second Life will take longer to display if it is too heavily loaded with image files. So, she has learned clever ways of using the same bitmapped image as a texture that's applied to many different objects in the same structure, so that it can be downloaded once and cached on the user's PC. For example, she has one generic image for a shadow falling on the floor, which she can trim and stretch to represent the shadows of different objects.

In general, the people who are having the most fun in Second Life are those who enjoy creating things to show off, share, or sell to others. But many first-time visitors never make it that far. They find themselves wandering aimlessly through what looks like a game, except that there's no way to win it. In fact, the experience is often compared to entering a foreign land and trying to explore it without knowing how to read the street signs.

That's one reason the number of "residents" in Second Life, which topped 3 million in January, isn't the best measure of the world's population, since many of those are the avatars of users who signed on once or twice before giving up. Also, since users can have multiple avatars, the resident population is about a third higher than the number of distinct users, which Linden now says is a little less than 2 million. But even that includes many inactive accounts.

The better number to watch, both in terms of the active population and the strain on Linden's servers, is the number of users exploring the world at any one time. The peak number of concurrent users hit 33,000 in mid-February, compared with 5,000 at the end of 2005. In a recent blog posting titled "Fearless Predictions," chief technology officer Cory Ondrejka projected that concurrency will top ▸

COURTESY OF LINDEN LAB

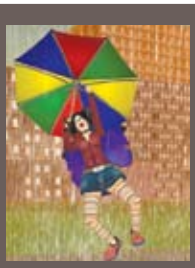
THE ANATOMY OF SECOND LIFE

Is the 3D virtual world in Second Life a fad, or a promising tool for people to collaborate on business projects or market to members? IBM, for example, is using Second Life to work on projects. To get the most from the site, a visitor must devote time to learn how the virtual world works, and then invest money in "real estate" in order to place a stake in the community established by San Francisco startup Linden Lab.

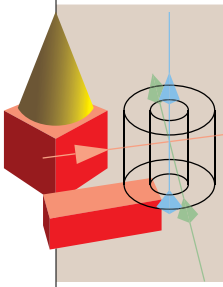
GETTING STARTED IN SECOND LIFE

Individuals (like IBM CEO Samuel Palmisano at left) or businesses can become members of the virtual world in Second Life, first by selecting a new name and then taking on an identity depicted by an avatar.

To start, a member needs to download a software client.



Second Life offers files that enable an avatar to move, templates to establish the look of an avatar, and textures and colors to dress an avatar or decorate a home or other property.



Second Life members can also **create new objects** from basic geometric shapes, style them by uploading "textures" (bitmapped image files), and program interactive behaviors using the Second Life scripting language.

Basic membership is free, but members who do not pay a monthly fee are not allowed to own land—although they can rent. Most members eventually want to establish a home or workshop in which to work on their creations, display their possessions and entertain friends.

Premium plans start at $9.95 per month. Residents who buy land must also pay a monthly maintenance fee of $5 to $195, in addition to the initial purchase price, which varies according to market conditions. Linden will also sell you your own island for $1,675, plus $295 per month maintenance.

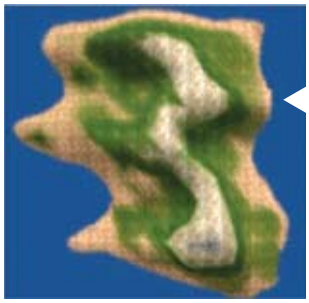
Second Life has its own **currency**, the Linden, which is traded on an open market. The currency can be used to purchase or lease land or buildings from Second Life members. Accessories—such as clothing and gadgets for an avatar—can also be purchased, resulting in business opportunities for some Second Life members.

HOW BUSINESSES CAN USE SECOND LIFE

EXAMPLE 1: Collaboration

More than 2,000 IBM employees sign up as members of Second Life, using the site to **share ideas** and work on projects.

IBM holds an **"alumni block party"** in Second Life, allowing current and former employees from around the globe to get together in a way that would be impractical in the physical world.



