DESIGN IN A VIRTUAL INNOVATION ECOLOGY:

A Cybernetic Systems Approach to Knowledge Creation and Design Collaboration in Second Life

by

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ABSTRACT

Design innovation makes a substantial contribution to the global economy, however there is a challenge to modern design praxis as design teams face difficulties when it comes to collaborators who are geographically distributed and unable to easily meet face to face in a physical context. This research undertook to interpret the knowledge creation life cycle of design innovation, and adopted a second-order cybernetic approach to describe the design process in the virtual world Second Life (SL). The researcher applied a cyber-ethnographic methodology to collect a bricolage of evidence in SL including observations; interviews; blogs; surveys; and conversations 'in-world'. The research considered three case studies of groups in SL: Sloodlers, Studio Wikiitecture, and *Design 2029* – The End Game. Three models were proposed to help describe cybernetic regulation of the design innovation ecology in SL: the spectrum of fidelity; indosymbiosis; and Lessig's four modalities of cybernetic knowledge regulation. The first two of these were developed specifically for this research. In addition, a design innovation organism or 'inogism' was proposed using a biological metaphor to describe the design innovation ecology in SL. The primary research question considered how Lessig's four modes of architecture, the law, the market, and norms all interact to affect the design ecology within SL. The secondary research questions considered how tacit knowledge creation and design collaboration could be inhibited or enabled through simulated face-to-face meetings. This research describes how the virtual ecology of SL can enable tacit knowledge creation and design collaboration and therefore contribute towards improved design innovation. It also suggests future research opportunities that could assist innovative design outcomes in other virtual worlds.

GLOSSARY

AI	Artificial Intelligence
ALS	Alliance of Library Services
API	Application Programming Interface
avatar	A graphical representation of a person or artificial intelligence in a virtual environment
BSD	Berkley Software Distribution license
CAS	Complex Adaptive System
CC	Creative Commons
cyborg	A cybernetic organism
DLF	Design Led Futures
DMCA	Digital Millennium Copyright Act 1998 (US)
DRM	Digital Rights Management
EFF	Electronic Freedom Foundation
EULA	End User License Agreement
freebie	A virtual object that is priced at $L0 or $L1
General AI	The ability to perform general intelligent actions.
GNU	GNU not Unix; a 'free software' operating system
GPL	General Public License
griefer	A SL subscriber who causes problems for others or causes problems with the running of SL
GRIN	Genetics, Robotics, IT, and Nanotechnology
GUI	Graphic User Interface
HUD	Heads Up Display
ICT	Information Communications Technology
IM	Instant Messaging
indosymbiosis	The life cycle of a design innovation organism, or inogism
inogism	A design innovation organism
in-world	In the virtual world, SL
IP	Intellectual property
IPD	Interpersonal Distance
IT	Information Technology
KM	Knowledge Management
Lindens	The name of avatars who work for Linden Lab
lindens	The currency in SL
LSL	Linden Scripting Language, the script programming language in SL
machinima	Machine + Cinema. Movie making using the 3D engine of a virtual world or game

MediaZone	A virtual island owned by the School of Design at Victoria University of Wellington, New Zealand
metaverse	Coined by author Neal Stephenson in the book *Snow Crash* (1992). Often used in to refer to the virtual world of SL
MMORPG	Sometimes shortened to MMO, Massively Multiplayer Online Role Playing Game
MOO	MUD Object Oriented
Moodle	Modular Object-Oriented Dynamic Learning Enivornment
MUD	Multi User Dungeons, or Multi User Domains
MUVE	Multi User Virtual Enivronment
noob	A cyborg, or person who is new to SL
notecard	A text file with SL
NZSG	Non-Zero-Sum Gaze
prim	A primitive shape used in 3D building in SL
resident	A cyborg in SL. Someone who has subscribed to SL in the virtual world
rez	Originally from the Sci Fi movie Tron (1982). Used in SL to describe the real-time rendering of a 3D object
RL	Real Life
sandbox	An area within SL that allows cyborgs to freely experiment with 3D designs and building
SECI	Model developed by Nonaka (1995). Socialisation; Externalisation; Combination; Internalisation
SET	Serial Endosymbiosis Theory
sim	Simulator, or server that hosts land in SL
SL	Second Life
Sloodle	Simulated Linked Object Oriented Dynamic Learning Environment.
Sloodler	A Sloodle group in SL
teleport	A feature in SL that allows fast transport to another part of the virtual world
teleporter	An interactive object that will teleport a cyborg to a new location
text chat	Communication in SL using text
TOS	Terms of Service
TSI	Transformed Social Interaction
VE	Virtual Environment
WELL	Whole Earth 'Lectronic Link, an early online virtual community
WikiTree	A 3D tool for collaborative building used by Studio Wikitecture for group design of architecture
WOW	*World of Warcraft*
X Street	Official SL website for buying and selling virtual objects and scripts

CHAPTER 1
1. INTRODUCTION

1.1. Background

Prior to the commencement of this thesis the researcher had spent 20 years in the screen industry, and ten years researching virtual reality (VR) as an entertainment and knowledge sharing technology. In screen post-production it had become apparent that there were difficulties with respect to international creative collaboration related to both practical technical issues and to copyright ownership difficulties; Creative Commons suggested one possible solution. Creative Commons is a charitable trust founded by Lessig and others to encourage artists and designers to share their creations and to encourage collaboration and remixing. It is a non-profit organisation that provides a flexible, simple means to identify the owner, rights and user guidelines of digital content use (www.creativecommons.org). The researcher’s discovery of the existence of Second Life (SL) in 2006 suggested new technologies that could facilitate international knowledge sharing and creative collaboration. This thesis grew out of an awareness of a new online area of social, and creative, opportunities that had not been fully explored in professional design and academic research.

1.2. The objective of the study

The purpose of this study is to gain a better understanding of the design innovation ecology within the virtual world SL. A review of the literature has identified a number of research questions related to design innovation, and the unique experiences of designers collaborating in virtual worlds. Using an ethnographic methodology, this research seeks to use case studies to understand how to design a virtual innovation ecology. It also considers the concomitant issues related to knowledge creation and design collaboration in SL.

The case study *Design 2029* – The End Game (hereafter *Design 2029*) provided a central research objective around which to organise and understand two other cyber-ethnographic case studies in SL. In a recursive way *Design 2029* provided a design objective and a case study. It was created for this research, but also heavily relies upon existing design initiatives in SL. *Design 2029* illustrated how design innovation can be regulated, and experienced inhibiters that prevented it from becoming a design innovation. *Design 2029* was comprised of two sub-groups related to the game's development and administration: they were *Design 2029* – The Guardians; and *Design 2029* – Dark Forces. These sub-groups were subsumed under *Design 2029* and form one unit of analysis. The two other case studies, Sloodlers, and Studio Wikitecture provided a rich source of evidence for the regulation of the design innovation ecology and were considered separately, and with reference to, *Design 2029*. In order to gather as much evidence as possible this research was not confined to these three case studies but accepted data from a bricolage of sources.

1.3. Research questions

The primary research question for this thesis is:

- How to design a virtual innovation ecology in SL?

There are two important sub-questions related to this:

- What enables knowledge creation during design innovation in SL?
- What enables creative collaboration amongst designers in SL?

Design 2029 was specifically created to challenge the primary research question. Together with the two other case studies, Sloodlers and Studio Wikitecture, this case study provided research to understand how designers in SL worked together to pursue the objective of design innovation.

1.4. The problem

If we consider virtual worlds as a sub-set of the Internet, the hundreds of millions of people who have or have had a presence in a virtual world are an extension of what Manuel Castells (2000) regards as the 'rise of the network society'. This can in turn be explained in cybernetic terms if the knowledge economy is considered as a 'superorganism', or 'global brain' that requires an ever increasing amount of information and knowledge delivered at an accelerating pace in order to maintain its evolutionary homeothetic trajectory (Heylighen, 2008; Kurzweil, 2005; Margulis & Sagan, 1997; Maturana & Varela, 1992).

Within the global knowledge ecology a positive feedback response keeps accelerating the rate of change, and demanding resources to supply the insatiable demand for ‘just in time’ solutions and innovations in order to survive (Heylighen, 2008; Highsmith, 2004; Kurzweil, 2005). Virtual worlds can be viewed through this evolutionary lens as a solution to demands for greater communications, and for knowledge sharing between culturally diverse participants. They can also meet the need to synchronise with the pace of accelerating change (Heylighen, 2008; Johansson, 2004; Kurzweil, 2005; Ondrejka, 2008; Salen, 2008). The synchronisation of design solutions with the pace of change is necessary to fulfill the requirement of the definition of innovation. This implies that an innovation must be neither too early nor too late for the user to find it useful. In other words, the timing of an innovation is crucial, and so a design innovation must synchronise with the pace of change (Hunter, 2008; Kurzweil, 2005).

Whether one accepts Thomas Friedman’s (2006) argument that globalisation is making the world flat, or Richard Florida’s (2002, 2005) that it is becoming spiky due to the flight of the creative class to conducive cities, both commentators acknowledge the role of the Internet in connecting networks of like-minded people. The pressures of globalisation and the mobility of creative individuals are starting to be felt as home workers and virtual office employees are feeling alienated and disconnected due to virtualisation (Shields, 2003). Companies such as IBM, and Sun Microsystems have begun to look for solutions to what they predict will be a problem, as well as an opportunity, for a globally dispersed workforce that no longer shares a physical presence (IBM, 2008; Reeves & Read, 2009; Yankelovich, 2007).

From the outset virtual worlds have been defined by their social nature, whether they support gaming or are community oriented, or whether they are a text-based Multi User Dungeons (MUD), or a 3D graphical interface like Active Worlds or SL (Bartle, 2004; Dibbell, 1998; Panteli, 2009; Rheingold, 1993; Schroeder, 2002; T.L.Taylor, 2006). However, according to Malaby (2009) the founders of SL were surprised by the social characteristics of the virtual world; their own ‘technoliberalism’ had focused on the creative potential of the individual more than the social ecology.

Technology is not self-deterministic but evolves through social interaction (Heylighen, 2008; Hine, 2000, 2005; Hippel, 2005). The evolution of technology can be understood as a complex adaptive system in which lead users, market forces, and physical environments, to name but a few, create an emergent ecology, and social interplay is at the centre of that evolutionary innovation (Heylighen, 2008; Hine, 2000, 2005; Hippel, 2005; Hussi, 2003; Von Krogh, Nonaka, & Ichijo, 2000). It is therefore possible to see the very rise of virtual worlds, of ‘wikinomics’, or mass collaboration, and of collective intelligence as a cybernetic response to a demand for improved communication channels, and a way to cope with the rate of change (Sunstein, 2006; Surowiecki, 2004; Tapscott & Williams, 2006).

The problems with globalisation and the trend towards the virtualisation of the design studios have encouraged a demand for simulations that can substitute for the channels of communications that are being lost, such as face-to-face meetings and tacit knowledge sharing (Dixon, 2000; Farshchian, 2003; Rive, Thomassen, Lyons, & Billinghurst, 2008; Shirky, 2008; Von Krogh et al., 2000). The early virtual communities, such as the 1985 text-based WELL (Whole Earth ’Lectronic Link), augmented their online connections with physical ‘meet-ups’ that helped to strengthen trust and increase tacit understanding (Rheingold, 1993). It is suggested that the population size of today’s virtual worlds is so large that it is quite possible that creative collaborators may never meet face to face. This suggests that virtual worlds need to simulate these experiences in order to benefit from what is experienced in a face-to-face meeting (Rive et al., 2008; Schroeder, 2002).

There is ample documentation of ‘masquerading’ and experimentation with digital identities in virtual worlds to suggest that trust is a fragile concept, and yet the large numbers of Internet romances as well as business partnerships online would also suggest that trust is surprisingly quickly gained, as well as lost (Au, 2008; Bartle, 2004; Boellstorff, 2008; Guest, 2007; Meadows, 2008; Reeves & Read, 2009). Trust is a major component of creative collaboration, and so in order for SL to be a successful design innovation ecology it will require ways to increase trust, tacit knowledge sharing and simulation of face-to-face meetings (Lin, 2001; Reeves & Read, 2009; Rive et al., 2008; Von Krogh et al., 2000). That trust can take the form of trust in the integrity and performance of the SL platform, and the company that runs it, as well as the ability of the law to uphold legal challenges to individuals’ copyright claims (Lessig, 2006).

Consider the example of a designer who would like to work on a design with other designers in SL. The designer could be risking their intellectual property (IP); their reputation; their time spent on the project; and other resources necessary to complete the design. In order to trust their design collaborators they must be reassured that the risks to these assets are at least lower than the potential gains from their collaboration. In SL a designer could be reassured if another avatar has an established reputation for professionalism and design. The longer an individual has invested in SL, and their avatar, the less likely they are to jeopardise that reputation by betraying trust. However, it is still relatively easy to create a new avatar and transfer assets from one avatar to another, and so trust can be challenged when the stakes rise. The significant communication bandwidth of physical presence is a challenge to SL, which is still unable to simulate all sensory receptors, and has a way to go before the simulation is indistinguishable from the actual (Rive et al., 2008).

Design innovation is a significant component of the knowledge economy, however organisations are facing the challenge of managing distributed design teams who must form strong bonds of trust, and easily share knowledge resources in order to achieve design innovation together (Dixon, 2000; Mau, Leonard, & Institute without Boundaries, 2004; Ondrejka, 2008; Reeves &

Read, 2009; Teece, 2000; Von Krogh et al., 2000). The massive amounts of user-generated content happening in SL suggests that it could be a fruitful area to explore how virtual worlds can support a design innovation ecology in the future (Ondrejka, 2006, 2008; Panteli, 2009; Tapscott & Williams, 2006).

