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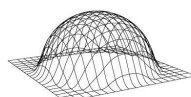
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World of Bizcraft

By Robert Bloomfield, Cornell University

Abstract

This article sketches the features required of a platform (which I refer to as 'World of Bizcraft') that supports virtual worlds dedicated to research and education on business-related topics. Key features include progressivity of content and challenges, which is a standard feature in most educational processes; certification of players' achievements, rather than the achievements of the players' characters; the ability to control participant interaction, collaboration and creation of game assets; implementation of induced value, which forms the foundation of experimental research in economics; production functions that capture the realities of real businesses; sophisticated property rights that support complex software-enforced contracts; and comprehensive systems for business reporting.

Keywords: virtual worlds; gaming; business education.

World of Bizcraft
By Robert Bloomfield, Cornell University

The Goal

For two decades I have been conducting research on small-scale laboratory economy, using networked software to create financial markets that bring a couple dozen people together to trade for a couple of hours. At the suggestion of the Financial Accounting Standards Board, I began exploring technologies that might allow researchers to conduct controlled studies of far larger economies that would capture more of the institutional complexities of market regulation. This article discusses the opportunities of one possibility: a virtual world populated with a variety of business-oriented "serious games." According to Abt (1970, p. 9), serious games

> "…have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement. This does not mean that serious games are not, or should not be, entertaining. We reject the somewhat Calvinistic notion that serious and virtuous activities cannot be 'fun.'"

Such a virtual world would enable educators and researchers to go far beyond the relatively simple settings that experimental economists have examined to date. By allowing participants to take on natural roles in business settings, virtual worlds can help students understand factory floors and trading floors, supply chains for potato chips and computer chips, marketing strategy, and (my own particular interest) how financial reporting regulations affect capital flows and financial markets. Outcomes in such worlds can also allow researchers to push their own frontiers of knowledge, much as experimental researchers have done, by constructing controlled environments designed to test specific hypotheses, rather than attempting to test hypotheses by looking at data generated for another purpose (and therefore not ideal data for testing the hypothesis in question).

My goal is similar, but not identical, to the goals of many others who study or build virtual worlds.

- A focus on *study* distinguishes my goal from the goals of existing game-oriented world makers, who seek purely to entertain (like Blizzard Entertainment, which makes World of Warcraft), or "to create a revolutionary new form of shared experience" (like Second Life). A platform used for study must not only consider educational goals in developing world content, but must have a variety of features that facilitate integration of inworld activities into more traditional forms of education. The platform must also grant instructors and researchers the control they demand over their students' and research subjects' inworld experiences, and the flexibility to modify those experiences to suit their needs.
- A focus on *games* is quite different from those who focus on non-game educational uses of virtual worlds, such as inworld streaming video, interactive three-dimension modeling, and new forms of business education. Naturally, however, a platform that supports serious games would ideally include many of the technological and educational non-game innovations.
- A focus on *business* distinguishes this effort from the many efforts to use virtual world to study other topics, ranging from art and architecture to literature and science.

- Finally, a focus on the study of *real-world* business also distinguishes my goal from that of others who study virtual worlds in their own right. For example, economist Castronova (2006) and anthropologist Boellstorff (2008) are effectively working as naturalists, seeking to understand, with minimal interference, how people use and interact with this new technology. Legal scholars Grimmelman (2005), Fairfield (2005) and Lastowka and Hunter (2004) pursue a similar goal in exploring the legal implications of virtual worlds. These are fascinating topics, but only touch upon one narrow and very new sliver of real-world business that students and researchers seek to understand.

Required Features

Virtual worlds are engines for innovation and collaboration. This makes them wonderful venues for the study of real world businesses, which are themselves engines of innovation and collaboration. However, educators need to control the challenges their students face, to emphasize the lessons they believe are most important in an order they believe is conducive to learning. Researchers need to control the forces acting upon their objects of study, to see how behavior responds to changes in those forces. Both educators and researchers also need to control collaboration among their students and research subjects, to ensure the integrity of the educational and research process.

Virtual worlds must possess seven required features for a virtual world platform for the study of real business. The first three features reflect the traditional need for control typically exercised by instructors:

- **Progressivity**. Progressivity is perhaps the most familiar and universal features of traditional education: students tackle simple tasks before harder ones, so that educators can provide the foundations for deeper understanding in later topics. Progressivity is already common in goal-oriented virtual worlds, which present increasingly difficult "quests" as a player gains experience.
- **Certification**. Progress toward educational goals must be acknowledged and verified. I propose replacing "leveling up" in games like "World of Warcraft" by certifying participants' specific achievements, rather than reflecting a broad measure of an actors' generic experience.
- **Control over participant interaction**. Educators and researchers will need the flexibility to control participants' ability to create, trade and use game assets (like scripts and information displays) when they feel it is appropriate to do so, and also control when participants are interacting inworld with real or scripted decision-makers.

The next two features are derived from the field of "experimental economics," which many business researchers use to study the effects of business institutions and incentives on human behavior.

- **Induced value**. Worlds designed for study of business must emphasize participants' motivation for inworld profit, while dampening their motivations for social interaction and entertainment, which will distract them from the intended topics of study.
- **Inworld production functions**. The platform must support inworld production functions (which map inworld labor and capital into inworld outputs) that are flexible enough to capture features or any industry. However, inworld production cannot interfering with educational goals (by, for example, simulating a skill that the participant needs to learn in real life).

The last two features are needed to capture elements of finance and accounting (my particular interest).

- **Sophisticated contracting**. Modern capitalism rests on a foundation of property rights, agreements between parties to transfer those rights, and laws that enforce rights and agreements. A successful platform would need to be implemented in a way that would allow for innovation in contractual arrangements (including tradable contracts, like equity, debt, derivatives and futures), while limiting the need for human intervention to enforce contracts and adjudicate disputes.
- **Comprehensive business reporting systems**. Good decisions require good information. A platform must support flexible and comprehensive reports that display information both inworld and to outside researchers, on the behavior of individuals, businesses and entire inworld economies.

Each of these features reflects my own philosophy and experience, and I expect to see all of them modified significantly ways as others weigh in. Each feature also poses a number of technical, logistical, educational and academic hurdles that I have only begun to explore, and should provide fodder for a great deal of future research and development.

Roadmap

Because many readers have little familiarity with virtual worlds, I use the Section 2 to provide a brief introduction to two of the most popular virtual worlds: World of Warcraft and Second Life. In Section 3 I elaborate on the features required of virtual worlds designed for the study of real world business. For each feature, I justify the requirement, describe some of the challenges it presents, and sketch out how it might be implemented. Section 4 provides a closing remark.

<div align="center">My Introduction to virtual worlds</div>

In this section, I provide some context for my interest in this new technology, and describe my own experiences in two important virtual worlds, World of Warcraft (WoW) and Second Life (SL).

Why I Became Interested in Virtual Worlds

For almost twenty years I have been conducting experiments based on "serious games," using the methods of experimental economics. In a typical study, I might have subjects buy and sell securities over a computer network, in order to understand how market behavior and trader welfare are influenced by financial reporting regulations or trading mechanisms.[1] Experimental economists are a minority in business disciplines (and are most common in economics, accounting and finance), but have become increasingly well-respected and influential. Vernon Smith even earned the 2002 Nobel Prize in Economics for "for having established laboratory experiments as a tool in empirical economic analysis, especially in the study of alternative market mechanisms" (Royal Swedish Academy of Sciences, 2002). Even a decade ago,

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[1] Many of my papers are available on my SSRN web page, http://papers.ssrn.com/sol3/cf_dev/AbsByAuth.cfm?per_id=48324.

experimental economics was a well-known teaching practice, and it has become an accepted, if still uncommon, teaching tool in introductory economics courses.[2]

In late 2006, I began discussions with the Financial Accounting Standards Board (FASB), while led to the founding of the Financial Accounting Standards Research Initiative (FASRI), under my direction.[3] FASRI's charge is to foster communication between academic researchers and standard setters, and to support and conduct research that can assist with FASB's deliberations about proposed changes in accounting standards. Experimental methods are well-suited to such research, for several reasons. First, there aren't many alternatives. Traditional empirical research methods use publicly available data archives to observe how existing accounting standards alter the relationship between financial reports based on those standards and market activity (such as stock prices, market liquidity, analyst forecasts, credit ratings, and other variables). Unfortunately, none of these data archives are available for accounting standards that have been proposed but not yet implemented. Theoretical research is also difficult to apply to the FASB's situation. Many financial reporting issues are simply too complicated for traditional economic modeling to be both relevant and tractable. Moreover, psychological and behavioral forces, which are typically absent in economic models, can have a dramatic influence on how accounting information is used (Bloomfield 2009a).

Experimental methods allow for the observation of variables that are otherwise unobservable, and also allow for controlled manipulations of key variables while holding all other variables constant (Bloomfield 2009b, Bloomfield and Rennekamp 2008). In principle, it would be possible to conduct an experiment in which researchers know all of the private information that a firm is attempting to convey through financial statements, and can compare the beliefs and behavior of investors, analysts, and markets across two settings that differ only in the governing financial reporting standards.