IBM **purchases islands** for use as meeting places and technology showcases, and for experiments in virtual reality business.

IBM sets up a Circuit City store and a Sears appliance store as **virtual commerce** demonstration projects.

EXAMPLE 2: Research and Marketing

Starwood Hotels **constructs a hotel in Second Life**– a prototype of the new Aloft brand hotels scheduled to appear in the real world in 2008.

The company **purchases two islands**: Aloft, for the hotel prototype, and Argali, where visitors can view the development project.

Aloft **designers use the Second Life scripting language** to make objects come to life, such as the sliding door on the front of the hotel or the lighting controls on the performance stage outside the hotel.

Working from a preliminary architectural sketch, the designers begin roughing out the layout, furnishings and textures of the hotel, which are then **refined in response to feedback** from the brick-and-mortar architects.

Second Life **visitors are invited to critique design** and layout.

Aloft's developers hold a launch party, featuring an "appearance" by musician Ben Folds.

Developers begin remodeling the hotel in response to feedback from Second Life residents.

IMAGES COURTESY OF LINDEN LAB, AIMEE WEBER STUDIOS, STARWOOD HOTELS

150,000 by the end of 2007.

But to get there, the technology behind Second Life is going to have to get a whole lot more robust.

THE SERVER CRUNCH

The growth of the Second Life virtual universe depends heavily on Linden Lab's server infrastructure and the software that runs within it. The equivalent of the Web server, or Web application server, in this architecture is the simulator. A simulator is a software process that tracks activities within 16 acres of virtual real estate, and Linden typically runs four simulators per server (machines with two dual-core processors, allowing each simulator to have one processor's worth of computing power to itself), according to technology VP Miller.

The simulators work in conjunction with MySQL databases, along with a network storage system that contains some 33 terabytes of images, object geometry files and other data, Miller says. The majority of this gear is hosted by data center operator 365 Main at a facility in San Francisco.

The simulators determine what each avatar should be seeing at any given moment, and transmit instructions and imagery across the Internet to each user's viewer. The simulators also communicate with other simulators that represent neighboring parcels of land, allowing users to see across the border into the next region. In addition, the system incorporates physics simulation software, licensed from Havok.com of Dublin, Ireland, which allows objects to behave as if they have weight, fall to the ground if they are dropped, and bounce back upon collision with other objects.

When things went haywire during the Jan. 9 Town Hall meeting, and flying avatars who tried to touch down in the auditorium found themselves falling through the floor, the likely reason was a communications breakdown between the simulator for that area and the viewers for those users, says Andrew Meadows, a Linden Lab senior developer, who was employee No. 2 at the young company. Normally, the simulator should have detected that an avatar had reached floor level and directed it to stop. But if the message from the simulator fails to reach the user's viewer, perhaps because of an interruption on an overloaded Internet connection, the viewer tries to extrapolate motion along the last known path, sometimes with comic results.

HOW TO CALCULATE THE COST OF A VIRTUAL/3D TRAINING SYSTEM (SEE NEXT PAGE)

So, strengthening the simulators, and the reliability of their communications with the viewer software, is one of Linden's many technical challenges.