Another challenge for professional designers is the rise of the amateur, and the threat of general and specific artificial intelligence (AI) that is beginning to encroach on their domain, and while this may even be beneficial to design innovation, virtual worlds are both a threat and an opportunity for the future of design practice and education (Goertzel, 2007; Howe, 2008; Leadbeater, 2000; Ondrejka, 2006, 2008; Tapscott & Williams, 2006; T.L.Taylor, 2006). It remains to be seen if ‘wikinomics’ can supplant formal design education and practice, however the open nature of innovation in SL, the self-organising features, and the complex adaptive system of this ecology suggest that there are positive lessons to be learned from this research (Bryan & Joyce, 2007; Chesbrough, 2003; Hamel, 2007; Tapscott & Williams, 2006).

1.5. The importance of design innovation

There is almost no field of endeavour that has remained untouched by design and design principles; whether it is in the field of human biology, Information Technology (IT) or production design for movies, design can be found almost everywhere (Mau et al., 2004). At the same time that design is having a profound impact on the world, it is also becoming increasingly hidden from view, virtual – often design is purely conceptual – and can be carried out at scales beyond human perception (using nanotechnology) (Hall, 2005; Highsmith, 2004; Mau et al., 2004; Sterling, 2005; M.C. Taylor, 1997).

In the area of IT, the virtual is becoming the real, and the real is becoming virtual; hardware is becoming software, and software is becoming hardware, and these states are no longer fixed but continually in transition, sliding backwards and forwards in a constant state of flux (Hall, 2005; Kurzweil, 2005; Mau et al., 2004; Sterling, 2005; M.C. Taylor, 1997). This represents a significant evolutionary shift in design, as designers grapple with the definition of ‘reality’ and the ethical questions of participatory design, as well as the definitions of human, human interface, and a global ecological worldview (Garreau, 2005; Kurzweil, 2005; Kurzweil & Grossman, 2004; Mau et al., 2004; Sterling, 2005; M.C. Taylor, 1997). A designer who uses computing to complete their design can be seen as merging with the machine to become a cyborg, a cybernetic organism, and within SL the designer becomes an avatar: part human; part machine; part network; a resident cyborg (Garreau, 2005; Grau, 2003; Haraway, 1992).

Not only is design at the intersection of these profound philosophical questions, it also sits at the hub of the so-called ‘knowledge economy’ as a driver of innovation and a determinant of evolutionary change (Kurzweil, 2005; Peters, 1997; Porat & Rubin, 1977; Stewart, 2001; Teece, 2000). Increasingly, all perceived value is determined by IP and design as the cost of material resources rapidly becomes inconsequential and the largest component of market value of the products, organisations and services is intangible or virtual (Drexler, 1986; Kurzweil, 2005; Lessig, 2001, 2006; Mau et al., 2004; Stewart, 2001). The realisation that intangible assets make up the biggest component of value in almost any area of analysis has created an uneasy tension in the global economy, as vested interests work hard to protect their political and economic privileges (Brand, 1988; Lessig, 2001, 2004, 2006; Mau et al., 2004; Turner, 2006). In the knowledge economy, where all value resides in knowledge, the creation of that knowledge and its market exchange become a crucial battlefield (Lessig, 2001, 2004; Mau et al., 2004). If the basis of all value in the economy is knowledge, and that becomes ‘free’, then it is likely to result in a revolutionary cultural paradigm (Lessig, 2004; Mau et al., 2004).

The old industrial paradigms of atomistic production are threatened by ‘free culture’, open source, and ‘rip, mix, and burn’ (Brand, 1988; Bruns, 2008; Lessig, 2008; Turner, 2006). The designer was reaching the heady heights of international acclaim at the end of the 20th century but a subversive cultural revolution in participatory design and democratic innovation has since taken place (Chesbrough, 2003; Hippel, 2005; Leadbeater, 2000; Sanoff, 1990; Tapscott & Williams, 2006). This revolution is popularly known by these various names: crowdsourcing; open innovation; wikinomics; and collective intelligence, and what these terms all imply is that professional designers are under threat from the collective of ‘prosumer’ designers who have little or no formal training, or from freelancers working outside formal company structures (Bruns, 2008; Bryan & Joyce, 2007; Chesbrough, 2003; Hamel, 2007; Hippel, 2005; Howe, 2008; Leadbeater, 2008; Surowiecki, 2004; Tapscott & Williams, 2006; Toffler, 1980). Designers, design schools, and design companies are beginning to sense the threat to their professional existence as amateurs enter into design helped by globalisation, the Internet, and inexpensive digital design tools. The size of the design sector in the knowledge economy is immense, and includes everything from the aerospace industry, the pharmaceutical industry, product design, and the screen production business, to name just a handful of areas that are heavily dependent on professional design. This implies massive change that demands close scrutiny (Mau et al., 2004). Can collective ‘prosumer’ design really improve on professional designers, and if so how will future design innovations happen? Design by its very nature is closely linked to forward planning, future scenarios, and normative problem solving that assumes the designer can find a ‘better’ way; an innovative solution. Together design and innovation shape much of the dynamics of the ‘knowledge economy’. In SL, the virtual world is almost entirely built by amateurs and designers who are not working for the SL development company Linden Lab.

A number of commentators have said that these are exponential times, and the technologist Ray Kurzweil (2005) talks of the ‘law of accelerating returns’. Kurzweil attempted to predict future design innovations by using sophisticated trend analysis to help design technology anticipate future needs and market expectations (Kurzweil, 2005). In the cybernetic context, Francis Heylighen (2008) identifies an evolutionary reduction of friction: ‘As a consequence, ever more results can be achieved with ever fewer resources’ (p. 305). General AI, or general intelligent activity that associates with consciousness, sentience, and self awareness, is expected to become commonplace within the next ten years, and the first experiences of this type of AI, which threatens to displace many knowledge workers, has been predicted to happen in virtual worlds such as SL (Garreau, 2005; Goertzel, 2007; Kurzweil, 2005; Moon, 2008).

Virtual worlds, game design, and social networks have become large business, involving hundreds of millions of people and billions of dollars (Bartle, 2004; Castronova, 2005, 2007; Tapscott & Williams, 2006). The economist Edward Castronova (2007) has even predicted an exodus to virtual worlds based on the theory that they can be more fun than physical reality. The number of people who use virtual worlds as a part of their working life, as well as their entertainment, is predicted to dramatically increase as interoperability between virtual worlds improves; as closer integration with the web develops; and full sensory immersion improves a sense of presence (Cascio & Paffendorf, 2007; Garreau, 2005; Gartner, 2007; Kurzweil, 2005).

In a cybernetic feedback loop, two large trends – globalisation and the virtualisation of the office – are being helped and simultaneously caused by virtual world technology and remote presence concepts (Friedman, 2006; Shields, 2003). Design is no longer a solitary role, performed in one physical location, but requires designers to work in virtual teams across multiple time zones (Highsmith, 2004; Mau et al., 2004; Ondrejka, 2008; Suri & IDEO, 2005). Virtual worlds such as SL are becoming important tools for managing synchronous, creative collaboration, and design innovation projects. SL has attracted a large amount of media, academic and business attention and yet despite the vital importance of design innovation, and the questions around what enables and limits knowledge creation in this virtual world, there is very little evidence of research into this important area (Au, 2008; Bennett & Beith, 2007; Boellstorff, 2008, 2009; Malaby, 2009; Ondrejka, 2008; Salen, 2008).

1.6. Research design

This section outlines the significance of ethnography and cybernetics to the research design. Ethnography is a qualitative research approach that has typically been applied to human societies and cultures with its origins in anthropology. It can be differentiated from cyber-ethnography as this qualitative approach is further extended into the study of online Internet culture. Ethnography is an accepted and commonly practised method of researching the Internet, and more specifically, virtual worlds (Boellstorff, 2009; Dumitrica & Gaden, 2009; Hine, 2005; Malaby, 2009; Rybas & Gajjala, 2007; Taylor, T.L., 2006). Typically, the researcher immerses themselves in the culture of the virtual world using participant observation, as recommended by Rybas & Gajjala (2007) and described by them as the 'epistemology of doing'. Modern ethnography and cybernetics shared early origins through the works of cybernetic anthropologists Margaret Mead, and Grerogy Bateson and their connection with the Macy Conferences (Turner, 2006).

The application of ethnography to virtual communities has been called by a number of names: cyber-ethnography; virtual ethnography; and netnography (Boellstorff, 2009; Hine, 2000, 2005; Kozinets, 2002; Rybas & Gajjala, 2007). In cyber-ethnography the concept of community is seen by some as problematic because it is not easily defined and is not fixed in one place; it can be loose and transitory, and implies a romantic sociological tradition that imagines a positive, unalienated communal living (Guimaraes, 2005). In an introduction to the *Cybersociology Magazine*, Hamman (1997) quotes a paper that provides 94 different definitions for community. Hamman compiled a set of necessary conditions to define a loose group, or community, in cyberspace.

> The sociological term community should be understood here as meaning (1) a group of people (2) who share social interaction (3) and some common ties between themselves and the other members of the group (4) and share an area of interest at least some of the time. (Hamman, 1997, cited in Guimaraes, 2005, p. 146).

Ethnography is now well recognised as a legitimate research tool for cyberspace, despite some researchers such as Castronova (2007) dismissing this qualitative approach in favour of a more quantitative analysis (Boellstorff, 2009). This competitive belief that one approach could be better than another stems from a bias founded on the mistaken understanding of both ‘reality’ and scientific method (Beckett, 2007; Boellstorff, 2009; Maturana & Varela, 1992; B.R. Wilson, 1970). In *Virtual Ethnography*, Hine (2000) discusses how the dichotomy of the real and the virtual, or offline and online, is assumed by ethnographic researchers of the Internet. In this thesis it is argued that this is a false dichotomy that has led to a confused methodology that hides this assumption despite utilising an ethnographic approach that emphasises context, subjectivity, and the participant observation of the researcher. This is surprising given the impact that second-order cybernetic anthropologists such as Mead and Bateson have had on the field of ethnography, and the emphasis placed on the inability of an anthropologist to remove themselves from the scene of their research (Bateson & Donaldson, 1991; Denzin, 1997). The virtual ethnographer who assumes this dichotomy finds themselves in the uncomfortable position of having to argue with their informants about the nature of reality, when their informants spend much of their waking hours in the virtual world and claim it is more real than the real. The informants in the virtual world the Palace told the ethnographer that they were all ‘quite sure about the “reality” of the feelings and personal relationships developed in cyberspace’ (Guimaraes, 2005, p. 145). Guimaraes settled for the dichotomy of online/offline as spheres of interaction, however, he acknowledges that this is also a blurred boundary. He quotes Watson, who wrote that many users do not regard their online presence as ‘not real’. Watson explains: ‘My experience has been that people in the off-line world tend to see on-line communities as virtual, but that participants in the on-line communities see them as quite real’ (Watson, cited in Guimaraes, 2005, p. 145).

Turner, in his history of the technological counterculture which focuses on the Whole Earth Catalog published by Stewart Brand, has convincingly traced the historical precedence of the foundations of cybernetic theory from Norbet Wiener to the present day ideology of 'Californian capitalism' that has shaped SL (Boellstorff, 2008; Malaby, 2009; Turner, 2006). The original cybernetic concepts such as feedback; human–machine interface; and control that were conceived by the likes of Wiener (1954, 1961) and others evolved into second-order cybernetics – which was developed by ethnographic anthropologists such as Bateson and Donaldson (1991) and epistemological biologists like Maturana and Varela (1992) – and the systems theory of Bertalanffy (1979). In this thesis the researcher found little evidence of explicit application of second-order cybernetics to design theory, with the exception of Thomassen's (2003) work on flow and feedback with reference to graphic user interface (GUI) design in web-based applications.

Turner (2006) explained how the likes of Kevin Kelly (1994) and Stewart Brand (1988) came to shape the thinking around the Internet and Silicon Valley. Their biological variations were based on the original mechanistic metaphors of Wiener's cybernetic control. SL was therefore created in the Silicon Valley milieu that implicitly viewed the Internet in contemporary cybernetic terms as a 'complex adaptive system' which would succeed through bottom-up 'emergent' behaviour, 'self-organisation', and other evolutionary biological metaphors (Au, 2008; Boellstorff, 2008; Hamel, 2007; Johnson, 2001; Malaby, 2009; Turner, 2006). One of the prominent theorists of VR, Michael Heim (1993), also recognised that the history and philosophy of cybernetics were closely entwined: 'Just as the cybernaut can gesture to create or alter objects in a virtual environment, so too the human race now inhabits a world in which almost everything we recognize results from our own doing. VR was born in this cybernetic dimension. From its embryonic stage, VR has been under constant social observation and discussion' (p. xii).