Traditional forms of experimental research will form an essential part of FASRI's research activities. However, we also have some more ambitious goals, such as studying how accounting standards affect the liquidity of capital markets and the nature of commercial contracts. Ideally, experiments addressing these issues would involve many types of participants (such as managers, auditors, investors, and analysts) making complicated decisions (such as valuation, production, capital allocation and contracting) in complex institutions (such as financial markets). Those participants would need to be well-trained, not only to understand accounting and finance, but also to understand a rich and self-contained laboratory setting.

The above description of the ideal experimental setting is remarkably similar to the description of a virtual world, which is typically populated by many types of players making complicated decisions in complex institutions. Moreover, most worlds provide natural mechanisms for residents to become well-trained in a rich set of inworld skills and knowledge, so that they can behave intelligently. Of course, most worlds focus on "orcs and elves" (a derogatory term for new worlds that differ too little from prior Tolkein-inspired worlds), rather than on investment bankers and credit analysts. Thus, my challenge became to learn enough

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[2] See Ball (1998), and the website of University of Virginia Professor Charles Holt (http://people.virginia.edu/~cah2k/) for more recent information on the use of experimental economics in both research and teaching.

[3] http://fasri.net.

about existing worlds to determine how worlds of orcs and elves could be modified to suit the needs of FASRI.

As my first step, I subscribed to two virtual worlds, World of Warcraft and Second Life. I discuss my World of Warcraft experience first, because most readers unfamiliar with virtual worlds will find it a far simpler environment to understand.

The Life of Ramat in World of Warcraft

I subscribed to World of Warcraft (WoW) by purchasing a two-week trial subscription for $1.99 at my local Best Buy outlet. Hoping my wife would play for me, I let my wife select a name (Ramat) and a character (a hunter). After my wife customized Ramat's cartoon-like representation (his "avatar"), she exhibited little interest in the game. I brewed some tea and settled in for a few hours on a rainy Saturday morning.

After selecting a "realm" to enter, I found myself in a colorful and graphically rich landscape. While a typical computer game forces a player into a predetermined sequence of challenges, I was able to wander about freely, chatting with the hundreds of other people nearby, and killing various beasts that roam the land. The beasts are controlled by artificial intelligence designed by WoW's developer, Blizzard Entertainment, and are often referred to as non-player characters (NPCs). Since I had chosen the "normal" mode of play, I was only able to attack NPCs; battle with participant-controlled characters requires their consent. Each time I killed a beast, I received some loot, such as the animal's pelt or other valuable body part, pieces of copper, weapons or clothing. I also received experience points. When I received enough experience points, I "leveled up" to become a Level 2 hunter, which increased my strength, health and other attributes.

After killing a number of mangy saber cats and wild boars, I began to choose from a variety of "quests" posed by NPCs. A typical early quest was to bring animal pelts to the NPC, in return for pieces of copper and a new weapon. (Copper, silver and gold form the basis of currency in WoW.) I also participated in a "raid," during which I joined with other players to raid a dungeon or cave that would have been impossible to broach on my own.

I didn't get much further than this in WoW, but I have learned more from talking with some players in the Cornell community. One student, Stephanie, studies to become a veterinarian during her working hours; when she has time (and often when she doesn't), she logs onto WoW as the Druid healer, Moliacoria. As a healer, Moliacoria joins forces with damage-takers (who serve on the front lines of combat) and damage-dealers (who can cast spells or use other long-range weapons from behind the damage-takers). Moliacoria finds a safe spot not too far from the action, so that she can track the health of her compatriots and allocate her precious healing powers as she deems fit.

Like most advanced players, Stephanie has logged a tremendous amount of time on WoW. She admits to spending about 12 hours a day on WoW during one summer when her parents were out of town. To make it easier to engage in quests and raids with her friends, Moliacoria has become a member of a guild called "The Unseen Order." Blizzard created guilds as a way to foster communication between players. Members of guilds select a customized tabard for their characters to wear as a uniform. During quests and raids, guild members can use

special chat channels to communicate with one another more effectively. Guilds have hierarchical leadership structures, and may implement their own requirements for membership (such as attending meetings) and their own rules for voting and decision-making. Guilds often form their own rules for allocating the loot dropped by their vanquished foes. Usually, the loot is divided according to need—as a healer, Moliacoria has little use for heavy weapons, but great need for items that sustain magic powers, and ingredients useful for alchemy. Players can roll computerized dice to settle disputes, or rely on their leader to make decisions in the best interests of the guild or warring party. In many cases, Moliacoria ends up with loot that is not useful to her, but is valuable to others. Fortunately, WoW provides a number of auction houses in which players can buy and sell goods for in-world currency.

Success at high levels in WoW requires communicating and processing a great deal of information, and doing so quickly. Fortunately, WoW supports some limited "scripting" that allows for improved information displays; there is even one for healers designed specifically to help them determine which fighters are the best to heal (considering their health and battle position relative to others, and the scarcity of the healer's remaining healing powers). Many players also use software outside of WoW to assist them. For example, members of the Unseen Order use the program *Ventrilo* to communicate by VOIP (voice over internet protocol) so that they can speak rather than type messages to each other while engaged in combat. They also use programs designed to capture information about WoW auction houses, in order to identify the best available prices for loot.

The Life of Beyers Sellers in Second Life

I joined Second Life (SL) in January of 2007 by downloading free software on the internet, and getting a free subscription. I chose a suitably business-oriented name for my character (Beyers Sellers), and clothed him in jeans and a t-shirt from a selection of options provided at no cost to newcomers (called "noobs" or "newbies").

After spending a few minutes on "Help Island" to master the skills of dressing, walking, flying, chatting, and looking around, my first step was to open the "map" window. The map provided a schematic map of the entire world of SL: a large mainland surrounded by countless small islands. Every avatar currently online was represented by a green dot on the map. On the day that Beyers Sellers was born there were about 40,000 people online.

Following the principle of "The Wisdom of Crowds" (Surowiecki 2004), I assumed that large groups of people must be somewhere worth visiting. I selected a spot laden with green dots, and teleported in. When I materialized, I found myself surrounded by several female avatars in provocative outfits. The walls were covered with advertisements—some providing photos of real women—and website addresses or phone numbers for traditional real life (RL) interaction, and others providing photos of avatars and their SL names for "escort services" to take place in SL itself. I turned around only to see an escort performing one such a service for her client. I wasn't sure how the escort was able to move as she did, or why the subscriber controlling the client found this service of value. I quickly concluded that I could answer such questions elsewhere, and opened my map again.

It may seem inappropriate to introduce Second Life with such a tawdry story—particularly since Second Life has since relegated adult content to a separate region I would have known to avoid—but readers should know that at the time this experience was hardly unrepresentative. My Wisdom of Crowds strategy brought me, over my first brief sessions on SL, to roughly equal numbers of sex clubs and casinos. Only two crowded places were reputable. One was a set of kiosks offering hundreds of Lindens ($1USD ~ L$260) for answering market-research surveys conducted by NPD Online Research. Another was a meeting for Linden helpers—about 30 people who were volunteering to work for Linden Labs (the creators of SL) had convened to discuss how to help newbies, and how to deal with "griefers"—those who intentionally cause problems for others, whether by inappropriate dress, verbal abuse or other methods. While I would have found the meeting interesting, I was politely asked to leave.

I then decided to teleport to lands with only one or two people. Now my adventures took me to stores selling clothing, furniture, music, animal avatars, and scripts that would animate avatars to dance or move in other ways (solving the puzzle of the escort). However, I didn't have much money to spend, and my attempts to find like-minded residents were relatively unsuccessful. Disappointed with what was on offer, I left SL, not to return for many weeks. (It was during this gap in my Second Life that I explored WoW.)

When I returned to SL with a mission to learn more about virtual worlds, I decided to exploit a new principle: "everybody likes a pretty girl". With a single click of a button, I transformed the androgynously-named Beyers Sellers into a young woman. I found a moderately crowded spot, which turned out to be a dance club. The club was playing music owned by a record label that was advertised throughout the club. (I later learned that the club owner was being paid for the publicity by the record label.) In the corners of the dance floor were "pose balls" that I could click to animate my avatar and make her dance to the music.

Dancing in a short skirt and a crowded bar, the new Beyers Sellers was instantly popular. The women gave me clothes and hair to replace my newbie attire, and the men gave me helpful notes (text documents) on how to manage my inventory, use the notoriously finicky in-world search engine, and other tasks of varying interest to me. While I was grateful for the clothing and the information, I clarified that I was interested in the business and educational aspects of SL, and again everyone was very helpful, spending quite a bit of time directing me to educational facilities, training sites, real estate agents, and other people, groups, and places that they thought might interest me.

Feeling more prepared to explore the potential of SL, I reverted to my male avatar. I also took the somewhat rare step of publishing information about my "first life" on my SL profile, expecting that my position as an accounting professor would discourage attention from those using SL purely for socialization, while making it easier to find residents who might be interested in my quest.