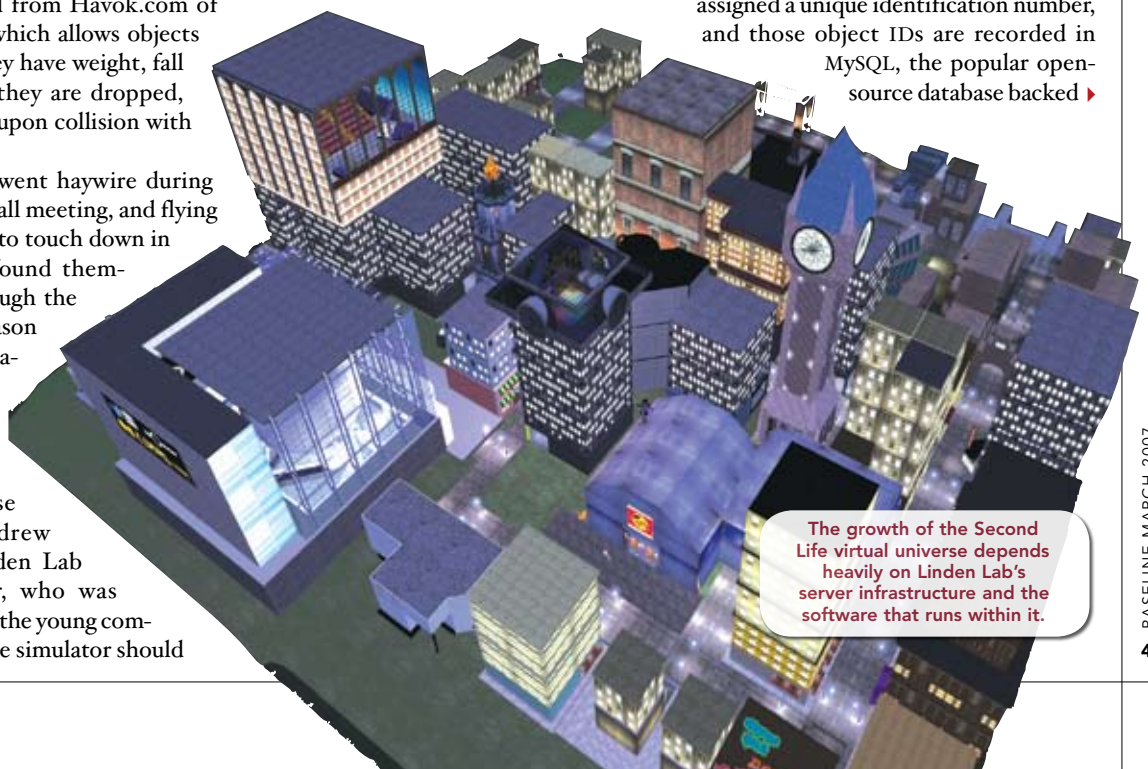
The simulator is also responsible for executing the user-written LSL scripts that make airplanes fly, doors open and close, and all sorts of other objects behave according to their programming. Linden is currently working to exchange its homegrown bytecode interpreter, the software that executes those scripts, for an open-source product called Mono that in tests has been able to run the same scripts 20 to 150 times faster.

The Mono project was started by prominent open-source programmer Miguel de Icaza and is backed by Novell Corp., where he now works as vice president of developer platforms. Its goal is to give Linux and Unix platforms an equivalent to the Microsoft .NET runtime environment, which among other things includes a bytecode interpreter that supports multiple programming languages (in contrast with the Java Virtual Machine, which targets only Java). So, in addition to delivering a performance boost, a Mono-enabled version of Second Life should be able to execute scripts written in programming languages other than LSL, such as Python or Microsoft's C#.

"The choice of Mono was mostly driven by dissatisfaction with our own bytecode interpreter," Meadows says, as well as the fact that it was open source "so we could bend it to our will if we had to."

Linden is also making some more basic tweaks, such as switching to using the Web's HyperText Transfer Protocol (HTTP) for downloads of object geometries and textures (binary images). Linden originally created its own download protocol, which was built on the assumption that geometries would make up the majority of the data transmissions. In fact, texture downloads turned out to have a bigger impact on performance. So, by switching to HTTP, Linden can employ the same kind of caching technologies that are used to speed downloads on the Web, Meadows says.

The actual geometric representations, textures and scripts for each object are recorded as files using storage systems from Isilon Systems of Seattle, according to Linden. Each object is also assigned a unique identification number, and those object IDs are recorded in MySQL, the popular open-source database backed



The growth of the Second Life virtual universe depends heavily on Linden Lab's server infrastructure and the software that runs within it.

COURTESY OF AIMEE WEBER STUDIOS

by Swedish company MySQL AB. The database tracks the ownership and position of each object, as well as properties such as whether it can be legally copied, modified or transferred to another resident.

Second Life started out with one central MySQL database, but has gradually moved to a more distributed architecture with, for example, multiple database servers responsible for tracking each resident's possessions, or "inventory."