In the ethnographic research of SL to date there have been only passing references to cybernetics, by Au, Boellstorff, and Malaby, and yet cybernetic theory is deeply embedded in their framework, and that of their informants (Au, 2008; Boellstorff, 2008; Malaby, 2009; Turner, 2006). This is not to say that the anthropologists have not acknowledged the influence of cybernetic theory, however much of the theory in their work is implicit rather than explicit, no doubt due to limited time and space in their publications (Au, 2008; Boellstorff, 2008; Malaby, 2009; Turner, 2006). Beginning with the early anthropological work of Mead, and Bateson, there has been an evolution of cybernetic ethnography into cyber-ethnography by the likes of Boellstroff and others as they examine online culture with a similar anthropological toolbox. A number of researchers have found that cyber-ethnography has provided a fruitful approach to SL and examined the constructed meaning of the ‘residents’ from a general anthropological approach (Boellstorff, 2008, 2009; Dumitrica & Gaden, 2009; Malaby, 2009).

Denzin argues that any ethnographic study cannot hope to understand and present a complete and comprehensive analysis of the cultural phenomena under research. With that caveat, this thesis has used a bricolage of evidence to present a fragmentary understanding of how designers approach design innovation in the ecology of the virtual world SL (Denzin, 1997; T.L. Taylor, 2006). According to Denzin and Lincoln (2005), a researcher using this approach is more like a quilt maker or film editor, assembling a montage of diverse images, piecing together new tools and techniques to interpret the scene. The researcher, as a ‘bricoleur’, assumes a role something like that of William Gibson’s (2003) participants in his science fiction novel *Pattern Recognition*, editing together fragments of the scene to be interpreted by the audience, or in this case the reader. Cybernetics is inherently a bricolage approach, as it foregoes a tidy unitary explanation in favour of deeper multi-disciplinary interpretations that Denzin describes as ‘messy’ because it denies the possibility of a grand unified theory.

The application of a cybernetic framework to this ethnographic research is both useful and appropriate as it is implicit in the ideology of the founders of SL and also provides a holistic understanding of the ecological dynamics within the design innovation system (Boellstorff, 2008; Malaby, 2009; Turner, 2006). In the Literature Review (Chapter 2) and the Theoretical Framework (Chapter 3)there is an attempt to give some context to the history of cybernetics and how it has impacted on the design innovation ecology of SL. Given the primary research question, which enquires into how to design a virtual innovation ecology, and the paucity of literature in the field, an ethnographic approach is likely to provide significant advantages over other approaches such as grounded theory (Creswell, 2009). Atkinson and Hammersley outline the features of ethnographic research:

> A strong emphasis on exploring the nature of a particular social phenomenon, rather than setting out to test hypotheses on them. A tendency to work primarily with 'unstructured' data, that is, data that have not been coded at the point of data collection in terms of a closed set of analytic categories. Investigation of a small number of cases, perhaps just one case, in detail. Analysis of data that involves explicit interpretation of the meanings and functions of human actions, the product of which mainly takes the form of verbal descriptions and explanations, with quantification and statistical analysis playing a subordinate role at most. (cited by Flick, 2006, p. 228)

According to Creswell, case studies and ethnographic research involves a detailed description of the environment and the individual informants followed by an analysis of the data. Creswell (2009) and Yin (2009) advise that a qualitative case study is appropriate when the researcher is looking for answers to 'how' and 'why' a social or cultural meaning is constructed and the boundaries between the phenomenon and the context are not clear. In areas of social research that are relatively new and without a significant body of literature, Creswell suggests that an ethnographic strategy, which helps to make the 'strange familiar and the familiar strange', is an appropriate means of qualitative research.

This research has assumed an ethnographic methodology examining innovation in SL from a design perspective as the field is still comparatively young, and a qualitative cybernetic approach has been identified as an interpretive means of understanding the behaviour and attitudes of the designer ecology. Ethnography provides the researcher with the tools and framework to interpret the culture of designers in SL and their unique language, attitudes and behaviours using fieldwork, interviews and documentation (Denzin, 1997). A second-order cybernetic approach applies an ecological system methodology that can reveal how knowledge flow reacts to positive and negative feedback within the virtual world. Biological metaphors and multi-disciplinary insights can assist the cybernetic interpretation of creative collaboration and the active creation of knowledge leading to innovation in SL.

1.7. The limitations of the research design

All research faces design constraints based on limited time and resources and this study is no different (Flick, 2006). In order to pragmatically manage the scope of this cyber-ethnographic research the study has adopted an instrumental collective case study approach as recommended by Sayre (2001) and Stake (2005). The units of analysis are bounded by their virtual communities, although the groups in SL are not static and design innovation happens in almost all areas of the virtual world. Making ethnography the primary research approach allows the study to extend beyond the case studies where other pertinent data can be pulled in as supporting evidence from a bricolage of sources, similar to the case study triangulation in studies by Hine (2000), Sayre (2001), T.L.Taylor (2006) and Yin (2009). The entire SL ecology is therefore opened up as a resource for ethnographic interpretation in relation to the research questions of this study.

Over the past four years the researcher has carried out participant observation of a diverse array of design innovation activities in SL. This observation has been augmented with structured and unstructured interviews, focus groups, group conferences, and informal events. The cyber-ethnographic approach is a qualitative methodology that requires the researcher to be aware of their own bias through reflexivity: ‘The qualitative researcher systematically reflects on who he or she is in the inquiry and is sensitive to his or her personal biography and how it shapes the study’ (Creswell, 2009, p. 182). The values of the researcher and their biography are described in an auto-ethnographic narrative in which the ‘personal-self becomes inseparable from the researcher-self’ (p. 182).

There are three overlapping case studies that inform the research and provide a focus for the research questions. They are the three formal groups in SL that have provided the basis for the case studies: *Design 2029*; Sloodlers; and Studio Wikitecture. According to Denzin (1997), there are no ethnographic studies that can pretend to be completely comprehensive, and the inevitable impact of the researcher's subjectivity in a participant observation is an obvious limitation of this study. Time, resources, and the engagement of the informants were also significant constraints. It is quite probable that significant events and experiences related to this research occurred while this researcher was not present in SL. It is also true that the researcher's avatar was only able to be present in one virtual place, at one time, and that the size and extent of design innovation in SL is so enormous that it would not be possible to record and interpret every innovative design that may occur amongst 70,000 concurrent residents 'inworld' at any one time. Because of the co-location and proximity of avatars who are communicating, it is difficult to apply tools such as Social Network Analysis that would assist in understanding the diffusion of innovations through database analytics (Krotoski, Lyons, & Barnett, 2009). The same challenges and the regulators of innovation that have been extensively reported in the literature all apply to this research project and are discussed in more detail throughout this thesis (Hunter, 2008; Hussi, 2003; Lessig, 2001, 2004, 2006, 2008; Von Krogh et al., 2000).

Virtual design has a long history that can be traced back to primitive cave drawings, the frescos of Pompeii, and the perspective paintings of the early Renaissance (Wertheim, 1999). The 20th century saw an increasing interest in virtual design and technology such as VR and artistic immersive experiences dating from as early as the 1900s (Grau, 2003; Ijsselsteijn, 2003; Packer & Jordan, 2001). This extensive history is outside the scope of this study, but belies the impression given by some writers who have focused exclusively on the recent history of virtual worlds from the modern perspective of IT and MMOs (Bartle, 2004; Ondrejka, 2008; T.L.Taylor, 2006). Without retracing the entire history of virtual worlds, it is important to note that these more ancient histories evoke a deeper philosophical connection between the virtual and the wider cultural obsessions of the Judaeo-Christian heritage, hidden in the recent past but barely beneath the surface of popular culture (Heim, 1993; Wertheim, 1999).

1.8. Recent historical examples of virtual world design

A narrow selection of historical examples of virtual worlds will illustrate certain aspects of previous virtual worlds that are pertinent to this study. According to Stewart Brand's (1974) *II Cybernetic Frontiers*, there was an early game that prefigured SL, long before the rise of Benkler's (2006) network culture, Hippel's (2005) lead user innovation, or Lessig's (2004) free culture.

Spacewar! (1962) is one of the earliest known computer games programmed on the DEC PDP-1 and featured an accurate star field. It was conceived and created by the fictitious 'Hingham Institute' at MIT. Brand (1974) wrote of *Spacewar!*:

> It was intensely interactive in real-time with the computer.
>
> It encouraged new programming by the user.
>
> It bonded human and machine through a responsive broadband interface of live graphics display.
>
> It served primarily as a communication device between humans.
>
> It was a game.
>
> It functioned best on standalone equipment (and distributed multiple-user equipment).
>
> It served human interest, not machine. (Spacewar! is trivial to a computer).
>
> It was delightful. (p. 78)

This early graphical game came from the birthplace of cybernetic culture, MIT, and joined hacker culture with early concepts of 'free culture', file sharing, and user-generated content (Levy, 1994). Many historical examples given by writers such as Bartle (2004) emphasise the early virtual worlds that supported games such as MUDs that were designed by Richard Bartle and Roy Trubshaw in 1978 at Essex University. In *Designing Virtual Worlds*, Bartle (2004, p. 58) provided a useful table for understanding the relationship between the designers of virtual worlds, and players, and content. As a pioneer of virtual world design, Bartle expresses his bias towards professional virtual world design, and in his opinion most players are incapable of designing a virtual world, even when they express strong opinions about what players would like to see in those worlds, and complain about how they work. This design philosophy goes beyond aesthetic content, and includes a large list of virtual world design features such as avatars, game physics, code, architecture, in-world economics, rules, and landscape (Bartle, 2004). He goes on to advise that ‘When designers begin work on a new virtual world, the question of who is to own it should be uppermost in their minds. It really does encapsulate the soul of the world’ (p. 60). Bartle explains that his first virtual world, MUD, ‘was originally little more than a series of interconnected locations where you could move and chat’ (T.L. Taylor, 2006, p. 22). Bartle then went on to develop, MUD1, ‘a fantasy environment’, or more specifically a vaguely medieval virtual world game environment. The early work of Bartle and Trubshaw, according to T.L. Taylor, was not only a significant contribution to game design but also marked the beginning of multiuser virtual worlds. The early worlds that were spawned from MUD1 came about largely due to the creators’ open source code ethic and their mostly university-based audiences helped to fuel the growth of multiuser worlds in general. In the history of virtual worlds, TinyMUD is said to be one of the first to allow players to design and build their own virtual objects, and was more interested in world building and socialising than slaying dragons. Created in 1989 by James Aspnes, a Carnegie Mellon student, TinyMUD was a deliberate move away from the ‘hack and slash’ game worlds. It was a text-only multiuser virtual world that served as an important forerunner of MOO (MUD Object Oriented). MOO was released in 1990 by Stephen White and made multiuser world design and user-generated content much easier because object oriented programming made it possible to extend the virtual world by using the modular aspects of the software language, thus enabling virtual building blocks for innovative designs. As a result, ‘The ability of users to learn the language relatively easily and create objects of their own made them particularly popular’ (T.L. Taylor, 2006, p. 23). What was apparent in these text-based virtual worlds, such as LambdaMOO, created by Pavel Curtis, was that many of the issues faced in

SL relating to social or normative phenomena had been experienced by earlier users without sophisticated graphics. Questions of sexuality, violence and governance were all played out in the well-known case of Mr Bungle and the text-only rape in LambdaMOO (Dibbell, 1998).

Another important historical virtual world with bearing on this research and a precursor to SL was *Habitat* (1985), created by Lucasfilm Games in association with Quantum Computing Services. The lead designers of Habitat, Chip Morningstar and Randy Farmer, are credited with first applying the word 'avatar' to the virtual world context and created their virtual world to be open-ended and pluralistic. As T.L.Taylor (2006) describes,

> This system was a significant development in networked virtual worlds. It was one of the first online graphical spaces in which average computer users could fashion for themselves avatars and undertake living in a virtual world. While games did exist in the space, its sense of emergent 'worldness' was foregrounded. (p. 25)

The sociability of virtual worlds had been an important part of their success right from when the very first multiuser virtual world went online and foreshadowed the rise of Castells' (2000) network society over a decade before the Internet went public. The aforementioned WELL, founded in 1985, was one of the earliest examples of a text-only virtual community as described by Howard Rheingold in his book *The Virtual Community* (Rheingold, 1993).

1.9. The growth of virtual worlds

Professional work practice has led to dispersed design teams and international creative collaboration becoming common occurrences that are often missing from design education (Mau et al., 2004; Thomassen & Rive, 2010). New tools that enable trust, creativity and communication in real time are being developed using virtual worlds that will assist in greater international design innovation in the near future (Reeves & Read, 2009; Tapscott & Williams, 2006). Forecasting and predictions are never easy to get right but a sample of a number of forecasts suggests that the population of virtual worlds is set to grow dramatically. In 2007 the Gartner Group predicted that by 2011, 80 percent of all Internet users, or 1.6 billion people will have a presence in a virtual world similar to SL (Gartner, 2007). At the end of 2009 a survey by Kzero (2009) predicted 688 million people would be active in virtual worlds, with 1 billion by 2011 and 1.89 billion by 2013. A new wave of virtual world residents is likely to start showing up soon in adult virtual worlds. The market penetration of existing virtual worlds in the 7-13 age group in North America is currently 70.85%; Western Europe 66.55% and Australasia 78.79%, and given the size of the population in Asia with a current penetration of only 29.06% (Kzero, 2013) it could be predicted that there will be a dramatic increase in virtual world and MMO cyborgs as fast bandwidth and Internet penetration continues to increase in countries such as China and India. One analytics company, Strategic Analytics, has predicted 27 percent growth in virtual worlds participants aged from five to nine years, with the total predicted number growing from 186 million in 2009 to 640 by 2015 ('Virtual Worlds News: Report', 2009). It is difficult to assess the numbers of individual cyborgs in virtual worlds as it is possible to have multiple accounts in multiple virtual worlds, however, the accumulated total of accounts under the age of 25, in the top 15 virtual worlds for the forth quarter of 2011 totaled 1.24 billion with good growth in the user generated content category (Kzero, 2012). Virtual worlds such as the 2.5D Farmville, are now starting to infiltrate social networks like Facebook. Facebook currently has over four hundred million users with fifty percent of users logging on everyday (Facebook Statistics, 2010), and there has been active development of virtual world interfaces for mobile phones. It is very likely that most designers will eventually have some experience of the virtual workplace (Kurzweil, 2005; Shields, 2003; Yankelovich, 2007). Computer gaming is becoming a common entertainment form for adults; the average age of a gamer is 35 and they have been playing for 12 years (Castronova, 2007).