My studies revealed that Second Life had a far more complex economy than World of Warcraft. As I wrote in Canada's National Post (Bloomfield 2008), World of Warcraft is a lot like Disneyland:

Tourists who visit Disneyland pay their money to Disney, because Disney created all the attractions in the park. In much the same way, players of World of Warcraft give their money to Blizzard Entertainment, because Blizzard created all of the attractions in the world — harrowing dungeons filled with monsters and treasure. Linden Lab's business model has created an entirely new type of world, based on entrepreneurship. It is as if a company chose to compete with Disneyland by saying the following:

"Come to our amusement park — for free. We aren't going to build much here ourselves. But we have lots of land for rent, and we will provide you the tools you need to build your own attractions. Once you build them, you can charge admission."

This unique model has attracted a thriving community of entrepreneurs in Second Life. In this 3D online world, residents rent land, which allows them a place to build their attractions and control access, and gives them space on Linden Lab's computer servers. They use Linden Lab's building tools to create objects, from buildings to hot air balloons, and use Linden's programming language, LSL, to bring their creations to life.

I became particularly interested in Second Life's financial community. Entrepreneurs need capital in Second Life, just as they do in real life, and in late spring and early summer of 2007, a number of banks and stock exchanges presented themselves as answers to this need. They collected billions of Linden dollars (worth millions of US dollars), offering the promise of exceptionally high returns. However, the banks were roiled by a series of crises. In July of 2007, a bank closed temporarily after an alleged embezzlement. Immediately afterwards, Linden Lab's decision to ban gambling caused most banks and stocks to decline precipitously, as gambling was a favorite investment and source of profit. One very large bank, Ginko, collapsed completely. After a series of such scandals, Linden Lab effectively banned banking activities in January 2008, largely eliminating this portion of the Second Life economy (Talbot, 2008).

The demise of Second Life's financial sector hardly spelled the end of Second Life's economy. Instead, entrepreneurs simply raised capital through more traditional channels in real life. My own continuing story in Second Life is emblematic, if not typical. In August of 2007 I arranged a series of guest lectures in Second Life for Cornell students interested in learning more about the Second Life economy. However, my proposal attracted attention from Second Life's entrepreneurs. An enterprising blogger, Nick Wilson, arranged to have the sessions filmed and broadcast.

What began as a low-key academic lecture series has blossomed into one of Second Life's most respected forums for serious discussion about virtual worlds and new media. Our guests have included top executives from many enterprise-oriented virtual worlds; academic researchers in law, economics, anthropology, psychology and business; entrepreneurs running real-world and virtual-world businesses; and policy makers from the U.S. Congress, European Parliament, and the Obama administration.

Production and funding of Metanomics are an object lesson virtual business. Funding for the show came from a number of real-world corporations that were interested in gaining visibility in Second Life, including Kelly Services, Cisco Systems, Saxo Bank, Generali Group, SAP, and Sun Microsystems. Metanomics was filmed and broadcast by a group of Australian entrepreneurs who believe that television shows filmed in virtual worlds ('machinima') have economic promise; their business, now called Treet.tv, partners closely with Linden Lab and is

attracting increased attention. While our personnel has changed over time, each episode of Metanomics has required collaboration among people spread across Canada, several States in the U.S., Australia and Europe. Metanomics is now owned by Toronto-based Remedy Communications, Ltd., and has developed an archive of over 80 episodes, available at http://metanomics.net.

The success of Metanomics has occasionally distracted me from my original goal of developing a platform for the study of real business in a virtual world. However, it has also provided substantial benefits. Hosting Metanomics has allowed me to create a similarly weekly broadcast for FASRI. More importantly, it has helped me to understand the features that would be required in an effective version of a 'World of Bizcraft', which I discuss next.

Features Required for World of Bizcraft

Armed with some familiarity with virtual worlds, we can now begin to explore their use for business education and research. Recall that my goal is not simply to use virtual worlds as a method for long-distance telecommunication. Rather, my goal is to allow participants to take on the roles of business people and make decisions in a realistic business environment: envision a World of Bizcraft that combines the goal-oriented focus of WoW with the business orientation and open-source philosophy of Second Life.

In this section, I discuss the seven key features that such a platform would need to allow: Progressivity, certification of participant achievements, and control over participant interaction ensure that participants are acting and learning independently. Induced value and inworld production allow worlds to capture the economic forces of real-world businesses. Sophisticated contracting and comprehensive business reporting systems allow participants to make intelligent decisions in a world with realistic inworld commerce.

Progressivity

Progressivity is perhaps the most familiar and universal features of traditional education: students tackle simple tasks before harder ones. Progressions are quite uniform across textbooks and course syllabi in most courses, usually because some topics provide the tools essential for understanding later topics. Sometimes the progression is more arbitrary: there is little reason for introductory classes in financial accounting courses to progress from the top left of a balance sheet to the bottom right, but most do exactly that. However, even when the progression through topics is arbitrary, texts still take advantage of the sequence of topics to introduce simple and foundational matters in the early topics, to provide for deeper understanding in later topics.

My account of WoW shows that game play is roughly progressive: I began by killing relatively manageable NPCs on my own, gradually shifting to more formidable prey with the collaboration of others. In contrast, SL provides provided me with no progressivity at all, leaving me to wander the world and tackle tasks as I chose (if I could find them). I became a frustrated drop-out, and don't believe that SL's goal-free philosophy would be appropriate for many students (although it may be possible to create progressive quests within SL).

One of the difficulties of providing progressive business education is that centuries of economic progress have allowed the evolution of incredibly complex institutions. Virtual worlds provide a natural way of turning back the clock to simpler times, with institutions that are likely to be familiar even to young students with little exposure to the business world. Most of the business institutions included in the world could be familiar to students with little business background: people get paid to create or transport goods, and engage in trade by exchanging money for items of value. Even this simple world provides many lessons in production, inventory management, competition and other topics. As participants become sufficiently comfortable with the world's traditional economy, quests can introduce new features, such as markets for labor and capital, and complex production process and commercial arrangements.

It isn't difficult to imagine a World of Bizcraft that would lead players through a progressive set of standard business topics. For example, assume that my first quest in WoB is to sell newspapers. I am endowed with some cash, and must find the newspaper publisher from whom I purchase my day's stock. I can make only one purchase a day, because of the time it takes to walk from the publisher to my assigned station. When I arrive at my station, I sell my wares to interested pedestrians.

Success as a newspaper vendor requires me to learn a good deal about the WoB, such as how to walk, communicate and enter into cash exchanges. I would have to be able to read a very simple set of reports that indicate how many newspapers I have, how much revenue I have received, and how much profit I have earned—all essential skills for further quests. Equally important, I must master the "newsvendor" problem, which is a staple of introductory supply chain management (Cachon and Terwiesch, 2005). Purchasing too many newspapers at the beginning of the day is costly to me, because unsold newspapers have no value at the end of the day. Purchasing too few newspapers is costly because I will miss out on profits I could have earned. I must therefore be able to find and interpret information about demand, and purchase the quantity that balances the relative costs of over- and under-purchasing.

Once I am successful at a simple newsvendor quest, I might engage in a number of more complex quests. For example, I might be asked to sell books instead of newspapers. Unlike newspapers, books are valuable even after the end of the day, so inventory unsold at the end of one day is available for sale the next day. Likewise, a customer who was unable to purchase a book on day may return the next day to purchase it. These ramifications of durable inventory dramatically complicate my decision, particularly if I have to wait several days to receive the books I have ordered (Bloomfield, Gino and Kulp 2009). I will need to master additional reports about inventory, order backlogs, shipments in transit and projected demand.

Once I have mastered the bookvendor quest, I would be well positioned to begin studying any number of topics. For example, I might continue with a sequence of quests in production and operations management by taking a job in a mine or factory, in which I operate machinery (to learn the basics of production) and move on to managerial decisions, like balancing an assembly line. Alternatively, I might pursue quests that introduce me to various topics in the economics of strategy, by requiring me to choose which goods to produce and sell, how much to sell and at what price, where to locate my business, and so on—all while competing for business with others in the same markets. As I progress, I can begin to confront possibilities that were not available in the world's traditional economy—borrowing money, entering into long-term

contracts, investing in R&D, and so on. Eventually, I may move into the world of finance, lending money and investing in other's businesses.

It may surprise the reader that I haven't yet mentioned my own field of accounting. Every business quest will require participants to be able to read and understand a variety of financial reports—how else can they assess their performance and make decisions? As the business setting becomes more complex, so does the accounting.

Thus, a progressive accounting education could be integrated into quests focusing on progressively complex business decisions.

In a similar way, "softer" business topics, such as leadership, management, teamwork and organizational behavior can be introduced through quests requiring participants to interact in varied organizational structures.

Certification of Participant Achievements

Certification vs. Leveling

Leveling is a central aspect of WoW and many other virtual worlds. Leveling provides a focused motivation for many participants, affects the attributes and privileges of the participants' actor, and can grant participants social status (such as being an influential role in a guild). However, leveling has two shortcomings for educational purposes.