"Your inventory could be in one database, and your friend's inventory could be in another," Meadows explains. So, if you give your friend something of yours, the system has to delete it from one database and add it to another.

However, there is still one centralized database for tracking user accounts and account balances, and for executing the transactions to transfer Lindens from one account to another. That remains one of the major chokepoints in the system, according to Meadows. The database team wants to break it up into smaller components, so that the workload can be spread across more servers, but they're still figuring out the best way to accomplish that, he says.

"We know this is a problem companies like eBay and Amazon have faced and have actually succeeded in fixing," Meadows says, so Linden should be able to overcome it, too. Although Second Life isn't handling anything like the dollar volume of eBay, the challenge in terms of database transactions may be nearly as great because of the number of micropayments the Second Life system must handle when tens of thousands of residents go shopping. More than 6 bil-

Starwood lets Second Life residents get a peek at the Aloft brand hotels it is developing.

COURTESY OF STARWOOD HOTELS

A PLACE TO STAY?

When Chris Holdren, Starwood Hotels' vice president of Web services, commissioned the construction of one of its new Aloft brand hotels in Second Life last spring, he had no idea what to expect.

"Most of our projects are very focused on the return and the objectives, but for this there was no model for us to go on," Holdren says. Instead, he had to approach it purely as an experiment: "When we started, we didn't know if the hotel would last a month."

That's just what most corporate ventures into Second Life are today—relatively low-cost experiments in a new Internet medium. But that does not mean they don't pay off—sometimes in unexpected ways.

In an August press release, Starwood promised that the virtual hotel then under construction would provide a sneak peek at Aloft's "urban-inspired, loft-like guest rooms, landscaped outdoor spaces and energetic lounge scene." Although Starwood was clearly seeking publicity, Holdren professes to be astonished by just how much was generated by that notice and the October launch party that followed. The Virtual Aloft hotel was featured in dozens of newspaper stories, as well as magazines like *Fortune*. Months later, news features on Second Life still routinely mention Starwood as one of the corporate pioneers in the virtual world.

Starwood got attention for being the first real-world hotel in Second Life, just as American Apparel before it was the first clothing retailer. And this series of "firsts" continues to generate press; for example, with the February announcement from TMP Worldwide, an interactive agency specializing in recruiting ads, which claims to be the first to do recruiting and organize job fairs in Second Life.

At the time Holdren approved the project, the only mainstream press coverage he had seen on Second Life was a *Business Week* cover story that appeared in May, "so there was no reason for us to expect to get a lot of press for it."

lion Lindens changed hands in January, for example. And although some technically knowledgeable residents have argued that Linden should switch to a commercial database such as Oracle, Meadows replies, "MySQL's been working great for us, overall, and at this point the work required to switch would be far more work than it would take for us to just fix our problems."

From a user perspective, database overload can mean that purchases don't go through, the inventory system that tracks each avatar's possessions breaks down, and the search function grinds to a halt. One posting on the official Second Life blog from mid-January even blamed database glitches for a problem that prevented users from teleporting to new locations—which is the equivalent of having hyperlinks stop working on the Web.

Second Life residents have also had to tolerate frequent scheduled and unscheduled outages, sometimes several times a week, when Linden takes the system down for maintenance. According to Miller, the firm's technologists recognize that has to stop, particularly now that more organizations are starting to do serious business in Second Life. For example, several universities are starting to teach courses in the virtual world, and they're going to expect the system to be up when it's time for class, he says.

"We're moving rapidly to a model that basically allows us to deploy new code to the grid without bringing it down at all," Miller points out. And that should be good news to the people trying to make a living on Second Life.

SECOND LIFE MATURING?

While most Second Life businesses aren't that big, many residents have learned to hustle up enough Lindens to cover their own expenses in the virtual world. And, of course, since that money has to come from someplace, there

The main reason for the project was to solicit feedback on the design of the hotel that Starwood promises would be reflected in brick and mortar when the first real-world Aloft hotels open in 2008.