Virtual worlds can be categorised as either gaming or non-gaming; SL, according to the company who developed it, Linden Lab, is not a game (Au, 2008). SL is currently the most popular and dynamic of non-gaming virtual world environments. In the USA alone there are over 500 universities with either a research or educational presence there; according to the official Linden

Lab statistics, at the time of writing there were over a million users in SL in a period of 90 days and at any one time there are 70,000 users in-world together. The SL economy sees over $US1 million traded per day (Linden Lab, 2010). Familiarity with the opportunities and limitations of virtual world environments is likely to become a necessary competency in design in the future.

1.10. The DNA of SL

There is a close ideological resemblance between second-order cybernetics, incubated at Boston's MIT Radiation Lab, and the beliefs of the founding managers and board members of Linden Lab (Boellstorff, 2008; Brand, 1988; Kelly, 1994, 2008; Rheingold, 1993; Turner, 2006). The legendary status of the virtual community of WELL and the virtual world evangelists Brand, Kelly, Rheingold and their friend Mitch Kapor, an investor and original chairman of the Linden Lab board, strongly suggests that cybernetic theory has had a lasting influence on the 'creationist capitalism' of SL (Boellstorff, 2008; Malaby, 2009; Turner, 2006). Cybernetic epistemology made no distinction between pedagogical theory related to a class room and the implications of knowledge creation and innovation in all walks of life (Bateson & Donaldson, 1991). 'Learning is a process of creating knowledge' (Weick, 1991, p. 2) and in SL this knowledge creation, which is a crucial component of design innovation, is related to, but not restricted to, formal education. Linden Lab's first Chief Technology Officer Cory Ondrejka (2008) wrote that business and education can both leverage the power of SL technology using pervasive connections and social networks to learn and teach innovation and entrepreneurial skills:

> Combined with the far lower capital expenses inherent in digital worlds, in *SL* hundreds of thousands of residents try out new roles, learn new skills, and approach learning with a passion and excitement they may not have possessed in school. This *ecology* is creating a new highly trained and flexible workforce not necessarily tied to national, ethnic, racial, or age boundaries. In the past year alone, sixty-five companies employing a total of over 220 people started within *SL* before moving into the real world. This group of *innovators* is leveraging education every day and building skills that also apply to the real world as they manage distributed employees from all over the world. (p. 230)

The first example of telepresence, or the ability to remotely interact with a physical environment through a virtual interface, took place in 1991 over ISDN lines in an art installation called *Home of the Brain* (Grau, 2003). Experiments and techniques of telepresence continued to develop, with research and development (R&D) by the likes of Terashima and colleagues and his 'HyperReality' solution (Tiffin & Terashima, 2001). In formal design education, virtual universities using virtual world technology, telepresence, and augmented reality (which overlays a virtual interface over an actual view of the world), will provide a bridge between the virtual and physical, suggesting both a new paradigm and a threat to traditional physically based learning (Tiffin & Rajasingham, 2003).

The accelerating pace of change has strongly recommended the Agile approach (Highsmith, 2004) to software development, and now project management and design innovation. This approach recommends low-cost, fast iterative, adaptive design using self-organising teams and digital prototypes instead of physical and expensive materials, and this is something that SL is ideally suited to do. SL is one of the first virtual worlds to offer a massive number of potential participants a shared collaborative design environment that has shown an outpouring of design innovation to date. This thesis attempts to understand and interpret the meaning of design innovation within the ecology of SL.

1.11. Introduction to SL

SL is a fast-growing virtual world that is unlike a game, although games have been designed and played in-world. It provides its 'residents' with both common land and private property, including the mainland and private islands that are persistent and remain after users log off. It opened to the public in 2003 and was founded by Philip Rosedale, supported by an influential board of well-known 'dot com' entrepreneurs. It is a contiguous virtual world that is not separated by different servers but joined together as one virtual world, approximately the size of two Manhattans. Residents view the virtual world from an open source application known as the SL client. At the time of writing approximately 1.4 million avatars had logged on in the previous month. At any one time there are approximately 70,000 concurrent users in-world and they can all communicate with each other, either by text chat, IM (instant messaging), or voice chat (Linden Lab, 2010b).

An individual is represented in-world by an avatar or cyborg, a cybernetic organism. There are tools to change the appearance of the avatars by the person controlling them, and the first general AI avatars have begun to have a presence. SL makes 3D building tools available to all residents who can design almost anything they can imagine. There are limitations on the number of 'prims' (primitive shapes used in 3D building), up to 256 of which can be joined together. The official size limit is ten metres for a prim.

There is an in-world economy that floats at around 270 Linden dollars to US$1 and is surprisingly stable (Linden Lab, 2010). There are numerous shops and vendors for selling virtual objects such as clothes, gadgets and houses. Land, including private islands, can be bought and sold from the company, Linden Lab, and amongst the residents. There is a flexible Linden Scripting Language (LSL) that enables creators to build in interactivity into virtual objects. There is an official SL time which corresponds to US Pacific Standard Time, although a day cycles every eight hours with the sun setting after four, and weather patterns including wind in-world. With the recent release of Viewer 2 it is possible to view the 'web on a prim' that has opened up more flexibility for rich media and interactive web functionality from within world. SL was built by user-generated content and not paid professional designers and the result has been content in excess of 270 terabytes of virtual objects and development years that well exceed all other games and professionally designed worlds combined. SL was quickly recognized as something new and worthy of study (Au, 2008; Bartle, 2004; Boellstorff, 2008; Howe, 2008; Ondrejka, 2006; Tapscott & Williams, 2006).

SL is treated as an entire ecology that provides a virtual place and a design toolset that is flexible, and also a software development kit. This research takes a similar approach as Hine's

(2000, 2005) in her study of the Internet and in this thesis SL is considered as both culture and cultural artefact. However, this cyber-ethnographic study does not pretend to be a complete interpretation of design innovation in SL; it can only reveal partial and fragmentary glimmers of meaning (Denzin, 1997).

1.12. Ethics

Ethics approval for this research was gained from Victoria University's Human Ethics Committee. As well as taking steps to ensure the privacy of individuals who control avatars in SL, further precautions were taken by using pseudonyms for those avatars who value their digital reputation and avoiding the possibility that information related here may damage someone's actual reputation through linking their avatar to them personally. The researcher of this thesis made no distinction between online and offline ethical considerations with regard privacy and the dignity of the informants (Boellstorff, 2008; Wilson & Peterson, 2002).

1.13. Current gaps in the literature

In the Literature Review (Chapter 2) a number of unanswered research questions are identified, and this thesis looks to contribute to the body of knowledge in design innovation, cybernetics and creative collaboration in virtual worlds. According to Yochai Benkler (2005), peer production, also known as co-design, and open innovation are important areas of research:

> For academics peer production provides a rich area for new research. Peer production, like the Net, is just emerging. While there are some studies of peer-produced software, there is little by way of systematic research into peer production processes more generally. There is much room for theoretical work on why they work, what are potential pitfalls, and what are solutions that in principle and in practice can be adopted. The role of norms, the role of technology, and the interaction between volunteerism and economic gain in shaping the motivation and organisation of peer production are also important areas of research, in particular in the study of how peer groups cluster around projects. (p 196)

In the literature there has been little detailed analysis of what is regulating design innovation in the SL ecology, and most writers have tended to only consider the enablers and not the inhibitors limiting knowledge creation and creative collaboration. Lessig, who is enthusiastic about how SL enables design innovation and user-generated content does not closely question the assumptions around the permissions system built into the SL client (Lessig, 2006, 2008).

This research has attempted to build on the existing literature and to extend cybernetic theory in the examination of a virtual design innovation ecology in SL. By conducting a close examination of how to design an innovation ecology in SL it is hoped that this research will identify the current limitations and advantages of this virtual world ecology, as well as potential directions for research into virtual design studios in the future.

1.14. Second order cybernetics in SL

In order to interpret the cyber-ethnographic culture of designers in SL this study includes instrumental case studies to focus on knowledge creation and creative collaboration as part of the design innovation process in the virtual world. This research applies the cybernetic epistemological linkage between knowledge creation and regulation, and the design innovation process in SL.This thesis takes a second-order cybernetics approach to the virtual innovation ecology within SL. It is a multidisciplinary approach that has strong roots in the anthropology of Gregory Bateson, known for his concept of ‘the ecology of mind’, and the biological epistemology of Maturana and Varela (1992) (Bateson & Donaldson, 1991). Second-order cyberneticists such as the evolutionary microbiologist Lynn Margulis (1970; Margulis & Sagan, 1997) and scientists James Lovelock (1979) question the neo-Darwinist evolutionary theories of Richard Dawkins (1976) who argued for the hyper-individualist theory of the ‘selfish gene’.

Margulis (1970) has convincingly argued for a theory of microbiological symbiosis, called endosymbiosis, that has profound implications for epistemology and knowledge sharing and is based on RNA and DNA analysis that shows that micro-organelles do not out-compete each other, but rather consume and retain the original code (or shared knowledge) within a symbiotic ecology. The link was then made between this biological epistemology and human knowledge by Maturana and Varela (1992) and further supported by Montague's (2007) theory of human decision-making.

Evolution, culture, innovation and learning are all closely connected in second-order cybernetics, and developed into complex adaptive theory that recognised the creative power of chaos, self-organisation and emergence (Gell-Mann, 1994; S. Johnson, 2001; Laszlo, 2007). These concepts have been adopted by business management theorists who then applied them to design innovation (Bryan & Joyce, 2007; Hamel, 2007; Hussi, 2003; Kurzweil, 2005; Marinova & Phillimore, 2003; Reeves & Read, 2009; Von Krogh et al., 2000).

1.15. Chapter summaries

Figure 1 gives a schematic overview of this thesis. Following this introduction, Chapter 2 undertakes a literature review that provides a discussion of previous work that informs this research and identifies the gaps in the fields of ethnographic and cybernetic research in relation to design innovation in SL. The limitations of the mechanical model of design innovation are identified here, and the theoretical framework for a second-order cybernetic ecology is summarised. The literature review also discusses the increasing importance of virtual teams, dispersed collaboration, and open innovation that all signify a paradigm shift in the knowledge economy and in design education and practice. Lessig's four modalities of cybernetic knowledge regulation are described as an important model that contributes to a theoretical framework outlined in more detail in later chapters.

Chapter 3 describes in detail the theoretical framework for the research and defines terms and models used for the interpretation of the data. New models are introduced: the spectrum of fidelity and the indosymbiosis life cycle of innovation. Lessig's four modes of knowledge creation regulation are described as a model.

Chapter 4 outlines the research design and methodology of this thesis and the argument for taking a cyber-ethnographic case study approach to design innovation in SL. The research questions and proposition of this thesis are presented before the methodology and definition of a collective instrumental case study are explained in detail. The research design concludes by documenting the research path to *Design 2029* and a review of the initial exploratory research undertaken.

Chapter 5 introduces the three case studies and then describes them in depth. This is followed by an analysis of the case study data and a wider analysis of the data relating to design innovation in SL. Each of the case studies is discussed with relation to the three models described in Chapter 3, with Lessig's modes of norms, the market, the law, and architecture providing a framework to discuss the cybernetic knowledge regulation of design innovation in SL in detail.

Chapter 6 revises the theoretical framework based on the data analysis in the case studies and presents a new model.

Chapter 7, the final chapter, outlines directions for future research that might contribute to further understanding of design innovation in virtual worlds.