- **Leveling pertains to actors, not participants.** Ramat leveled up in WoW after killing about a dozen small beasts. While all of this combat experience may well have made Ramat stronger, it didn't make Rob Bloomfield stronger. Thus, leveling reflects Ramat's accomplishments, not mine.
- **Leveling is too vague.** Every animal Ramat killed earned him experience points that moved him closer to leveling up. However, experience points are not tied to specific educational goals (for example, learning different battle techniques or how to manage parts of the game interface). As a result, I personally learned little as Ramat gained experience.

A platform for business research and education should replace leveling up with a more robust form of certification, which differs from leveling up in that it certifies participants' specific achievements, rather than reflecting a broad measure of an actors' generic experience. For example, succeeding in the newsvendor quest requires me to master a number of skills: choosing orders quantities that are appropriate given available information about demand and the relative costs of over- and under-ordering; interpreting the information displays; and knowing how to interact with both my supplier and my customers. An educator could verify that I have mastered these skills by examining my profits earned, assessing the correlation between my ordering decisions and the optimal orders, and perhaps even quiz me on how to interpret reports. Once my mastery is verified, I could be granted certification as a Level 1 Supply Chain Manager. Mastering the skills needed to manage subsequent supply chain tasks (such as handling durable inventory) might earn me Level 2 Supply Chain Manager certification. In contrast, a quest requiring me to assess the credit risk of potential borrowers might earn me certification in Commercial Banking.

Certification will have a number of uses. First and foremost, certification would allow an educator to verify that a student has actually completed the teachers' educational requirements (e.g. college transcripts).

Certification can also be used as a gateway to new challenges. For example, a participant wouldn't be able to attempt a Level 2 Supply Chain quest until receiving Level 1 Supply chain certification. Participants might not even be able to enter certain worlds until receiving appropriate certification. This ability would be particularly helpful for researchers who have little interest in studying the behavior of economies unless the economic decisions reflect considerable knowledge and experience. Because many researchers would likely reward participants with items of real-world value, certification thus becomes valuable in itself.

Certification may also become useful inworld (as level is in WoW). World designers might grant inworld assets (such as additional cash) to the actor of a participant who has achieved certification. Certainly, certification (if made public) is likely to play a role in inworld decisions by other participants. For example, I would be more likely to entrust someone with financial responsibilities if they had extensive certification in finance.

If certification is viewed by businesses as sufficiently reliable indicators of business acumen, it wouldn't be too hard to imagine a resume that includes the following information:

> I am a 40th level commercial banker in World of Bizcraft. I have certifications in risk management, derivatives (including interest rate strips and swaps), as well as financial analysis and credit risk assessment. I am currently head of the commercial banking division of Q-Bank, and have seen its profits grow 40% in the last three months.

Challenges in certification

Certification poses a number of challenges. First and foremost among these would be to maintain academic standards. This challenge would be difficult even if all quests and certificates were assigned by a central body, just as Blizzard Entertainment solely determines how many experience points are granted to an actor for a given activity, and how many experience points are required for leveling up. However, an open platform for research and educational purposes would allow many people to construct their own worlds and quests. These would either have to be idiosyncratic (resulting in multiple brands of certification) or approved by an oversight body. Both solutions seem feasible, and a combination of approaches might be effective: a small number of oversight bodies who assigning their own certifications, and also approve certification transfer credit where they deem appropriate (for example, a player can use evidence of a particular certification approved by oversight board A to receive an appropriate certification form oversight board B.

A second challenge is that certification cannot be too easily transferred from one participant to another. Many news stories have been written about WoW "farms" in China, in which Chinese workers take a WoW actor through many levels, and then sell rights to the actor to wealthy but time-constrained Americans. Those relying on certification must have appropriate means to verify that a participant has actually earned their own certifications. Solutions might include a combination of

- An honor code (perhaps included in the end-user licensing agreement) that all participants must sign indicating that they will neither allow other participants to control actors purportedly controlled by themselves, nor control actors purportedly controlled by other actors, at risk of termination of their account; and
- Sporadic but brief "pop quizzes" to ensure that participants have the skills they are certified to have mastered, with failure resulting in revocation of the appropriate certificates;
- Computer programs that identify participants who appear to be behaving in ways inconsistent with their certification, possibly triggering a quiz or other intervention to verify certification.

Control over Participant Interaction

As any student knows, educators exercise considerable control over their learning environments. Educators using virtual worlds will need to have the flexibility impose controls as they deem appropriate, while also taking full advantage of the freedom virtual worlds can provide. In this section, I focus on three particular decisions that balance freedom and control: whether roles are taken by participants-controlled actors or NPCs; whether the quests take place in persistent or bounded worlds; and whether participants have the ability to create new game assets.

Participant-controlled actors vs. NPCs

The reader may have noted that I never specified which roles are played by NPCs, rather than other human participants. This is a crucial issue because every role taken by a participant-guided player also reduces the educators control over the process. Assume, for example, that my newspaper publisher is a more advanced participant. If that participant had trouble managing her own inventory, I might find it difficult or impossible to achieve my goals. Unless the educational intent of the quest is to illustrate how inventory problems propagate along the supply chain, the control provided by NPCs is probably useful.

On the other hand, NPCs can be gamed and provide participants with "exploits"—methods of achieving outcomes that were not anticipated by the world designers, and that defeat the intended purpose of the game. Thus, artificial intelligence for AIs will need to be thoroughly tested for robustness to exploits.

Persistent or Bounded Worlds

Second Life represents a "persistent" virtual world because the servers that control them run continuously, allowing software programs to alter the world even when no members are present, and the worlds continue as long as running the game publishers choose to sustain them. Traditional computer games, like *Doom* or *Thief* are "bounded" virtual worlds because the world does not exist or change when no members are present, and each world has a definite and end. WoW is actually a blend of persistent and bounded worlds. The larger environment is a persistent world with thousands of participants interacting; however, when a team chooses to raid a dungeon, WoW creates a new "instance" of the dungeon in its initial unraided state, and allows only the team members to enter. When the raid is over, this bounded dungeon world is erased, to be recreated again in its unraided state for another party.

Most extant educational games use bounded worlds, because they afford the most control. Persistent worlds impose two key challenges to the educator or researcher seeking control.

First, what happens in a persistent world when a participant is not there to control her actor? This is not a problem in WoW, because an actor does not suffer from absence (except for the opportunity cost of missing in on a profitable hunt, and perhaps losing the trust of guild members who expect dedication). The actor cannot be killed when the player is offline, nor does it lose health. In contrast, an actor in a business setting would need to pay rent and other expenses, regardless of whether or not the participant is online. Moreover, sharp turns in the economy could cause the actor to miss out on opportunities to avoid catastrophe. As a result, a participant could log on to find that her actor has gone bankrupt. One solution to this problem is to allow participants to program their actors to engage in routine decisions during their absences. Another possibility would be to create worlds that are persistent, but intermittent: for example, online from 7-9pm on every Wednesday. Yet another solution would be to allow instances of bounded worlds to be created upon demand within a larger persistent world, much like the creation of dungeon instances for raiding parties in WoW.

Second, persistent worlds must be able to evolve for long periods of time without rampant inflation. Inflation plagues many virtual worlds, because all players wish to make progress in the game, leveling up and receiving better weapons and armor. Once better weapons become available to the top players, they sell, trade or even give their once-valuable weapons to less-advanced players, causing a trickle-down effect. Overseers of virtual worlds must pay close attention to the sources and sinks of currency and property. I discuss this problem further in the section on inworld production.

Ability to Create Game Assets

Many virtual worlds allow players the ability to create and trade game assets. If the newsvendor quest were created by an educator in SL, it would be a simple matter for players to build and share notes that guide newbies through the quest. They could also create a market for information displays that aid decision-making, or even scripts that would automate the behavior of the actors and guarantee optimal inventory management.

Most educators would probably encourage students to read any helpful materials, as long as quests were immune to "exploits" that would allow participants to accomplish the stated goals without actually learning the intended content). However, automation scripts effectively act as exploits, and I doubt instructors would want to permit their use. Information displays are a more difficult question: displays could provide a natural way to help participants understand the decisions confronting them, or could simply provide a solution without communicating any insights.

Instructors clearly need the power to determine whether any or all of these forms of assistance are to be encouraged or prohibited.

Induced value

Experiments in Economics

We now come to a feature required by educational business games that is almost surely incompatible with worlds created for entertainment or business: the ability to control and observe participants' preferences over game outcomes. The need for this control is laid out by Vernon Smith (1976, 1982). To clarify the role experiments can play in testing economic theory, I lay out five basic assumptions underlying any economic prediction:

- **Institutions.** The game has a well-defined set of rules (economic institutions) that govern what players know, what actions are possible, and how those actions map into outcomes;
- **Preferences.** Actors have well-defined preferences over outcomes;
- **Beliefs.** Actors form beliefs about the outcomes that will result from their actions, given their beliefs about the environment and other actors actions; and
- **Rationality.** Actors behave rationally, given their preferences and beliefs.
- **Solution Concept.** Behavior will be consistent with some fundamental assumptions about economic equilibria. (For example, the theory might assume that behavior must satisfy the condition of Nash equilibria).