The unveiling of the hotel gave Second Life residents the opportunity to hang out in the lounge, sit in the bar and talk with each other, or tour a sample guest room. One of the first bits of feedback concerned the guest room bathroom, which visitors didn't feel afforded enough privacy to someone sitting on the toilet. The designers belatedly realized they'd left out the bathroom door that was specified on the real-world blueprints because, as they explained on the project blog at Virtualaloft.com, "avatars do not spend much time in bathrooms." But since the omission bothered people, they quickly added the door.

"We've also gotten a lot of great feedback from the community that we are applying to the fabric textures and colors being used throughout the hotel," Holdren says, which is one reason he thinks Starwood has, in fact, gotten its money's worth. Without disclosing exactly how much he spent, he calls the cost comparable to what's required to field an ordinary Web site. "You can spend a lot on it, but you don't have to spend a lot on it," he says. In other words, thousands or tens of thousands of dollars, but not a million.

The actual construction was done by Electric Sheep, one of the premier virtual-world consulting companies, under the supervision of Electric Artists, a digital marketing agency. But Holdren made regular walk-throughs, sometimes in the company of the Aloft architects or company lawyers. That's part of what made it more like a real construction project than the construction of a Web site.

"We'd go in there, and the team would be putting up walls and adding textures to them," Holdren says. "When you suggest a change in Second Life, rays shoot out of the designer's hand, and it's changed right before your eyes."

Starwood's experience also shows some of the potential hazards of entering Second Life. If you toured the Aloft hotel during the first couple of months after the launch party, what you found there at most hours was a big, empty hotel. You could still sit in the lounge or tour a room, but the place was dead. Not exactly the vibrant new hotel experience the company wanted to portray.

"That is a major criticism on many of the 'corporate' builds here—nice, but empty," says Gwyneth Llewelyn, a prominent Second Life citizen. While saying she prefers to withhold her real name for personal reasons, Llewelyn identifies herself as a technology and marketing consultant, and a veteran of several Internet startups, who lives in Portugal. She sees Second Life today as being much like the Web in the early 1990s, when browser technology was immature and many conservative companies were initially reluctant to set up shop side-by-side with the Star Trek and porn Web sites. So, companies like Starwood deserve credit, she says, for having the imagination to see beyond the current limitations of Second Life to the possibilities this technology holds for the future.

In retrospect, Holdren says he was so focused on getting the hotel open that he didn't stop to think what should happen next. Now he is working to revive the excitement around the virtual hotel by hosting more events and by providing more things for visiting avatars to do there, even when the place is deserted. For example, there's now a sort of vending machine that dispenses Starwood Preferred Guest cards, which visitors can then use to obtain a free bathing suit and the animations necessary to swim in the hotel's pool.

"It's not something you can just build and forget. It's something you have to maintain and keep focused on to keep it alive," Holdren points out. So, in late January the Virtual Aloft developers went back to work, tenting the entire hotel in a shroud marked "Under Construction," soon to be unveiled for the second time as a hotel Second Life residents ought to feel more of an attachment to—since they helped design it. —*D.F.C.*

are also plenty of users who are strictly consumers, pumping in more U.S. dollars than they earn.

Linden Lab operates the main "currency exchange" where dollars are swapped for Lindens, and takes a commission on each trade. It also makes money by selling server space in the form of new "land" that's added to the world. At current rates, premium land in the form of a private island costs $1,675 to purchase, plus a $295 per month maintenance fee.

According to chief financial officer John Zdanowski, Linden's revenue will be in the range of $10 million to $12 million for 2006, once the books are closed, compared with $4 million in 2005. Linden also cleared its first profit in December, he says. About 80% of the money comes from land and land maintenance fees (the equivalent of selling site hosting and dedicated server accounts on the Web), while 20% comes from subscriptions. Although you can enter Second Life for free as a visitor, users must pay a $9.95 per month subscription fee if they want to own land. As of January, there were 57,702 premium account holders.