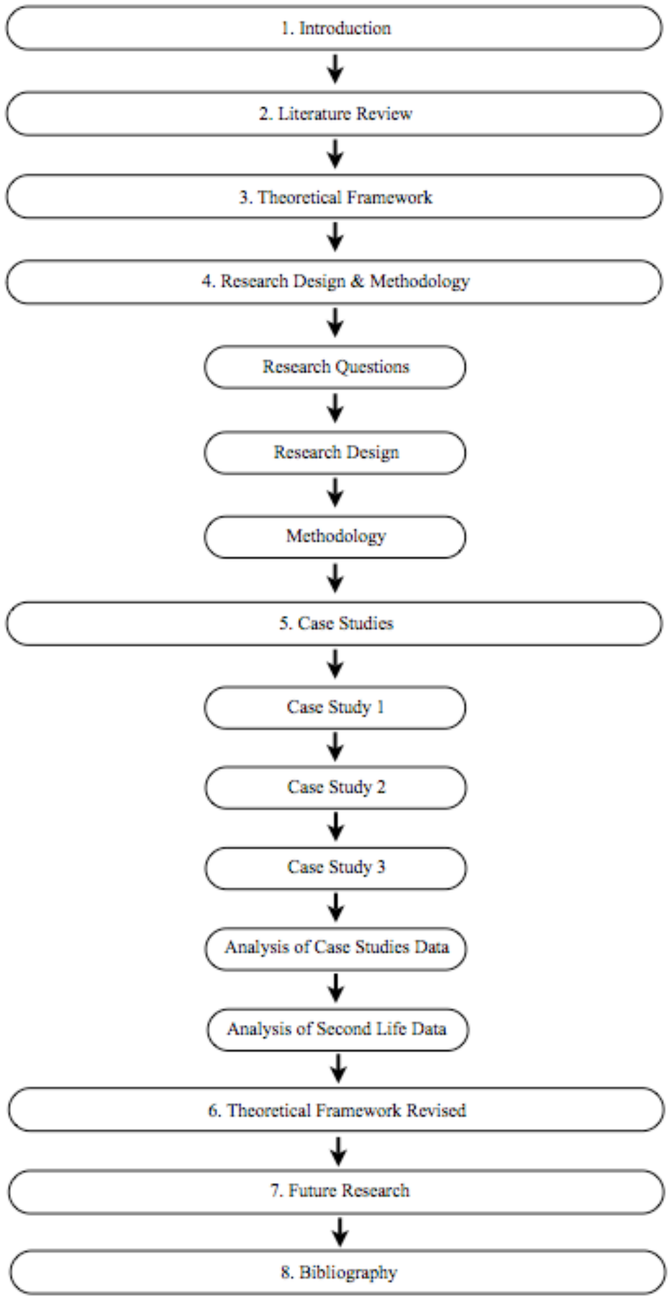

Figure 1. Schematic overview of thesis

CHAPTER 2

2. LITERATURE REVIEW

For consciousness to be able to imagine it must be able to escape from the world by its very nature; it must be able by its own efforts to withdraw from the world. In a word, it must be free.

— Jean Paul Sartre (cited in Von Krogh et al., 2000, p. 267)

Imagination is more important than knowledge.

—Albert Einstein

2.1. Introduction

This literature review reveals the historical context of IT and the role of cybernetics in the early conceptualisation of the human–machine interface and the augmentation of human intellect. Early cybernetics focused on mechanical devices and mechanical metaphors that encouraged an emphasis on technological solutions and VR that concentrated on the presence of the individual, as opposed to the social, concerns of virtual worlds. Cybernetic anthropologists such as Mead and Bateson worked with other theorists to conceive second-order cybernetics which adopted biological metaphors. They were more interested in the ethnographic social aspects of knowledge creation and collaborative behaviour. This review of the historical evolution of cybernetics helps to inform the context of the virtual world SL and provide a theoretical framework for the description of a new cybernetic model that can interpret design innovation in SL. The research questions of this thesis were initially shaped by the experiences of the researcher and a subsequent literature review that helped to define what design innovation is, and how design innovation relates to knowledge creation in virtual worlds. This chapter is constructed to illustrate the context of this research and identifies the gaps in the literature in order to provide a foundation for the research undertaken in SL. The review is structured according to the primary and secondary research questions under the following subsections:

- Design innovation
- The cybernetic context of a virtual innovation ecology
- Design collaboration in SL
- Lessig's cybernetic knowledge regulation
- Evolution of a new cybernetic model

In order to understand the context of design innovation in SL it is important to first define it and appreciate the context of a virtual innovation ecology. Design innovation theory exists within the historical context of the knowledge management (KM) discipline, which is understood to be closely related to IT and puts an emphasis on explicit information theory that evolved from first-order cybernetics. The realisation that KM suffered from an emphasis on a mechanistic cybernetic philosophy led to the next generation of KM and a remodeling of second-order cybernetics that adopted biological models to explain knowledge creation rather than explicit information transfer. Anthropology and ethnography took a new approach to knowledge creation and creative collaboration to help interpret the design innovation process and the context of a virtual innovation ecology. Biological metaphors assisted the understanding of how a virtual simulation of a face-to-face design process is regulated through various different modalities according to Lessig's model of knowledge creation and creative collaboration. When second-order cybernetics is applied to Lessig's (2004) model it is possible to interpret knowledge regulation and the design innovation ecology in SL according to the four modalities of norms; architecture; the market; and the law. The synthesis of a cybernetic design innovation knowledge life cycle and Lessig's model suggests a new second-order cybernetic model discussed later in this chapter.

2.2. Design innovation

Why is design innovation so important? Design is both pervasive and ubiquitous in the knowledge economy (Mau et al., 2004). Economics define the parameters of this knowledge-intensive practice, and innovation is its lifeblood, forcing design to adapt to the accelerating pace of change and dynamic market forces (George, Works, & Watson-Hemphill, 2005). Innovation is therefore important to both design and the future of the knowledge economy (Teece, 2000). IT, networks and communications have had a profound effect on design practice, encouraging globalisation and the virtualisation of the design studio (Castells, 2000; Mau et al., 2004). The accelerating pace of change and the opportunities for Agile design teams to self-organise and innovate within virtual worlds suggest that this little studied area will become increasingly important in the future (Halal, 2008; Kurzweil, 2005; Mau et al., 2004, Schroeder, 2002). A review of the literature identifies some important gaps with respect to the primary research question of this thesis; more specifically, with reference to design innovation in the virtual world SL and what is required to regulate a cybernetic innovation ecology to encourage design innovation. An overview of the research to date is provided and the similarities and differences between physical design innovation and a virtual process are examined.

The importance of design innovation is well understood as a significant contributor to the knowledge economy (Hamel, 2007; Mau et al., 2004; Stewart, 2001; Teece, 2000; Von Krogh et al., 2000). Ian Hunter (2008), a business historian, has described the seven pillars of innovation as: Vision; Creativity; Knowledge; Time; Resources; Focus; Persistence. This framework is supported by other writers on the subject and assists us to see the challenges faced by design innovation (Hamel, 2007; Hippel, 2005; Johansson, 2004; Kurzweil, 2005; Lessig, 2001; Mau et al., 2004; Peters, 1997; Sanoff, 1990; Shavinina, 2003; Sterling, 2005; Stewart, 2001; Suri & IDEO, 2005; Tapscott & Williams, 2006; Teece, 2000; Thomassen & Bijk, 2003; Von Krogh et al., 2000). Von Krogh et al. (2000) provide a knowledge creation framework to help understand the enablers of design innovation and the differences between tacit and explicit knowledge exchange in the context of the virtual world. Hussi (2000) takes this model a step further to account for the process of intellectual capital formation and exchange. A second-order cybernetic model provides an additional method of describing the symbiotic regulators that influences the feedback to the system and the designers in SL (Maturana & Varela, 1992; Wiener, 1954, 1961). Lessig's (2006, 2008) regulators are applied to the specific context of the design innovation ecology in SL.

The inception of a creative idea is recognised as an individual act and yet design innovation and knowledge transactions are seen as collaborative activities (Hamel, 2007; Hunter, 2008; Von Krogh et al., 2000). Thus, knowledge creation and creative collaboration in the virtual innovation ecology are seen within the social context of SL. The dual effects of globalisation and the virtualisation of the office are being felt by designers. The technology both causes these effects and, paradoxically, assists with their symptoms, as design teams become more dispersed and face-to-face communications are further reduced (Friedman, 2006; Mau et al., 2004; Shields, 2003; Tapscott & Williams, 2006). The design innovation ecology continues to search for balance, and to overcome constraints in the cybernetic system. It has been argued that as the evolutionary pace of technology has being increasing, there has been a concomitant rise in social networks and virtual communities; what Castells (2000) has described as the 'rise of the network society'. The rising popularity of virtual worlds such as SL offers opportunities and challenges to the design innovation process, starting with individual designers and translating into specific issues for companies of all sizes. The economics of design innovation and knowledge creation come together in virtual worlds (Balkin & Noveck, 2006; Castronova, 2005; Dibbell, 2006a, 2006b; Lessig, 2006; Ondrejka, 2006; Purbrick & Ondrejka, 2006).

There is a lack of research into the cybernetic enablers and limiters faced by design innovators in virtual worlds and the question of how to design a virtual innovation ecology such as SL. It has become important to understand what can either stimulate or inhibit knowledge creation and creative collaboration in the virtual design innovation process. This is not just a question of economics; it is an important area of research for the benefit of all human endeavours that are touched by design. This research attempts to fill some of the gaps in the body of knowledge in the broad areas of:

- design epistemology
- design innovation
- cybernetics and creative collaboration in SL

2.2.1. Design defined

Since the 16th century the word 'design' has had two meanings. The *Oxford English Dictionary* explains that it comes from the Italian word 'disegno', also 'dissegno' and 'designo', that originally meant, 'purpose, design, draught, model, plot, picture, portrait'. The modern French differentiates the artistic sense of 'design' from the planning sense and has both 'dessin' (meaning 'design in art') and 'dessein' (meaning 'purpose, plan'). In English both meanings were retained in the one word, meaning 'design' can mean something that is both artistic and a plan. The two definitions of 'design' used in this thesis are:

- A mental plan. A plan or scheme conceived in the mind and intended for consequent execution; the preliminary conception of an idea that is to be carried into effect by action; a project' (*The Compact Edition of the Oxford English Dictionary*, 1971, p. 698).
- A plan in art. A preliminary sketch for a picture or other work of art; the plan of a building or any part of it, or the outline of a piece of decorative work, after which the actual or structure or texture is to be completed; a delineation or pattern' (*The Compact Edition of the Oxford English Dictionary*, 1971, p. 698).

2.2.2. Innovation defined

Since the 1940s theories of innovation have been shaped by early cybernetic theory such as Norbert Wiener's 'black box' model of the innovation process, despite the fact that cybernetics is often implicit and not mentioned by name in many models of innovation (Foerster, 1995a). The prevailing philosophy of first-order cybernetics tended to be based on logical positivism and concentrated on explicit information theory via mechanical IT conveyed by individuals. Since the black box theory, which only looked at the inputs and outputs of innovation, there has been more focus on both the cause and effect of innovation, which has resulted in a vast amount of research. Since the early 1990s the discipline of KM and the sub-discipline of Design Management have had a deep interest in innovation and knowledge creation (Firestone & McElroy, 2003). The word 'innovation' is often used loosely and can be used to imply novelty, uniqueness and invention. However, for the purposes of this research it is important to give it a more precise definition.

The *Oslo Manual* (OECD, 2005) defines innovation as 'the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations' (p. 47). Sternberg et al. (2003) stressed that in order to be innovative the invention must be not just novel but also useful (2003). The influential OECD publication goes on to specify four types of innovation:

1. Product innovations: new or significantly improved goods or services.
2. Process innovations: new or significantly improved methods for production or delivery (operational processes).
3. Organisational innovations: new or significantly improved methods in a firm's business practices, workplace organisation, or external relation (organisational or managerial processes).
4. Marketing innovations – new or significantly improved marketing methods. (OECD, 2005, p. 49)

According to Leppävuori,

> research is the transformation of money into knowledge [and] innovation is the transformation of knowledge into money. Equating innovation with science and research is at best an incomplete picture, which misrepresents where the greatest benefit from innovation can be created and captured for a country.
> An alternative view is that the smart application of knowledge to transform businesses is the key to achieving innovation, both for firms and for nations (LEGC, 2008, p. 2).

There is a notable lack of academic studies of informal innovation, with a focus instead on linear, formal R&D. 'This fixation on R&D has probably delayed the slow progress made over the 1990s towards an expanded view of innovation that includes informal activities' (OECD, 2008, p.

51). Of a large survey of innovative small and medium enterprises in the EU, 31.5 percent answered that support programmes for collaboration were crucial to their innovative success. The process and measurement of knowledge sharing and collaboration have been neglected and so there is a research requirement to fill the gap (OECD, 2008; Stewart, 2001). This literature review highlighted the necessity to research the informal social networks that form within SL and could support collaborative design, the design innovation process, and organisational knowledge creation. As noted earlier, the focus of this thesis is design innovation and how it is enabled specifically in SL. According to Hunter (2008), vision is one of the most important of the seven pillars of innovation, and this can also be applied to design innovation.

2.3. Vision and creativity in design innovation

Hunter (2008) wrote that vision and creativity provide an innovator with the ability to imagine a better process, organisation, or product sometime in the future. It is this ability to imagine some future world in which the innovation not only exists, but in which its tangible impact is embraced by customers, that is the starting point for both breakthrough and incremental innovations (Hamel, 2007). Hamel discusses a crisis in corporate management and recommends that large companies lead rather than simply manage by using their ‘knowledge vision’ and shared strategic objectives. Furthermore, Hussi points out that only by articulating a knowledge vision can an innovative company build its intellectual capital and generate innovations for the future.

> Vision and strategy are essential for intellectual capital because it can only exist and be developed in the context of an organization’s strategy. In other words, intellectual capital does not exist without a purpose and an approach. Vision is a shared, rousing and comprehensible goal, which describes what an organization wishes to be in the future. (Hussi, 2003, p. 4)

Christiansen (2000) has described how different industries have different innovation requirements but communication of the strategic vision and a shared commitment to innovation are seen as necessary precursors to successful innovation management. For example, without a long-term commitment to innovation from senior management new product ideas were considered too risky by career chemists in an industrial chemical company. There was a lack of understanding and support for a culture of innovation that would encourage experimentation and risk-taking over a period of time and therefore there were insufficient resources committed to allow innovations to keep pace with the regulators, lead users, and their customers (Hippel, 2005). May (2007) has argued that defining the difference between incremental and radical innovation is not useful, and that it is the regular nature and speed of innovation that will result in breakthrough design innovations over a shorter amount of time. Teece and others have also identified systemic innovations that can cause a complete change to an industry or process in the context of radical breakthroughs that are riskier and take greater amounts of investment (Chesbrough, 2003; May, 2007; Teece, 2000).