Assume that a researcher wishes to test whether an increased fine for underpayment of taxes reduces tax evasion. After the legislature passes the law, tax evasion use shows no change. What can the economist conclude? Perhaps the new law is never enforced, or taxpayers don't actually control the behavior that is being measured as "evasion" (the institution assumption is wrong). Perhaps taxpayers view the fine as a badge of honor to protest government policies (the preference assumption is wrong), or don't believe the fine will be enforced (the belief assumption is wrong). Perhaps taxpayers don't act in their own self-interest, and are not deterred by the higher fine even though they would prefer to be (the rationality assumption is wrong). Finally, perhaps the solution concept is wrong. The prediction assumes that taxpayers and tax auditor settle into a Nash equilibrium in which each party responds optimally to the anticipated action of the other, and that those anticipations are correct. However, there are other solution concepts (such as rationalizability) that would lead to different predictions.

Experiments are helpful in part because they allow researchers to exercise direct control over institutions, and exercise indirect control over preferences and beliefs. (Experiments also allow measurement of variables that are unobservable outside the laboratory.) Experimenters can exercise direct control over institutions and indirect control over many beliefs by providing detailed instructions that spell out the new law, the likelihood of enforcement, and any other key information. Experimenters can exercise indirect control over preferences by making sure that participants' receive real-world payoffs that are large enough to dominate any other non-monetary preferences they might have. With these controls in place, the experimenter can then draw inferences about participants' rationality and the predictive validity of the solution concept being assumed.

Inducing value in virtual worlds

Vernon Smith's 1982 paper lays out some of the elements needed to exercise sufficient indirect control over preferences that the results of an experiment can be generalized to real-world settings. Modifying Smith's discussion to reflect my own views, inducing value for a particular player in a virtual world requires several features:[4]

- Rewards. There must be some reward of value that participants can pursue within the experiment.
- Nonsatiation. Participants must prefer more reward to less (they cannot be indifferent, no matter how much they earn).
- Saliency. Participants must be aware of how game outcomes map into rewards.
- Dominance. Rewards must be large enough, relative to participants' uncontrolled preferences, that those other preferences have the same size and type of effect on behavior in the controlled setting as they would in the real world.

Satisfying all four of these conditions allows the experimenter to "induce" value preferences in participant that the economic theory assumes hold in the real world.

Virtual worlds do a very poor job of controlling preferences, primarily because they fail the "dominance" test. While participants in WoW are indeed motivated to achieve their goals of gaining experience and leveling up, and many earn financial compensation for doing so, this is far from their only goal. They also seek the simple pleasures of virtual combat, along with the social pleasures afforded by collaboration and leadership. SL, as a world without goals, deviates even further from the tenets of induced value. Of the roughly one million users who logged into SL during the month of August, 2009, only about half spent a single Linden dollar.[5] Clearly, SL subscribers are using SL for pleasures that a researcher is unlikely to know, and is certainly not controlling. Student participants won't be able to learn any more than researchers if their competitors are more interested in changing their avatar's hair and chatting with friends than earning profits.

For the behavior of a single person to be generalized to real-world settings, one must induce value successfully for everyone that person might interact with, even indirectly (by interacting with someone who interacts with that person). Consider the newsvendor quest. It would not be difficult to make certification and profit very important to a newsvendor, and to limit the participant's ability to engage in behaviors that are irrelevant to the quest (for example, no opportunity to modify their appearance). However, the newsvendor's optimal strategy

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[4] Smith defines saliency as a link between institutions and rewards. I have revised this definition to capture the fact that participants must be aware of this link. I also modify Smith's definition of "dominance." His definition requires non-reward preferences to have no effect on behavior. My definition allows experimenters to study behavioral factors expected to be important both in the lab and the real world. Smith includes "privacy" as a requirement, out of concern that real-world institutions always make rewards private information, and that public revelation of rewards might create incentives for cooperation or competition that are not intended. I exclude this element because privacy may or may not be incorporated as part of the institution being studied (many rewards are public), and because any non-reward preferences created by privacy are addressed by the element of dominance. I also exclude Smith's element of "parallelism," which is an assumption that behavior in a controlled setting will apply to non-laboratory settings with similar institutions. I exclude this element because this assumption is not controlled by the experimenter, other that through the choice of similar institutions.

[5] http://secondlife.com/statistics/economy-data.php

depends on her beliefs about her customers. What determines their likelihood of walking by her station, and buying a newspaper if they do? Will running out of stock on one day affect demand the next day? Might demand be affected by changing the gender, appearance or name of her avatar? If the newsvendors' customers are controlled by human participants, and their value is not induced by strong financial incentives, the newsvendor's task becomes exceptionally complicated, and there is no objective way of determining what information is relevant to her decision, or even what decisions are appropriate. As a result, certification becomes quite difficult—good or bad performance could simply indicate luck. Moreover, the newsvendor's task is no long a simple building block in a progressive set of quests, because success at the task would require extensive marketing research to clarify the value of the newspaper to its readers, as well as readers' traffic patterns.

Experimental economists would recommend a simple solution to this problem: make the newspaper readers NPCs, and simply tell the newsvendor the algorithms governing their decisions. Sample instructions might be:

You can expect residents to pass by your station approximately every 30 seconds on a sunny day, and every 60 seconds on a rainy day. Each one has a 10% chance of purchasing a paper regardless of the weather.

Such instructions tremendously simplify the newsvendor's task: she need only check the weather, and make sure she understands some basic statistics.

A more general solution: controlling consumption value

The ultimate driver of behavior in any economy is consumption. I refer to consumption as those products, services or experiences that people demand because they are ends in themselves, not merely means to another product, service or experience. Out in "meatspace" (a derogatory term used by those who prefer their virtual lives), people consume food, shelter, entertainment, security, status, and the like. Consumption is a slippery concept, because it is difficult to identify anything that does not both serve as both an end in itself and a means to another end. For example, a nice car provides some immediate pleasures and some value as a means to acquire more pleasures (such as impressing people in social and business contexts or providing transportation to the supermarket).

Participants in WoW consume both entertainment (which is not easily controlled or measured) as well as experience points and loot (which can be converted into real-world currency). Some participants in SL consume Lindens (if they exchange Lindens for real-world currency), but most derive consumption pleasure from social interactions, and many (like my personal assistant) derive consumption pleasure by building—an activity that I would consider work. This "Tom Sawyer" effect makes these worlds are challenging ones for the purpose of exercising control over preferences.

Preferences for consumption can be induced by endowing many goods and services with an artificial consumption value. For example, the newspaper could have no value other than that the NPC-controlled actors who purchase it can exchange it for inworld currency, and that all other actors are controlled by human participants and have their utility induced so that they care exclusively about their financial performance. While this sounds simple, such an army of NPCs

could drive an entire supply chain, from newsvendor to publisher to ink and paper factories and farms and mines for pigments and wood.

More generally, every actor, whether NPC or participant-controlled, would have consumption value for every good or service in the economy. This would capture the reality that inworld characters do consume items (like food).

Controlled consumption value will pose special challenges to those in marketing and the behavioral sciences, who wish to study and understand people's preferences. A platform for business research and education can and must support worlds in which preferences for consumption arise naturally. However, these worlds must be adequately segregated from worlds that are designed for progressive study of the economy.

Inworld Production

While consumption is the ultimate driver of economic activity, production is the means by which demands for consumption are fulfilled.

A generic production function in the real world maps the inputs of labor, goods, and time into a new set of goods. For example, baking cookies requires flour, eggs, sugar, milk and water; an oven, a mixer, some cooking trays and implements; labor to mix the ingredients, place the batter in the oven and remove the cookies when done; and time for baking. There are as countless production functions, and a large element of business involves studying how various production functions affect industry behavior, the value of goods and services, accounting reports, and the like. Thus, if a virtual world is to provide a platform for studying real-world business, it will need the capacity to instantiate real-world production functions. Such production functions will, in turn, require a complete description of the goods that might be available in the economy, and the effects of human labor.

Inworld vs. Real-World Production

One of the difficulties of designing production functions is determining which aspects of production take place inworld, and which take place out of world. To see the difficulty, consider WoW. Assume that two participants collaborate to kill an NPC that will drop loot of 100 silver pieces and two valuable weapons. Looking only at inworld activities, one could describe the production function as creating the loot from capital goods (the weapons used in battle, which may deteriorate or even be destroyed), the actor's "human capital" (the strength and skills of the actors), possibly some intellectual property (perhaps one of the actors holds a map indicating the location of the creature), and the actor's labor (they must expend health and other personal attributes, and could be devoting themselves to another task instead). However, this is an incomplete description of the production function, because acquiring the loot also requires the participants' capital (a computer), intellectual property (their acquired knowledge of WoW), labor and time.

Real-world production is even more important in SL than in WoW. Consider the production function for creating clothing in SL. Clothing (like any other visual structure in SL) is constructed of "prims"—primitive shapes, like cubes, spheres and cones, that can be distorted, hollowed, and joined to form objects—and "textures" that determine the visual appearance of the

surface. Prims and textures are free, but any particular area in SL can support only a limited number of prims. Thus, prims and land are essential capital-good inputs. However, unlike WoW, actors in SL do not have any intrinsic attributes that affect the creation of clothing—all intellectual and human capital other than what the actor might purchase from other SL actors resides outside the game, entirely in the hands of the participants.