Revenue is rising at about the same rate as usage of the system—about 25 cents for every hour a user is online, with more than 10.8 million user-hours invested during the month of January, Zdanowski says. So, if Second Life were to achieve the roughly fivefold increase in usage that Ondrejka is predicting for the coming year, Zdanowski would expect revenue to be five times higher as well. However, the real money to be made may still be years away, as the technology continues to improve.

"If in five years, the Second Life experience is as good as watching the movie *Shrek*, there will be uses for it that we don't understand yet," Zdanowski says.

Thus, Linden doesn't fear the competition that an open-source future (see "A Place to Stay?" p. 44) could bring into the Second Life world. "We view this as a $100 billion opportunity," Zdanowski says. "I'm not worried about how much of it Linden Lab gets because it's so large, there's no way we can get all of it."

There are several direct competitors to Second Life, including There.com and Active Worlds, as well as other software platforms like Multiverse from Multiverse Network of Mountain View, Calif., that can be licensed to create a private virtual world. There's also a more academically respectable software platform for 3D interaction, known as Open Croquet, which is backed by computer industry luminary Alan Kay, one of the originators of object-oriented programming and graphical user interfaces.

And, after waves upon waves of favorable, perhaps uncritical press coverage, a backlash against Second Life has started to appear. Late last year, Internet consultant and New York University professor Clay Shirky published a series of articles in *Valleywag*, the Silicon Valley online journal, arguing that Linden was publishing inflated statistics related to its membership and the economic activity within its world. *Valleywag* also quoted excerpts from an article that financial consultant Randolph Harrison published on the *Capitalism 2.0* blog, showing how difficult it was to cash out Second Life wealth, since putting any large amount of wealth onto the market tends to rapidly depress the exchange rate between Lindens and dollars. He took this as proof that this is an economy where dollars flow in a lot easier than they flow out.

Questions about the liquidity of the Second Life economy also undermine the claim to fame of Anshe Chung, the avatar who kicked off a wave of press attention for Second Life when she claimed to be the virtual world's first millionaire, which she based on the value of her land holdings. Anshe is the avatar of Ailin Graef, who last year formed Anshe Chung Studios with her husband, Guntram. He insists his is a real business, which started when his wife learned to create and sell animations and clothing, shortly after she entered Second Life in March 2004. That, in turn, provided money to start a real estate business, and by June she was making serious money, he says. "About a year later, the business supported both of us," he says.

But the backlash may be almost as inflated as the hype that has surrounded Second Life the past couple of years. True, Shirky's heckling eventually prompted Linden to start releasing the number of distinct users, as opposed to residents. But Rosedale has been reasonably open about the fact that only about 10% of residents are active users who sign on at least weekly, and he has acknowledged the high attrition rate of those who don't like or never figure out how to navigate the virtual world.

As for the Second Life economy, it's not as vast as it has sometimes been portrayed, but there is something real there. According to Edward Castronova, an

Aimee Weber Studios, a Second Life development company, has set up a clothing store in the virtual world.

COURTESY OF AIMEE WEBER STUDIOS

Indiana University economics professor who has studied the economies of virtual worlds for years, "It's just a market that is thinner than is being reported."

The surprising thing is not that cashing out Linden wealth would be hard, he says, it's that anyone would expect the Second Life economy to be as liquid as the U.S. economy. Given that only a few tens of thousands of people are active within it at any one time, it's more like the economy of a South Seas island. In other words, if you got rich on money denominated in coconuts, you really would be rich in terms of the local economy, but you might have a hard time converting your coconut wealth into dollars. Also, the Second Life economy is largely speculative, fueled by the land rush of people who think they can get rich on virtual real estate, Castronova says.

The economic statistics page on the Second Life Web site states that in January, 21,627 residents had positive cash flow, and 97 of them made the equivalent of more than $5,000 in Linden wealth. However, Catherine Fitzpatrick, the woman behind the activist Prokofy Neva, says those figures are deceptive because Linden excludes the cost of the monthly maintenance fees paid by land owners from this "profit" calculation. "I get a break on bulk discounts, but still it's a big bill—something like $2,000US," she says. What's left over, after all expenses, is the equivalent of about $500 to $750 per month. So, Prokofy labors mostly to cover his own expenses, and Fitzpatrick directs whatever is left over to a few nonprofit ventures she runs within Second Life, including a land preserve and Tibetan monastery.