The Stage Gate Process Model was developed and trademarked by Dr. Robert G. Cooper and was introduced in his 1986 book, *Winning at New Products*. It was created to help management prioritize new ideas and allocate scarce resources better, by weeding out those ideas that have the least potential, while supporting those with the most potential, (Cooper, 2003). Incremental innovation is often associated with the Stage Gate model due to its inherent top-down bureaucratic management and lack of input from large numbers of employees, customers and suppliers (Hamel, 2007; Teece, 2000). The slow and less creative approach of traditional management models of design innovation has seen a recent increase in the numbers of business writers and academics who are calling for a more open, crowd-based approach, sometimes called Web 2.0 or Enterprise 2.0 (Bryan & Joyce, 2007; Chesbrough, 2003; Hamel, 2007; Leadbeater, 2000; Stewart, 2001; Tapscott & Williams, 2006). Hamel (2007) identified a number of Web 2.0 tools such as wikis and social network portals like FaceBook, LinkedIn and SL as ways to bring the various design innovation stakeholders together to increase creativity. This open approach to innovation is described by John

Seely Brown as ‘innovating innovation’ (Chesbrough, 2003) and, as Hamel (2007) noted, must include the innovation of corporate organisational structure.

2.4. Simulation and design innovation

Thought experiments, modelling and simulations are used to theorise and imagine scenarios that are either impossible to view or too expensive to realise. These techniques have become more and more common as computer speeds have increased and the cost of rendering bits and bytes compared to manufacturing physical prototypes has continued to decline. ‘New product development – be it for industrial products, consumer products, or internal business processes – is being driven by two resolute forces: the continuing demand for innovation and the plunging cost of change (low-cost exploration)’ (Highsmith, 2004, p. 253). A strategy for increasing the pace of design innovation has been recommended by Highsmith. A significant element of this strategy will involve software and the manipulation of bits rather than atoms, driving a low-cost exploration product development process that should strive to:

- fill products with ‘bits’
- create a bit-oriented product development life cycle (i.e., model and/or simulate products in software as far into the lifecycle as possible)
- relentlessly drive down the cost of changing bits (low-cost iteration)
- develop people and processes capable of the above strategies (agile people and processes). (Highsmith, 2004, p. 254)

The increasing rate of change and the miniaturisation of electronics are carrying design into a future in which its outputs will become totally invisible and wholly intangible (Kurzweil, 2005; Mau et al., 2004; Sterling, 2005; M.C. Taylor, 1997). Software is becoming hardware, and hardware is becoming software (Kurzweil, 2005). Sometimes in design an object remains software, as in a digital artefact. Sterling (2005) wrote, ‘Sometimes I really want an object . . . At many other times, many crucial times of serious decision, I’m better served with a representation of that object’ (p.

95). Kurzweil (2005) argued that as we approach nanotechnological manufacturing, information will be the only value component of any product:

> The portion of a manufactured product's cost attributable to the information processes used in its creation varies from one category of product to another but is increasing across the board, rapidly clothes, food, energy, and of course electronics – will be almost entirely in their information. As is the case today, proprietary and open-source versions of every type of product and service will co-exist. (p. 339)

Already in SL there are designs and simulations that only exist as 3D software but nevertheless have significance and can be described as design innovations. All designs begin as a virtual representation of the final output; today some designs remain always in a virtual world but have profound impact on people's lives (Mau, 2004).

2.5. Trends in design innovation

In *Massive Change*, Mau et al. (2004) wrote:

> Design is evolving from its position of relative insignificance within business (and the larger envelope of nature) to become the biggest project of all. Even life itself has fallen (or is falling) to the power and possibility of design . . . We are designing nature and we are subject to her laws and powers. This new condition demands that design discourse not be limited to the boardrooms or kept inside tidy disciplines. As a first step to achieving this, we abandoned the classical design disciplines in our research and, instead, began to explore systems of exchange, or design 'economies'. (p. 16)

Mau et al. (2004) sees three big concepts dominating current design: distributed; plural; collaborative. 'It is no longer about one designer, one client, one solution, one place' (p. 17). Design teams, or as the design scientist Bill Buxton calls them, 'renaissance teams' (2004), will work together collectively to develop design solutions for projects. The romantic view of a solitary designer with a sketch pad and HB pencils has been replaced by a new model of virtual teams globally dispersed and working collaboratively on projects that are computer-designed and robotically built – including designs that are mostly invisible to the eye. At the same time as design is becoming more and more collaborative, there is an equally important trend towards ‘disintermediation’ as brokers and middle people are removed from the process (Kurzweil, 2005). Increasingly, designers have at their disposal tools that allow them to augment both the hard and soft processes, including specialised AI that can design design, and rapid replicators that can build the builders using 3D printers such as the self-replicating manufacturing machine, RepRap. Interestingly, while some would see this as a healthy trend towards cost reduction and efficiencies, it tends to overlook the tacit knowledge role played by those intermediaries (May, 2007; Von Krogh et al., 2000).

Design sits at the important intersection of this debate as management attempts to convert tacit into explicit knowledge and package ‘how to’ into tidy knowledge objects and object-oriented modules. Northern hemisphere management, especially European management, has typically relied on IT tools that provide explicit KM solutions (Tiffin & Rajasingham, 2003). They have denigrated the role of the so-called ‘middle men’, seeing them as superfluous costs to be replaced by technology that can simply replace inefficient information carriers (May, 2007). The Japanese approach to tacit knowledge and iterative design teams has also recognised the creativity of middle managers acting as knowledge translators using the ‘Toyota Method’ (May, 2007; Von Krogh et al., 2000).

According to Mau et al. (2004), designers will inevitably ‘implicate [them]selves in the consequence of [their] imagination’ (p. 18). The professional designer is not only implicated, however; they become participants in an ecology that is seeing the rise of amateur ‘prosumers’ and ‘produsers’ who are not passive consumers of products but ‘co-creators’ of the design (Bruns, 2008; Tapscott & Williams, 2006; Toffler, 1980). Creative collaboration and knowledge sharing are essential elements of design innovation in and outside virtual worlds and so the field of KM is integral to design innovation (Panteli, 2009; Schroeder, 2002). It is important to review the KM landscape in order to appreciate the gaps in both the design epistemology within SL and the research into creative collaboration in a virtual world ecology.

2.6. Knowledge creation and design innovation

The study of design innovation and knowledge creation has close linkages with the discipline of KM and the history of IT. First-order cybernetics tended to focus on explicit information theory and encouraged a hyper-individualistic approach to IT related to the human–machine communication of that information. Early KM also suffered from this bias and tended to ignore the creation of tacit knowledge and the ethnographic social context of knowledge creation and innovation. KM became something of a fashion in the 1990s (Stewart, 2001; Teece, 2000) with the realisation that central to wealth creation in the knowledge economy are the concepts of intellectual capital, IP, tacit knowledge, and knowledge creation, and how they all contribute to design innovation and competitive advantage (Abramson, 2005; Goldman & Gabriel, 2005; Hussi, 2003; Lessig, 2001; Teece, 2000). There is some debate over the exact inception date of KM as a discipline however there is consensus that it became widely recognised in the early 1990s. *The Knowledge Creating Company* by Nonaka and Takeuchi (1995) became the cornerstone of the new discipline and included an explanation of tacit and explicit knowledge conversion (Hussi, 2003; Snowdon, 2002). An important component of the Nonaka and Takeuchi knowledge creation model was the concept of 'Ba' or the context of knowledge creation in a shared space in which emerging relationships develop according to the physical, mental or virtual space in which that knowledge evolves. Davenport, Prusak and Wilson (2003) claimed that they held the first KM conference in 1994 and introduced the first academic course in KM to the Texas Business School in 1995. In the early 1990s the advent of new information technologies such as the World Wide Web and collaborative 'groupware' tools such as Lotus Notes gave the concept of KM real traction. This history underpins the general philosophy of design innovation and establishes a connection with IT and virtual worlds with respect to knowledge creation and collaboration, as well as with the history of the cybernetic movement and the context of SL.

2.7. The cybernetic context of a virtual innovation ecology

Prior to KM and dating as far back as 1948, Norman Wiener, in his seminal book *Cybernetics, or Control and Communication in the Animal and the Machine* claimed that the quality of human–machine communications would define our inner well-being (Packer & Jordan, 2001). Later, in 1962, Douglas Engelbart (2001) wrote how machines could one day amplify the intellect and augment human cognition. According to Rosenberg (1982), the first model of innovation used by economists was a ‘black box’ theory borrowed from Wiener’s cybernetics that stated that innovation was not an important process in itself; only the inputs and outputs were relevant. Most of the attention was directed towards the output of innovation and largely ignored the input, or the ecology of design innovation and what conditions made it conducive. Early cybernetics tended to be overly simplistic, atomistic and mechanistic in terms of knowledge theory and like early KM it tended to focus on IT to the detriment of knowledge theory and biological models. IT has continued to build on this history and individualistic aspects of VR technology can be seen as a branch of this movement, coming back into the mainstream with virtual worlds and design innovation (Grau, 2003).

From around 2003 virtual worlds and Massively Multiplayer Online Role Playing Games (MMORPG or MMO) started to have considerable impact on economics, government policies, education and KM practice in organisations (Castronova, 2007; Rive et al., 2008; *Virtual Policy'08*, 2008). The first generation of KM has been often criticised for the emphasis on IT and focus on the individual user, due largely to a lack of distinction between *knowledge* and *information* management. Firestone and McElroy (2003) sought to define the distinction through the Knowledge Life Cycle, a second-order cybernetic systems approach, and a move away from IT and mechanical first-order cybernetics, in the process suggesting a biological metaphor. Von Krogh et al. (2000) also make it clear that there is an important social and tacit component to knowledge creation, as opposed to information as data, which can be codified and is explicit. They argued that information becomes knowledge when individuals interpret it, and give it a context based on their own justified beliefs and commitments within a social context.

2.8. Second-order cybernetics and a virtual innovation ecology

The history of cybernetics traces the close intellectual development of evolutionary biology, physics, mathematics, engineering, anthropology and sociology (Turner, 2006). Wiener used his entrepreneurial skills to pull together interdisciplinary researchers and developers in the shadow of Second World War and the Cold War that followed. His fascination with the biological function of homeostasis came from his interest in human biology and his friendship with the physiologist Arturo Rosenbleuth, however his mechanical metaphors associated the human brain with computers. The word 'cybernetics' was adopted during the Second World War by scientists led by Wiener and Rosenbleuth to give unity to a set of problems, 'centering about communication, control, and statistical mechanics' (Wiener, 1961, p. 11). Wiener (1961) wrote:

> We have decided to call the entire field of control and communication theory, whether in the machine or in the animal, by the name Cybernetics, which we form from the Greek κυβερνήτης or steersman. In choosing this term, we wish to recognize that the first significant paper on feedback mechanisms is an article on governors, which was published by Clerk Maxwell in 1868, and that *governor* is derived from a Latin corruption of κυβερνήτης. (pp. 11–12)

From their inception virtual worlds have had a close association with cybernetics and MIT. Vannevar Bush, the Vice President of MIT, wrote an influential essay for the *Atlantic Monthly* on the human–machine interface entitled 'We May Think' (1945) which impacted the thinking of Wiener and a number of MIT graduates and pioneers of VR. Two MIT graduates influenced by Bush were Englebart and Ivan Sutherland, who envisaged the first graphical user interfaces, the first steps in visually immersive IT. In 1968 Sutherland and Bob Sproull, a student, created the first VR and augmented reality head-mounted display (Grau, 2003). At MIT Wiener and his colleagues were fascinated with how IT and computing could interface with human cognition. According to Grau (2003), Wiener, along with Alan Turing,

> saw analogies between the work processes of humans and computers and thus laid the foundations for later theories of robotics, cybernetics, and research on artificial intelligence. Wiener defined cybernetics as the science of conveying messages between humans and machines. This remarkable conceptualization derived from an idea that later formed the basis of all concepts of interaction and interface design: communications between humans as the model for communication with or between machines. (p. 161)

Thus cybernetic theory underpins the history of VR and virtual worlds and Gibson's description of a virtual world, as cyberspace, was derived from the conflation of 'cybernetic space', and Boellstorff in his introductory history to SL wrote that many writers on virtual worlds have emphasised this very close relationship with cybernetics (Boellstorff, 2008). According to Markley (1996),

> Cybernetics is connected to virtual reality technologies in much the same way as Cartesian space is connected to contemporary mapmaking. Through such seminal ideas as information, feedback loops, human-machine interfaces, and circular causality, cybernetics provided the terminology and conceptual framework that made virtual reality a possibility. (p. 34)

As an anthropologist who adopted an ethnographic approach to SL, Boellstorff also points out that 'Many anthropologists became interested in cybernetics during the middle of the twentieth century, particularly Margaret Mead and Gregory Bateson.' (2008, p. 37). Boellstorff's (2008) in-depth cyber-ethnographic research in SL, published as *Coming of Age in Second Life*, was conducted while consciously harking back to the influential work by Mead in her *Coming of Age in Samoa* (1928).