Because the goals of this virtual world platform are educational, I propose the following guideline:

No aspects of production take place inworld if they accomplish a participant's educational objectives.

For example, a student of sales would need to charm possible purchasers through real-world voice chat, but her actor would be given a prediction skill that determines the accuracy of demand estimates that are simply given to him. In contrast, a student of statistics would need to construct their own estimate of demand, but her actor would possess a skill determining the probability of making a sale.

Inworld Production functions

Because real-world industries are so varied, a virtual world platform will need to allow people tremendous flexibility to create their own sets of goods and production functions. In this section, I sketch an extremely preliminary set of features that would be required to can capture most real-world industry characteristics.

First, actors would have a variety of attributes that determine the productivity on matters of no educational import. As indicated above, actor attributes might include the charm that a salesperson can exert over an NPC customer (but not for a student of sales techniques), or the ability to predict future demand (but not for a student of statistics or market research).

Second, the economy would need to be filled with goods of many varieties. In addition to their consumption value, goods would be characterized by a variety of attributes that would determine their influence in production functions (quality, quantity, etc.), and would also have attributes that affect transportation and storage needs (location, volume, density, rate of deterioration).

Some goods (functional goods) would also possess production or transportation functions: machines would have rules that convert inputs into outputs (production), while vehicles would have rules converting inputs into changes in the location of other goods (transportation).

Goods also include meta-objects, like information about other goods or future conditions. These are crucial elements in business games, as they allow people to make better decisions and commercial arrangements, and therefore can have substantial value.

User-created production functions

Because of the tremendous variety of production functions needed to emulate various industries and business topics, a more ambitious goal would be to allow world developers to create their own production functions. However, the ability for actors to create new production functions must be severely limited. Otherwise, actors will be able to create machines whose production functions convert minimal inputs into valuable outputs. On the other hand, production methods in most economies improve over time, and any world devoted to illuminating real-world business issues would have to capture these technological improvements.

I offer three suggestions on how to address this issue. First, the educators and researchers governing the world could simply retain total control over the introduction of new production functions, so that they can introduce improvements as they see fit. This is essentially the model followed by WoW.

Second, overseers can create a world with a fixed set of production functions, but not all of them are known to the participants. Participants could learn the new production functions by investing in inworld research and development (which could simply involving using inworld currency to hire NPC scientists). This would allow the world to capture strategic issues associated with technological innovation, while limiting inflationary pressures.

Third, technological innovation could be the result of activities that reflect real-world learning in non-business topics. Underlying much economic growth is scientific and artistic creativity by people who have little or no business knowledge (the talent), who are employed by those who incorporate scientific and artistic achievements into the economy (the suits). It is not hard to imagine a synergistic educational endeavor in students of art, science and other fields achieve their educational objectives by acting as the talent, using their real-world knowledge to create inworld assets and production functions, and sell their time or output to business students acting as the suits.

Inworld Commerce: Property rights, contracts and voting

Modern capitalism rests on a foundation of property rights, agreements between parties to transfer those rights, and laws that enforce rights and agreements. In this section, I discuss some of the key legal features that would be required in a virtual world for business study. I wish to clarify right away that I do NOT discuss the fascinating and complex issues pertaining to the interface between real world and inworld law (Balkin and Noveck, 2005). Instead, my focus is on creating an inworld legal system that will allow for the study of real world commerce.

My discussion emphasizes two key differences between inworld law and real world law. First, virtual worlds allow for the automatic and perfect enforcement of property rights and commercial agreements (contracts) through the application of software algorithm (Lessig, 1996; Grimmelman 2004). For example, short of hacking into Blizzard Entertainment's computers, it is impossible to steal an item from another actors' inventory—the software will not permit it. Second, virtual worlds provide no formal methods for parties to seek compensation when they believe they are injured by actions lying outside the narrow confines of rights and contracts enforced by the software. For example, if I agree to build a house in SL for another participant, once they have paid me the money I can refuse to keep up my end of the bargain, and they have

no formal recourse within SL.[6] Similarly, if I see a magic staff on the ground in WoW, I can pick it up and retain complete property rights, even if eyewitnesses confirm that the previous owner dropped it accidentally, and had no intention of relinquishing ownership.

Participants have responded to the lack of legal institutions by creating their own. For example, consider a common misbehavior in WoW: waiting until others complete a arduous hunt and kill, and then sweeping in and collecting loot. Those who made the kill arguably have a right to the loot, but most games provide no method of enforcement. In response to this, some players have created their own methods of allocating loot, and enforce those methods through social sanction.

Organic legal structures are a very promising area for the study of virtual world business, they interfere two features—progressivity and control—that are required for studying real-world business. Organic legal structures interfere with progressivity because each actor would potentially need to know a complex legal structure in order to obtain relief for nonperformance of even the simplest contract. Organic legal institutions interfere with control because they are likely to differ from the real-world institutions the educator or research wishes to study.

Developers can limit the emergence of organic legal structures in two ways: by creating software that enforces a more complete set of property rights and agreements, and by creating their own legal institutions. The latter solution still interferes with progressivity, for the same reason that organic institutions do—they require participants to understand the institution for relief in even the simplest settings. Moreover, they impose a tremendous burden upon those overseeing the world to resolve disputes, either by human intervention or sophisticated AI—both of which would need to be fully developed before the first newspaper is sold.

The alternative to creating legal institutions is to create a set of property rights that can support the complex commercial arrangements seen in real-world business. These rights must go much farther than simple notions of "ownership". Accountants are painfully aware that ownership is a slippery concept. Assume that an airline enters into a contract with Boeing to lease 20 airplanes for 15 years. The airline has the right to use the planes as they wish, and has the right to purchase the planes for a fixed price at the end of the lease term. In exchange, they must pay Boeing some fixed amount each year for 15 years. Who owns the planes? Perhaps Boeing owns the planes, and are being paid to allow the airline to lease them, or perhaps the airline owns the planes, having effectively bought them on credit.

These questions of ownership are difficult for two reasons.

- "Ownership" sounds like a unitary construct, but it isn't. Rather, "ownership" is a term used to summarize a number of distinct rights to engage in various activities relative to the good. People might disagree over what rights are necessary to say that someone "owns" a plane, but the rights themselves are very clear.
- The leasing transaction described above schedules transfers in the various rights over the airplane, leaving each party facing a set of circumstances that may be unambiguous, but that defy one-word summary descriptions.

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[6] They may be able to sue in state court, however. See http://www.law.com/jsp/article.jsp?id=1161939921797.

Summary terms like "ownership" will be very important for business reporting, which is discussed in the next section. However, before dealing with summary terms, it is essential to lay the basic and unambiguous constructs that indicate participants' rights, and how they can transfer those rights among one another. Once that is done, we can worry about describing various distributions of rights and obligations in terms that are useful for decision-making.

Property Rights (Authorities)

I now describe a set of property rights defined with enough nuance to support complex commercial arrangements. The term "property right" is misleading, because it suggests that someone ought to be able to do something, but might somehow be prevented from doing so. (I have a right to enter my own house, but someone could change my locks without my permission.) Because these rights can be perfectly enforced with software, I refer to them as "authorities"—they can always be exercised without restriction.

I specify seven authorities. Five are authorities over goods or attributes of goods (primary authorities), while two are authorities over other authorities (meta-authorities).

The five primary authorities are:

- **Consumption**. An actor with consumption authority over a good has the right to receive the consumption value the good provides to them (which may across actors). Recall that consumption activities may or may not alter the properties of the good. For example, entering land or a building would be unlikely to alter their properties. However, consuming bread would cause the bread to cease to exist.
- **Production**. An actor with production authority over a productive good (a machine, vehicle or data collector) can use the good for production. An actor with production authority over a non-productive good can use that good in a machine over which they also have production authority.
- **Modification**. An actor with modification authority over an attribute of a good can change that attribute.
- **Transportation**. An actor with transportation authority over a good can alter the location of that good by using a vehicle over which the actor has production authority.
- **Information**. An actor with information authority over an attribute of a good can know that attribute.

The two meta-authorities are:
- **Transfer.** An actor with offer authority over another authority has the right to transfer that authority to another actor, conditional on the acceptance of the authority by the recipient.
- **Assignment.** An actor with assignment authority over the authorities of a new good produced by a machine can offer those authorities to actors, conditional on the acceptance of the authority by the recipient.

This relatively simple set of authorities and meta-authorities can describe a broad array of real-world business situations. For example, an actor employed as a cookie baker would have a variety of production, modification and transportation authorities over the ingredients he must

work with, but would rarely be granted any consumption authorities. A trucker would be unlikely to receive any authority other than transportation, and perhaps information over the volume and density of the good. A broker might have a transfer authority over the consumption authority for a good, but not actually have the consumption authority itself. Note that meta-authorities provide the ability to offer rights to others, but not impose those authorities upon them—this is essential because some authorities may be undesirable (like authorities over toxic waste).