Making a true profit is possible, but it takes so much work that on an hourly basis it's not a very high rate of pay, Fitzpatrick says.

Timeless Prototype is another prominent resident who identified himself only as a programmer working for a British digital media company, Graphico, that is starting to do work in Second Life.

Timeless is best known as the creator of the MultiGadget, a scripted object that, among other things, makes it possible for users to fly higher and chat over longer distances than would be possible otherwise. It also includes a software update system of his own design. He sells the MultiGadget and other creations through his own Timeless Gadget Shop and a network of resellers. But he views these ventures as simply a way to pay for his hobby and generate enough cash for periodic home computer upgrades.

Although he is not extracting serious profits from his business within Second Life, Timeless has no doubt that it is possible. "If you run a good shop in SL, you can earn a good living and can trade that cash out for USD$ via LindeX or another currency exchange," he says during a chat conducted across the conference table in his workshop.

Charities have also found a home on Second Life. The American Cancer Society raised about $41,000 with a Second Life version of one of its Relay for Life fund-raisers, and the return on investment was pretty clear, given that the cost of a temporary server rental was about $1,200, says Randal Moss, manager of the society's Futuring and Innovation Center. For the event, avatars raced through landscapes created by volunteer designers and raised money through pledges of Lindens.

"We're treating the Second Life community in the same way we would treat any community we would enter into," Moss says. "We attempt to find people who are attuned to the mission, people that care, and we empower them to work and develop the society's mission in their community."

So far, at least, none of the major companies establishing operations in Second Life are looking at Linden profits as something that's going to boost their bottom line. Instead, many look at selling or giving away branded items in Second Life as a way of pursuing real-life brand loyalty.

From a business perspective, probably the most attractive thing about Second Life is that it is a ready-made platform for creating 3D content and interactive experiences. Starwood, for example, had no need to create a virtual world from scratch, and saw its Virtual Aloft experiment more as a way to engage the existing Second Life audience as a focus group for the new brand.

The Second Life environment is perfect for that kind of "rough prototyping," says Terry Beaubois, an architect who runs the Creative Research Lab at Montana State University. As he discovered while teaching a class in collaborative technologies for architects, the Second Life building tools were a good way to play at building a structure together. "We found we couldn't get the accuracy and tolerance real architects need to conduct their work," he says, but it was still a good way to brainstorm ideas for a building at the stage when it's not necessary to have a complete architectural specification for that building.

In much the same way that architects can invite Second Life residents in for a tour of a proposed building, IBM's Kearney suggests other companies can use this type of environment to preview proposed products. "If I were manufacturing an airplane, for example, I could invite customers from another part of the world to walk through the interior of the airplane and look at it, and change their minds about various design decisions before I ever get to full fabrication," she says.

Granted, as a development platform, Second Life has some growing up to do, says Jeff Barr, Web services evangelist for Amazon.com, but he's confident Linden is up to the task. He enters Second Life regularly (as Jeffronius Batra) to give presentations on how Second Life applications can tie into Amazon's services. So far, the XML Web services support available from within LSL isn't sophisticated enough to tie into some of those services, such as the Amazon shopping cart. But Amazon affiliate Snowbooks has a Second Life bookstore where you can walk through the stacks; clicking on a book cover takes you to the bookstore's Web site. And if you visit the Echo Park Listening Lounge, which promotes the musical artists The Bird and the Bee, the music you'll hear there is streamed from Amazon's S3 storage service.

Says Barr: "They're doing some amazing things to make the physics work, and to stream 3D renderings out to all these clients. These are not easy things to do. They're pushing the state of the art in any number of dimensions simultaneously, and they seem to have a good handle on where they need to go."

COURTESY OF AIMEE WEBER STUDIOS

Aimee Weber is the avatar of Alyssa LaRoche.