The etymology of cybernetics suggests two major themes that are discussed in detail in the Theoretical Framework (Chapter 3). The Greek origin of the word is *kurbernetes* or 'steersman' and implies some sort of direction, control and organisation. Mechanical control and information feedback were important aspects of first-order cybernetic theory, epitomised by the Radiation Lab at MIT and Wiener and his colleagues (Turner, 2006). The formulation of systems theory by the likes of Wiener and others led to the establishment of cybernetics, and that in turn led to what is known as second-order cybernetics, or the cybernetics of cybernetics. This was an attempt to build on the first generation of cybernetic theories, and to describe the more complex realm of biological feedback that was too simplistic and localised in the mechanical models. This legacy of cybernetics closely associates the theory with ethnographic anthropology, social network theory and IT, which were later developed by the likes of Brand and Kelly, which in turn influenced the founders of SL (Boellstorff, 2008; Brand, 1988; Kelly, 1994; Turner, 2010). As Turner (2006) noted,

> Networked forms of commerce, and the integration of information technologies into them, quickly began to seem like stages in a natural, rather than a socio-technical, progression. Suddenly mankind had entered a new stage of *evolution:* the scientists of the artificial-life movement, wrote Kelly, had already shown that 'evolution is not a biological process. It is a technological, mathematical, informational, and biological process rolled into one.' (p. 203)

A whole new evolutionary approach or 'biologic' (Kelly, 1994) that borrowed heavily from physics, biology, AI, artificial life and medical science transformed the models that sought to explain knowledge creation and technological innovation. The influential alumni of MIT took their theories and understanding about second-order cybernetics and spread it amongst the entrepreneurs of Silicon Valley, applying biological models to the Internet (Turner, 2006, also refer to the Appendix).

Foerster (1995b) noted that 'it needs a brain to write a theory of the brain' and the importance of circularity was recognised by second-order cybernetic anthropologists in ethnographic studies through the research methodology of 'participant observation' (n.p.). The implication of second-order cybernetics is that the study of culture, or even reality, becomes a recursive exercise in which everything is mediated and so it becomes meaningless to talk of 'computer-mediated communications' because even the perception of the actual is mediated by the senses. There is no clear separation of the actual and the virtual world (Boellstorff, 2008; Maturana & Varela, 1980). The epistemological process of design innovation, so closely linked to KM, is also also closely linked to second-order cybernetic anthropology and a biological field known as evolutionary epistemology. Biologists such as Maturana and Varela began to examine the unique nature of biological systems and coined the word 'autopoiesis' to describe how biology is self-creative and reproductive. This was fundamentally different from the earlier machine theory. In their work into evolutionary epistemology and the 'biology of cognition', Maturana and Varela (1980) concluded that in the operation of the nervous system perception and hallucination were indistinguishable. They would agree with Gibson (1984) that in SL and other virtual worlds a 'consensual hallucination' is created that is no less real to the participants immersed in those realities.

The second-order cybernetic biologists Margulis and Lovelock conceived virtual evolutionary models based on symbiosis, such as a cybernetic theory of microbial atmospheric modulation and the whole earth network theory of Gaia (Margulis, 1996; Margulis & Sagan, 1997). Their theories presented cybernetic models, or virtual world simulations, showing how biological systems and even the planet can maintain a homeorthetic trajectory through symbiotic feedback loops. Evolutionary biology and a homeorthetic trajectory are also the foundation for innovation models such as the 'S' curve of innovation (discussed below) which imply an open-ended context rather than a simplistic closed innovation theory as depicted by bell curves and homeostasis.

Everett Rogers (1962), in his book *Diffusions of Innovation*, sought to explain the rate of technology adoption with his popular theory, the 'S' curve of innovation. Rogers (1983) concentrated on the diffusion or adoption of innovation and defined 'innovation' as a subjective view of an 'idea, practice, or object that is perceived as new by an individual or other unit of adoption' (p. 11). The 'S' curve implies a technological *life cycle* which is a biological metaphor, not a mechanical one. The popular models of innovation have tended to be mechanistic and reductionist and based on Cartesian models instead of systems theory, which considers design innovation as a cybernetic complex adaptive system based on biological models (Capra, 1983b). The mechanical analogy of the Stage Gate innovation process, and the common references to innovation ‘engines’ still dominate the thinking of many academics, designers and corporate managers today. These theories typically associate with Darwinian assumptions about competition and evolution based on ‘survival of the fittest’ and are not based an explanation of innovation or ‘origin of fitness’ (Kelly, 1994). However, a significant number of theorists argue that human and technological evolution is based on symbiotic sharing and creative collaboration (Kelly, 1994; Margulis, 1970; Margulis & Sagan, 1997; Maturana & Varela, 1980, 1992, also see the Appendix).

In the context of this thesis a biological second-order cybernetic approach was found to be more effective in explaining the virtual innovation ecology as a symbiotic, social approach and how it links to KM theories of design innovation.

2.9. Co-design and second-order cybernetic KM

Second-order cybernetic theories are implicit in the growing interest in social networking, co-design, and the concept of Web 2.0 for the enterprise. These have refocused attention on the social and political regulators within companies that act as barriers to knowledge creation, sharing and design innovation (Bryan & Joyce, 2007; Halal, 2008; Hamel, 2007; Lessig, 2006, 2008; Ritke-Jones, 2008; Sunstein, 2006). It has been recognised that the architecture of these physical networks goes far beyond simply providing a transport for information and can actually provide a valuable means of building social capital within a symbiotic ecology (Castells, 2000; Kelly, 1994; Lin, 2001). Lessig (2008), Boellstorff (2008) and Tapscott and Williams (2006) all recognise how SL is part of the next generation of ‘user-generated content’ in which users share knowledge. In a cybernetic sense this co-design can also be seen as symbiotic knowledge sharing. SL allows distributed design teams to have a sense of co-presence and improves upon past ‘groupware’ that made it difficult for fellow team members to engage emotionally and convey tacit knowledge (Bowers et al., 2008; Panteli, 2009). SL extends the ability of symbiotic cyborgs to become ‘co-creators’ or ‘co-designers’ and to partake in rapid prototyping with other residents and corporate designers. While there are not many well-known brands in SL that give the residents the opportunity to co-create, the consultants McKinsey recently found that 60 percent of all respondents would be willing to experiment with co-creation in SL (Bughin et al., 2008). Leadbeater and Hippel take this argument even further to include the concepts of 'user centric' design and 'democratising innovation', whereby the user is no longer involved only in focus groups or useability studies, but actively designs the product and service with the company that commercialises it (Hippel, 2005; Leadbeater, 2000). Hippel describes this in his book *Democratizing Innovation* (2005), published under Creative Commons. The argument is that 'crowdsourcing', openness and sharing will result in greater innovation through symbiotic knowledge creation. This was the driver for Lawrence Lessig to help establish the not-for-profit Creative Commons in 2001, based on the Free Software Foundations and the General Public License, which has successfully been employed by the Linux OS and other Open Source projects. It is also the basis of what some economists call 'wikinomics', or 'folksonomy' (Tapscott & Williams, 2006). SL is still in a relatively early stage of development and is mostly populated by well-educated early adopters and lead users (de Nood & Attema, 2006). This provides innovators with participants that can offer real value to their design projects. According to Hippel (2005), who developed the concept of the lead user, they have two distinguished features:

> (1) They are at the leading edge of an important market trend(s), and so are currently experiencing needs that will later be experienced by many users in that market.
> (2) They anticipate relatively high benefits from obtaining a solution to their needs, and so may innovate. (p. 4)

Lessig (2006) and Ondrejka (Purbrick & Ondrejka, 2006) argued that because SL has provided its residents with the ability to own their own creations, an explosion of design innovation in the virtual world has resulted. Lessig and others have discussed how the copyright and patent systems are in crisis, and that rather than motivating innovation, legislation is acting as a barrier to knowledge creation and design innovation (Abramson, 2005; Ghosh, 2005b; Goldman & Gabriel, 2005; Lessig, 2004). The context of design innovation in SL is set against a backdrop of global concern over IP and how to encourage faster innovation as the pace of change accelerates (George et al., 2005; Kurzweil, 2005; Lessig, 2001, 2006; Mau et al., 2004). The question of design innovation and knowledge creation in SL is thus connected to the broader discipline of next-generation KM based on second-order cybernetic theories of collaboration and ecological evolution. Marionova and Phllimore (2003) reviewed six generations of innovation models, with each generation getting more complicated and iterative than the last (see also the Appendix). They outlined the history of the models from a closed 'black box' model, which only monitored inputs and outputs, to later models such as the Evolutionary model and the Innovation Milieux.

Firestone and McElroy (2003) described the next-generation KM as *knowledge process management*, 'the management of knowledge production, knowledge integration, the Knowledge Life Cycle, and their immediate outcomes. A key aspect of knowledge process management is innovation in knowledge process to enhance performance of the Knowledge Life Cycle' (p. 61) The concept of a life cycle clearly suggests a complex adaptive or biological system that can also integrate second-order cybernetic theory of feedback and move beyond a mechanistic 'black box' approach to attempt to explain emotional and tacit inputs.

2.10. Second-order cybernetics and the intellectual DNA of SL

Second-order cybernetics provided the intellectual DNA for many of the design and business decisions of the founders of SL (Boellstorff, 2008; Turner, 2006). Second-order cybernetics is ideally suited to the study of design innovation in SL because of its intellectual heritage; it provides a 'biologic' systems approach and like computer software it is recursive and is 'thinking about thinking' (Foerster, 1995a; also see the Appendix). In the 1960s cybernetics gave hope to the likes of Stewart Brand who attended lectures by the ecologist Paul Ehrlich and anthropologist Gregory Bateson. Brand recognised that ecological social science and cybernetics, with its attendant support from computing, could create a virtual utopia (Turner, 2006). This represented an early linkage between the Californian ideology of individual technological liberation, what Boellstorff has called 'creationist capitalism', and cybernetic evolution and virtual worlds. For many in SL this ideology now had a home (Boellstorff, 2008; Turner, 2006). Wiener's cybernetics viewed IT, human biology, and missile defence systems as analogous, and over 20 years built a substantial following in academia, business and government. The R&D style of cybernetics saw an unprecedented amount of collaboration amongst those who regarded themselves as cyberneticists. 'They began to imagine institutions as living organisms, social networks as webs of information, and the gathering and interpretation of information as keys to understanding not only the technical but also the natural and social worlds' (Turner, 2006, p. 4). Through events such as the Macy Conferences the flow of ideas went in all directions, and so cybernetic theories on computing and machine feedback also filtered into biology and vice versa, giving rise to second-order cybernetics (Bateson & Donaldson, 1991; Kelly, 1994; Margulis, 1970; Margulis & Sagan, 1997; Turner, 2006; Wiener, 1954, 1961). According to Turner (2006), second-order cybernetics had found its way into microbiology (such as Margulis' network theory of endosymbiosis) and became a 'communications science, allied to cybernetics, information theory, and computers' (p. 44). However, the fear of a nuclear war and the Cold War that followed the Second World War led to a counterculture who were frightened by the potential threat of the industrial military complex and the command and control that cybernetics could provide to governments.

Allied to second-order cybernetics, Complex Adaptive Theory has been used to criticise the mechanistic Stage Gate approach to innovation, arguing that biological and symbiotic evolutionary theory has much to teach us about ideation and emergent innovation (Koch & Leitner, 2008; Margulis & Sagan, 1997; also see the Appendix). The evolutionary microbiologist Margulis (1996, 1999) envisaged humanity as a global network linked genetically and biologically by symbiotic microorganisms that communicate chemically. Researchers and authors studying KM and innovation have turned to this complexity theory, which is explained by Koch and Leitner (2008):

> Complexity science deals with the dynamics and evolution of complex systems found in diverse areas such as physics, biology, society, and the economy. Funnels in tornadoes, flocks of birds, and

> schools of fish are all examples of orderly behaviour in systems that are neither hierarchically planned nor centrally controlled. No single or commonly agreed complexity theory yet exists, however, Complex Adaptive Systems (CAS) theory (Holland, 1995; Kauffman, 1995) has attracted attention, particularly when applied to explaining the behaviour of human and economic systems. (p. 217)

With respect to design innovation in SL, this cybernetic CAS theory and symbiotic evolution are useful for explaining how groups self-regulate and how knowledge creation and flow is regulated between groups and individuals.

2.11. Cyberspace and the background to SL

The ability to vividly imagine and describe whole worlds has a long tradition pre-dating written language and is described in ancient myths and legends (Campbell, 1971). Following in this mythological tradition J.R.R. Tolkien imagined a world of dungeons and dragons, which inspired early MUDs, and later MMOs, such as *World of Warcraft*. William Gibson (1984), in his science fiction novel *Neuromancer*, described a virtual world of the future and coined the word 'cyberspace':

> The matrix has its roots in primitive arcade games. . . . Cyberspace. A consensual hallucination experienced daily by billions of legitimate operators, in every nation, by children being taught mathematical concepts. . . . A graphic representation of data abstracted from banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the nonspace of the mind, clusters and constellations of data. Like city lights, receding. (p. 69).

And it was Neal Stephenson (1992) in his science fiction novel *Snow Crash* who provided the inspiration for SL's Metaverse.