Note that every primary authority refers to a particular good or attribute of a good (e.g, a production authority over a particular machine). Similarly, every meta-authority refers to a particular primary authority. However, a single authority may be held by multiple actors. For example, many workers in a factory would likely have production authority over the same machine. A useful generalization is to represent each actor as possessing a number of votes over that authority, and the authority having a "threshold" number of votes to be activated. For example, if every actor in a game had the right to know an attribute, they could all be granted a single vote, and the "threshold would be 0." If three people each had one vote, and if the threshold for the authority were 0.65, two actors would have to approve exercise of the authority in order for it to occur.

It is worth noting that there is no authority governing the ability to disclose information to another party. The reason is that such an authority would have little practical value. For example, assume I am permitted to know the consumption value of a good that I have non-transferable consumption authority for, but am not permitted to tell anyone that quantity. Would I be able to publish a report that lists my total quantity of consumption value? If so, I could construct a pair of reports that would communicate the quantity in question (one that includes it, one that does not). But if I cannot incorporate the information into any report, I would be dramatically hindered in reporting aggregate information. An additional consideration is that I could easily circumvent the restriction by conveying the information in prose, through chat or instant messaging.

Contracts

Commercial arrangements are transfers of authorities from one actor to another. Contracts are agreements to transfer authorities in the future, contingent on certain events. A structure for contracts in a virtual world would need to allow for basic commercial arrangements without requiring participants to know the complete legal structure, while also allowing participants to construct contracts as sophisticated as they (or their instructors) desire. Certainly, the structure would need to support employment contracts (with incentive compensation and deferred compensation), long-term construction contracts, leasing arrangements (including sale-leasebacks), derivative securities (like puts, calls, futures, and interest rate swaps), and investment contracts (including long-term debt, equity and debt-equity hybrids).

I now describe a simple structure for constructing enforceable contracts. The fundamental unit of every contract is a "link" that specifies the transfer of an authority from one party to another under a certain circumstance, and then specifies the next link to evaluate. Specifically, each link is an if-then statement of the following form:

Link X: If [condition] is TRUE, then transfer [votes] of [authority] from [party 1] to [party 2]. If transfer is successful, evaluate [link], else evaluate [link].

Each of the terms in brackets indicates a variable specifying exactly what conditions must arise for the transfer to occur, how many votes of which particular authority is being transferred, who is relinquishing and receiving the authority, and what link is evaluated next, depending on whether the transfer is successful or not. (The transfer will fail only if the transferor lacks the indicated authority.) The last component of a link is a command to evaluate another link; in this way, links form chains of transfers. Chains, in turn, can be bundled together to create a contract, which is defined as a set of bundles that are approved together. By constructing contracts from uniform building blocks, it is possible to construct arbitrarily complex contracts.

For example, imagine Jane wishes to write John a call option giving John the right to purchase the consumption rights to a cookie for $1. Because the price of cookie consumption rights might change, Jane will demand $0.10 compensation for writing the option. The chain of links might look something like this:

Link 1: If [this contract is binding] is TRUE, then transfer [1 vote] of [all authorities over $0.10] from [Jane] to [John]. If transfer is successful, then evaluate [Link 2], else evaluate [null].

Link 2: If [John has exercised option] is TRUE, then transfer [1 vote] of [all authorities over $1.00] from [John] to [Jane]. If transfer is successful, then evaluate [Link 3], else evaluate [Link 2].

Link 3: If [TRUE] is TRUE, then transfer [1 vote] of [consumption authority over cookie] from [Jane] to [John]. If transfer is successful, then evaluate [null], else evaluate [Link 3].

Link 1 is evaluated as soon as both parties agree to the contract: John buys the call option that Jane has written, and authority over the cash is transferred automatically from John to Jane. If John does not have the authority to write the call option, the transfer fails, and no further transfers occurs (because there is no next link). However, if the transfer is successful, John need only indicate that he wishes to exercise the option in order for Link 2 to evaluate to true. Assuming John has the authorities over $1.00 to transfer, link 3 would be evaluated and executed immediately, because the condition is trivially true (TRUE = TRUE). Assuming Jane possesses consumption authority over a cookie, the cookie is transferred from Jane to John, and because there is no subsequent link, the contract is complete.

Several observations are in order. First, by basing the contract on transfers of precisely-defined authorities under precisely-defined conditions, software can enforce the terms of the contract perfectly, without the use of judgment. While this contract uses only the conditions of exercise (link 2) and successful performance of prior links, many other conditions are possible. One particularly common condition would be the passage of time (for credit sales, for example). More complex conditions could require aggregate calculations based on any number of attributes that at least one party to the contract is permitted to know. For example, a secured borrowing might have a payment triggered if the quality of the collateral—or the most recent trading price

for an identical item—falls below a predetermined level. Such information would require a comprehensive business reporting system, which I discuss in the next section.

Second, because there is no other institution to resolve controversies, the contract must spell out all contingencies. This particular contract has several contingencies built in. If John accepts the contract, but does not have authority over $0.10, the contract simply becomes void (no further transfers occur). In contrast, if John exercises the option but does not have authority over $1.00, the transfer of money will occur as soon as he acquires such authority. If Jane does not have consumption authority over the cookie, the transfer will occur as soon as he acquires such authority. However, the contract does not specify any penalties. However, it wouldn't be hard to incorporate such penalties into the contract itself, by modifying Link 3 and adding an additional link as follows:

> **Link 3 (revised): If [TRUE] is TRUE, then transfer [1 vote] of [consumption authority over cookie] from [Jane] to [John]. If transfer is successful, then evaluate [null], else evaluate [Link 4].**
>
> **Link 4: If [TRUE] is TRUE, then transfer [1 vote] of [consumption authority over two cookies] from [Jane] to [John]. If transfer is successful, then evaluate [null], else evaluate [Link 5].**

This revised contract effectively penalizes Jane by one cookie if she cannot provide the first one when John requests it.

Third, note that it is not necessary for a party to actually possess an authority in order to promise it to another party. This allows Jane to write a call option even though she does not have consumption authority over a cookie—essentially, she is promising to "sell short," and will have to go out and buy such authority if she is to avoid suffering the contingency. The ability to promise authorities not currently possesses is critical to supporting liquid market for debt, derivatives and futures contracts.

Finally, note that the contract refers to a good of a certain type (a cookie) but not a particular cookie (the one on at the back right of the cupboard). A contracting mechanism would have to support both types of agreements to deal with both fungible and unique goods.

Securitization and Incorporation

To capture more of modern-day finance, it will be essential to incorporate two other features: transferability of contracts, and incorporation.

Loosely speaking, a "security" is a contract that has a standard form to allow large and liquid markets, and promises delivery of cash, a commodity, or another security. In real-world business, securitization (transforming contracts into securities) typically requires a high degree of standardization in contract terms and low degree of non-performance of the parties to the underlying contracts, so that the security can be viewed as a fungible commodity.

For example, Jane could write a put to an undetermined party "bearer" and follow a standard form for contingencies (in case of nonperformance of some link) and definitions of the authorities being transferred (e.g., consumption authority over goods of type "cookie" with quality and condition meeting some minimum threshold). Standardizing this contract form allows the development of a market for "cookie call options" where the only features that would need to be specified would be the price of the option itself ($0.10 in the contract above) and the strike price ($1.00 in the contract above). A well-functioning market would also require that those who are permitted to trade the options have established their credit-worthiness, so that traders would face minimal counterparty risk.

Incorporation in real world business allows people to form a legal entity that can be a party to a contract. Incorporation requires a mechanism for individual actors to create a corporation (with an appropriate set of bylaws determining who has authority to make decisions on the corporation's behalf). Note that corporations cannot itself actually take any actions: a corporation cannot consume, transport or even approve a contract. Those actions must be taken by an actor who has the authority to act on behalf of the corporation. Thus, a corporation can be viewed as an actor that possesses authorities and transfer those authorities to others. Corporations typically provide limited liability to officers, employees and shareholders. This can be supported by having agents of the corporation transfer rights to approve contracts to which the corporation (but not the agent) is a party.

Future directions

This section has provided only a very preliminary legal structure for virtual worlds intended to capture real-world business. The goals have been to allow sophisticated commercial arrangements to be perfectly-enforced without requiring a great deal of administrative and judicial institutions supported by human judgment or artificial intelligences. Achieving this goal places tremendous stress on the design of property rights and contracts (so that actors can protect themselves from nonperformance). I anticipate that the system of authorities and contracts I have proposed can be improved in many ways.

Even if authorities and contracts are improved, perfectly-enforced contracts always require perfectly-describable conditions for each link. These conditions will not always be possible. It is difficult to see, for example, how one would describe the precise conditions that would trigger transfers in the case of non-disclosure and non-competition agreements.

For these reasons, other legal institutions would surely be valuable in a number of worlds. I hope that legal scholars will join me in attempting to describe how they might be constructed. I also hope software developers will examine whether this system of contracts might be implemented in Second Life or other worlds to assist the business that is conducted there.

Comprehensive Business Reporting Systems

Underlying every virtual world is a database that includes all of the software-relevant information about the world's actors, goods, authorities, contracts, production functions, and other world assets. A virtual world for studying real business would need to provide methods for reporting that data in meaningful ways to help participants make smart inworld decisions, to help educators assess participant (student) performance, and to help researchers draw conclusions about their topics of study.

Why accounting is harder than any other field of business

In this section I take the first steps toward describing some business reporting considerations for a virtual world. My discussion reflects a basic truth that won't surprise accountants: it isn't easy to create an economy (with actors, goods, production functions, and commerce), but it is far harder to describe the state and performance of the economy in summary terms that people can understand. As accounting provides the "language of business," this means that accounting is harder than economics, finance, operations, and all other disciplines required to create the economy.

To see the validity of my grand claims for accounting, let us examine the most basic decisions that accountants would have to make for a typical business transaction. Assume that one actor (call him Sellers) owns a machine with a long-term and probabilistic production function. Sellers must put $10 into the machine every day for 100 days, in return for a 20% chance that the machine will produce a left-handed widget at the end of the last day. Another party (call her Beyers) has contracted to purchase the good for $10,000 from Sellers, if it is successfully produced. (If the good is not produced, no transaction takes place.) Sellers has contracted to lease a left-handed widget to a third party for 8 years at a cost of $3,000 per year, at which point the good is expected to be worthless. Beyers' contract with the third party is not conditional on Sellers' successful production; if Sellers does not deliver the good, Beyers will have to find another source.

Now, assume 60 days into Sellers' production process (so the widget will not appear for another 40 days if production is successful), we wish to create meaningful descriptions of Beyers' and Sellers' business situations. At that date, accountants would have to describe the states of each business in a balance sheet that captures the assets and liabilities of the business (with the difference, net assets, reflecting the equity of the owner), and the performance of each business in income statements over the 60 days (revenue and expenses, with the difference, net income, equaling the change in net assets). Thus, accountants would need to answer the following questions:

- What should Sellers report as income for the 60 days of production? On the one hand, Sellers has not received any cash, and has no assurance that production will be successful. On the other hand, every day of production increases the expected value of receiving a payoff.
- If you conclude that Sellers should report income, either his assets must have risen or his liabilities have fallen (because net income equals the change in net assets). Has the widget machine increased in value, or should Sellers report a new asset (inventory) that doesn't yet and may never exist? Does Sellers have any liability, even though he owes Beyers nothing if production is unsuccessful? Also, if Beyers has income, he must have revenue—even though he has received nothing of value over the 60 days.
- What should Beyers report as income for the 60 days of production? Beyers hasn't done any work at all, and hasn't received anything of value. However, every day of Sellers' production increases the probability that Beyers will be able to profit from the leasing agreement.
- If you conclude that Beyers should report income, what assets does she have that have increased in value? Also, how should Beyers report the obligation to provide the widget to the third party, which she must purchase from another source if Sellers' production is unsuccessful?

These are not easy questions—even members of the Financial Accounting Standards Board, which sets accounting standards for the US, would probably disagree on the best answers.

To this point, I have simply presupposed that summarizing the state and performance of a business in accounting terms is a useful exercise. To determine when this is so, and why doing so is difficult, I divide my analysis into two parts. The first discusses issues arising when decision-makers devise their own reports to assist their own decision-making (internal reporting). The second discusses the far more difficult issues that arise when decision-makers must rely on other parties' reports (external reporting).

Internal Reporting

The purpose of business reports is to aid decision-making. When I teach internal reporting to MBA and executive MBA students, I begin each course and each case study with the following four questions:

1. What decisions must our business make wisely in order to succeed?
2. What information must we have in order to make those decisions wisely?
3. What report will convey that information in a meaningful way?
4. What business reporting system will produce those reports in the ordinary course of its operations?

Some decisions can be aided with relatively simple reports. For example, assume Beyers' decision is simply whether to agree to the contract with Sellers, which requires attempting to produce a left-handed widget under the terms described above. The information useful to make such a decision would include the cost of production ($1,000), the expected revenue of $2,000, the time value of money (the cash is spent early, and the payoff is received late) and the risk (there is an 80% chance of no payoff). It is straightforward to incorporate these features into a report that will assist the actor in making an intelligent decision.

What business reporting system would produce useful internal reports in the ordinary course of its operations, without excessive human intervention? Unlike the real world, the virtual world is likely to provide all relevant information in objective, machine-readable form. As a result, the likely solution would be a "reporting script" that culls data over which the participant has information authority, and then presents that data in the form of a meaningful report (probably using some combination of SQL queries and XML).

Despite the technical feasibility of a reporting script, challenges quickly become apparent. Because participants in a virtual world will be making so many different decisions, the world will need to support a variety of reports capturing information relevant to those decisions. Even for a single decision, instructors, textbook authors, researchers and participants will disagree on the appropriate report form, and would therefore require different reporting scripts.[7] Moreover, it isn't clear how robust reporting scripts could be. A script that generates figure 3 would probably be able to generate meaningful reports even with different assumptions about the daily cost of widget production, the number of days required, and sales price. However, the script would probably need to be altered to handle even slight changes in the production function

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[7] Textbook authors and publishers are likely to want reports that integrate seamlessly with their textbooks. For example, there would presumably be a different set of newsvendor reports for each textbook on supply chain management, each designed to match, as precisely as possible, the format used in the text.

(for example, the addition of a fixed cost) or contract terms (an upfront payment by Beyers plus a weekly royalty). Either scripting would need to be easy enough for participants to modify reporting scripts themselves, or a library of scripts would need to be sufficiently complete and well-documented that participants could easily find the script that would be appropriate for a given decision.

External Reporting

While a robust and largely automated system for internal reporting is difficult, such a system for external reporting may well be impossible. Internal reporting requires a script that summarizes the information available to Sellers in a way that helps him make a better decision. External reporting requires a script that summarizes the information available to sellers in a way that helps a third party make a better decision. For example, the script might need to help Sellers' employer determine whether Sellers determines a raise, to help Sellers' banker determine whether Sellers deserves a loan, or to help an equity investor determine the value of Sellers' business.

Because these are different decisions, they may require different scripts. But more importantly, each decision requires a script that converts detailed private information into summary items that have a meaning that is shared among all participants. These terms would probably include, but won't be not limited to, standard accounting terms like asset, liability, revenue, expense and so on. Thus, external reporting requires a considerable institutional structure:

- **An ontology** that describes the fundamental meaning of the key terms used in to describe the underlying economic reality;
- **Reporting standards** that convert facts into terms defined by the reporting ontology;
- **An assurance mechanism** that allows those receiving external reports to trust that they implement the reporting standards appropriately.

Ontology has presented real-world accounts with nearly insurmountable problem. The FASB and IASB have debated the meaning of the terms "asset" and "liability" for some time with little evidence of progress. Ontology is arguably easier in virtual worlds than in the real world, because the virtual world rests upon a database that stores all information about the state of the world (including actors, goods, their attributes, rights and obligations). However, the database is not complete. Many business arrangements may be informal, and result in rights and obligations understood by the parties but not recorded by the database (because they are not software-enforced contracts). Moreover, the reporter may not have information rights to all items in the database that are needed to describe their situation.

Assurance is considerably easier than in the real world, because a reporter like Sellers could transfer all his information authorities to an auditor, who could verify the fundamental information.

However, reporting standards pose a difficult problem. Accountants often distinguish between "principle-based" and "rule-based" standards. Principle-based standards spell out fairly general goals in how facts should be mapped into accounting terms. For example, a principle on lease accounting might state that "a lessee should report the leased item as an asset as long as

they are receiving substantially all of the ownership rights to the item, and are exposed to substantially off of the risks of ownership." In contrast, the FASB's current rule-based standard for leasing states that a firm leasing an item should report it as an asset if four mechanical calculations are satisfied (for example, the length of the least term is more than 75% of the useful life of the asset).

Grimmelman (2005) has noted that software-enforced laws are, by necessity, rule-based (even though those rules can be extremely complicated, and possibly not even understood by any one individual). However, accountants have confronted serious problems with rule-based standards because they are so easily distorted by contracting innovations that exploit the precision of the rules. For example, Merrill Lynch has created a "master lease" program that allows firms to lease items under terms that appear to violate lease-reporting principles, but stay just within the bright-line rules specified by accounting standards (Reilly 2007).

Is it possible to create a robust system for business reporting without too much human oversight? To this accountant, financial reporting seems to be the most difficult feature discussed in this document. This may reflect the inherent difficulties of accounting, or may simply reflect the fact that accounting requires a complete description of the other elements of the economy, which have not been fully developed.

Conclusion

This paper envisions a virtual world appropriate for education and research on real-world business. My goal in this paper has been to sketch out the motivation for such a platform, and describe some of its essential features. However, incorporating business-oriented content into a world still remains a formidable endeavor.

Since I began exploring virtual worlds in late 2006, available technology has expanded considerably. It may be possible to adapt off-the-shelf worlds (including enterprise versions of Second Life, currently in development) to such a purpose. Alternatively, residents of Second Life could embed some of the features described here into their own content in the public world.

I hope that educators and researchers, working with virtual world developers and perhaps textbook publishers, will find the will and the funding to tackle such a project. Anyone interested in pursuing a 'World of Bizcraft' or similar platform is encouraged to contact the author.

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