> Your avatar can look any way you want it to, up to the limitation of your equipment. If you are ugly, you can make your avatar beautiful. If you have just gotten out of bed, your avatar can still be wearing beautiful clothes and professionally applied makeup. You can look like a gorilla or a dragon or a giant talking penis in the Metaverse. Spend five minutes walking down the Street and you will see all of these. (pp. 33–34)

The founders of the ‘virtual community’ WELL envisaged it as a type of ‘electronic frontier’ a virtual space where, ‘The Main Street is a central minicomputer’ (Turner, 2009, p.172). Computer networks and circuitry continue to evolve in biological ways that find success through emulating nature; these systems Kelly (1994) called ‘vivisystems’; they behave like hives and swarms without central control. Cities such as Tokyo are described as being ‘like a computer program which ceaselessly keeps adding new subroutines’ and as a city making ‘the transformation from a hardware to a software city’ (Morley & Robins, 1995, p.320). The Internet itself as it has been left to evolve and to self-organise has taken on a similar pattern as natural networks determined by power laws. The network theory of Castells describes the evolution of the ‘informational city’; he identifies ‘the historical emergence of the space of flows, superseding the meaning of the space of places’ (Morley & Robins, 1995, p. 318). The city has been characterised as both an informational network and analogous to a living cell or organism: ‘In the place of a discrete boundary in space, demarcating distinct spaces, one sees spaces co-joined by semi-permeable membranes, exposed to flows of information in particular ways’ (M. Wark cited in Morley & Robins, 1995, p. 318).

By way of comparison the Internet has often been characterised as a space, or cyberpsace. John Perry Barlow wrote that the Internet ‘has a lot in common with the nineteenth century West. It is vast, unmapped, culturally and legally ambiguous, verbally terse . . . hard to get around in, and up for grabs’ (Turner, 2006, p. 172). This former member of the Grateful Dead, saw the Internet as a virtual LSD trip, blending the consciousness of the entire planet. The accelerating rate of change and the emerging ability to design, from the atom up, are creating innovative opportunities which are quite literally only limited by the imagination of the designer. SL provides an early virtual world in which to play out scenarios that appear closer to fantasy and magic than science and technology. And yet, we are reminded of the Arthur C. Clarke quote, ‘Any sufficiently advanced technology is indistinguishable from magic’ (cited in Kurzweil, 2005, p.4). The revelation in physics that there is possibly an infinite number of parallel universes, along side our own, has given license to those who imagine alternative realities within virtual worlds, and creativity that is enabled with the realisation of the multiverse. Even more poignant is Nick Bostrom's philosophical speculation, also the subject of the VR movie, *The Matrix*, that we are all in fact part of a massive computer simulation (Chown, 2007). William James wrote that 'Philosophy is the habit of always seeing the alternative' (quoted by Heim, 1993, p. 137). Yet, we are admonished by the philosopher Michael Heim (1993) that when we create a virtual world it

> should evoke the imagination, not repeat the world. Virtual reality could be a place for reflection, but the reflection should make philosophy not redundancy . . . Cyberspace can contain many alternative worlds, but the alternateness of an alternate world resides in its capacity to evoke in us alternative thoughts and alternative feelings. (p. 137)

Some writers have seen VR as the cyclotron of the mind, in which ideas are accelerated and creativity enabled. Thus, presence for these writers is not about a physical reality but a state of mind, or psychology. 'Advanced virtual environment engineers may whirl minds through cyberspace to understand something fundamental about the structure of experience – in a word, consciousness' (Biocca, 2003, para. 13). These ideas on virtual worlds and cyberspace prefigured SL and have helped to shape it.

2.12. Futurism, knowledge creation and imagination

SL provides designers with a virtual world that can break free from restrictive structures and in which they can prototype and test innovative designs with users in a virtual environment that can be physically built or simply exist purely as a digital design. SL is also a stimulating virtual environment that is conducive to creative collaboration and imaginative design in a context where everything is open to question, and even the laws of physics can appear to be warped or broken. Our view of the world and its possibilities are the ultimate boundaries of our imagination, and this worldview is our self-imposed ceiling that limits our ability to design and innovate; we cannot go beyond what we cannot imagine. SL helps to expand the horizons and raise the sky above a fly zone that was never previously imagined possible. This can powerfully assist creativity and innovative design for both the physical and digital worlds. The extent to which the imagination can both expand, and restrict, design possibilities is apparent when we compare the ease of 'teleporting' in SL with the limitations of travel and communications suggested by Stephenson (1992) in *Snow Crash*. While Hiro Protagonist is able to travel at speeds up to 60,000 kilometres an hour on his virtual motorbike, this is still much slower than the ability to be anywhere within seconds via the teleport feature in SL. In his novel Stephenson was unrestricted by the same technical limitations faced by the creators of SL, however; his imagined Metaverse was contained by his knowledge of computing and his use of the Apple *User Interface Guidelines* that shaped what he imagined to be possible.

In a fictional forerunner to cyberpunk and precursor to *Star Trek*, Alfred Bester made teleporting a central theme in his science fiction novel *The Stars My Destination*, in which his antihero Gully Foyle uses his mind to 'jaunte' or physically teleport to places, including other planets (Bester, 1957). The teleport feature in SL has a long history in popular culture and is connected with the perception of virtual co-location and a sense of instant proximity that contracts a geographical sense of the planet. Wiener (1954), the founding father of cybernetics, conceived of the modern design office in which he imagined an architect using a device he called the 'Ultrafax' whereby a facsimile of all documents could be sent to the construction site.

> In short, the bodily transmission of the architect and his documents may be replaced very effectively by the message-transmission of communications which do not entail the moving of a particle of matter from one end of the line to the other. (p. 98)

Wiener further imagined physical teleportation:

> It is amusing as well as instructive to consider what would happen if we were to transmit the whole pattern of the human body, of the human brain with its memories and cross connections, so that a hypothetical receiving instrument could re-embody these message in appropriate matter, capable of

> continuing the processes already in the body and the mind and of maintaining the integrity needed for this continuation by a process of homeostasis. (p. 96)

From the imaginings of scientists such as Wiener has evolved SL, whereby the modern design office can not only share images and documents in real time, designers can virtually 'be' anywhere as a digital embodiment that can teleport around the world at fantastic speeds.

The power of the imagination to conjure both improbable and possible worlds into existence has an ancient history in art and religion (Grau, 2003; Wertheim, 1999; Wilson, 1963). Creativity was imbued with an almost mystical origin, as it was once considered to be reliant on communion with the gods (Grau, 2003; Root-Bernstein, 2003a; Wertheim, 1999; Wilson, 1963). From the Renaissance until the 20th century there were efforts to chase mysticism from scientific enquiry that led to pedagogical theory and practice that made a rational distinction between the sciences and the arts (Root-Bernstein, 2003a; Watson, 2005). Consequently there arose a mistaken belief that creativity and imagination had little or no place in scientific enquiry (Root-Bernstein, 2003a). Logical positivists believed that reality was objective, physical and tangible, while the arts were thought to be subjective, intuitive and intangible. Empiricism held sway until Einsteinian physics began to undermine our confidence in 'reality' itself, and it was discovered that sub-atomic particles appeared to be conjured into existence by the observer instead of having a physical objective reality. Suddenly, science became as odd as fiction, and parallel universes were proven 'realities' (Chown, 2007). Today there is no such thing as one reality and one truth, but infinite realities and infinite truths, and the obvious ceiling to our imagination is our own disappointing capability. Despite our all-too apparent limitations, our design capability is already far beyond that of the beginning of the 20th century, and it is predicted that we will see the equivalent of 20,000 years of change rocket past in the next hundred years (Garreau, 2005; Kurzweil, 2005).

Even a rudimentary understanding of quantum physics, advances in nanotechnology, computing and advanced materials can expand the scope and imagination of a designer to contemplate innovations. Innovative scientists and technologists have always used creative techniques with their imagination, connecting their consciousness with a deeper understanding of our world. For Root-Bernstein (2003a), the arts and sciences should in fact support each other in the innovation process: 'the arts contribute to scientific innovation through fantasy that is to say though the generation of possible worlds that scientists can test according to the constraints of what is known about the real world' (p. 267). In SL there is a huge diversity of user-generated content, with some residents going to laborious extremes to re-create their view of 'reality' while others create fantasy worlds with animal-like avatars or build castles in the air. Some even experiment with artificial life and AI (Goertzel, 2007).

SL is a very flexible 3D virtual world that enables designers to create interactive designs with a social user interface (Tapscott & Williams, 2006). Thought experiments, simulations and models have often been used to assist science and the innovation process and SL can also be thought of as providing the same assistance. There is a constant danger however that these simulations may be confused with the actual subject, and while there is a constant interplay between the actual and the virtual in SL, modelling has also caused problems in science, such as the computer modelling of evolution (Margulis & Sagan, 1997). SL offers a low-cost exploratory and experimental environment based on bits rather than atoms in which innovative ideas can be rapidly iterated. The visualisation of a world such as SL offers agile design innovation opportunities and experimentation commonly applied in science and technology (Highsmith, 2004).

2.13. Knowledge creation and imagined worlds

Von Krogh et al. (2000) noted that a number of successful innovators have used imagined worlds to inspire employees to see new and unique products and services of the future. Dr Helmut Volkermann, who was the Director of R&D at Siemens in the 1980's, created a virtual team, an imaginary group of people from the future who are able to visit the present and past and have special names and distinctive attributes. Volkermann would then introduce an everyday entrepreneur to the mix. In this imagined scenario they would ask, ‘I would like to know more about the future, and make my company the best for your society. Can you tell me how to do this?’ (Volkermann cited in Von Krogh et al., 2000, p. 167). Volkermann wrote a thousand pages about the team’s adventures, complete with in-depth dialogues. Using the Socratic method, Volkermann allowed this virtual team to explore the future and the past in his head. The importance of asking the right questions to gain insight and using the imagination for foresight are essential parts of knowledge creation and design innovation (Root-Bernstein, 2003b; Von Krogh et al., 2000). Kurzweil (1999, 2005) also used the Socratic method to imagine near and distant futures. Another thought experiment by Volkermann, designed to inspire innovation, was the Xenia, or Knowledge City.

> My vision is that there are cities where the knowledge of experts is not isolated and does not rest just in their heads. Knowledge is in the air, and everybody who is interested can use it. Someone who wants to solve problems and enter a knowledge city may end up finding something she did not expect or get advice just to try something different – like wading barefoot through a fountain. The main slogan for a knowledge city is “Meet people, communicate, think: gain knowledge through contemplation! Put knowledge into practice: act!” (Volkermann cited in Von Krogh et al., 2000, p. 169)

For Volkermann, the city metaphor could represent knowledge in the following ways:

- the topology and layout
- the design of buildings – events and exhibition spaces
- a supply of intangible goods in multimedia form
- a display of meta-knowledge through signs all over the city

For example, different streets and buildings contain different types of knowledge: a tower could be seen as symbol of vision and the big message on the front of the tower advertises that vision; billboards and posters advertise ideas, problems, knowledge and solutions (Von Krogh et al., 2000). In SL the whole concept of a 'knowledge city' could be truly brought to life through 3D graphics and interactive scripting using LSL (Purbrick & Ondrejka, 2006).

In addition to these advantages, in SL there is the ability to create stimulating multimedia virtual environments that can provide video, audio, and an immersive sensory experience, all in real time, for participants from around the world. Before SL Siemens employed Volkermann's concept of 'ateliers of innovators', which were miniature knowledge cities designed to provide exciting stimulus to participants to inspire and excite their creativity and imagination. These knowledge cities were carefully created homes for knowledge work to provide an ideal setting for sharing tacit knowledge creating ideas. The Siemens ateliers of innovators were inspired physical and virtual spaces such as a conference room with multimedia displays, photos, colourful pictures, and anything else to inspire creativity. There were moderators, editors and designers there to help the focus group and provide specialist groups with useful background information. They also provided technical help with computer networks etc., and caring experts and conversation managers to help smooth the conversation. They used a 600 square metre room with flowers, computers, charts and other equipment. 'Here is really the place to think!' declared one manager (Von Krogh et al., 2000). SL allows a designer to create a space similar to what Siemens had physically designed, at a faction of the cost and available to a dispersed project team.

Thus creativity can be assisted by the creation of imaginative worlds and this in turn links to the cognitive science of perception and consciousness (Riva et al., 2007; Riva & Waterworth, 2003). The more someone in a virtual world experiences co-presence, the more the participants will share a common situational awareness and sense that they are in the same place at the same time (Panteli, 2009; Riva, Davide, & Ijsselsteijn, 2003; Schroeder, 2002). Virtual architecture and virtual objects both add another layer of contextual, non-verbal communication to the participants in a virtual face-to-face meeting in SL. These cultural artefacts very quickly communicate the intended purpose and context of a meeting, and continue to provide a shared virtual environment that conveys social cues. Companies such as IBM have constructed elaborate conference centers with staging in order to suggest to the SL visitor that that space is intended for knowledge transfer in a situation similar to an actual world experience. This issue of design innovation and knowledge flow within SL is at the core of cybernetic knowledge regulation and research into whether the virtual ecology will enable or limit the knowledge creation life cycle.

2.14. Lessig's cybernetic knowledge regulation

In second-order cybernetics, feedback provides a systematic means of advancing the epistemological evolution of design innovation. The barriers and enablers of knowledge creation can be examined as knowledge regulation and flow (Lessig, 1999; Thomassen, 2003; Von Krogh et al., 2000). Lessig (1999, 2007) argues that there are four modalities that constrain and enable the free flow of ideas and knowledge rights which are based on cybernetic principles of feedback and control. This provides us with a cybernetic framework to consider both barriers and enablers and how we can improve knowledge creation and creative collaboration within a virtual innovation ecology by addressing what these modes are and how they are regulated.

Lessig's modes are:

- market
- architecture
- law
- norms

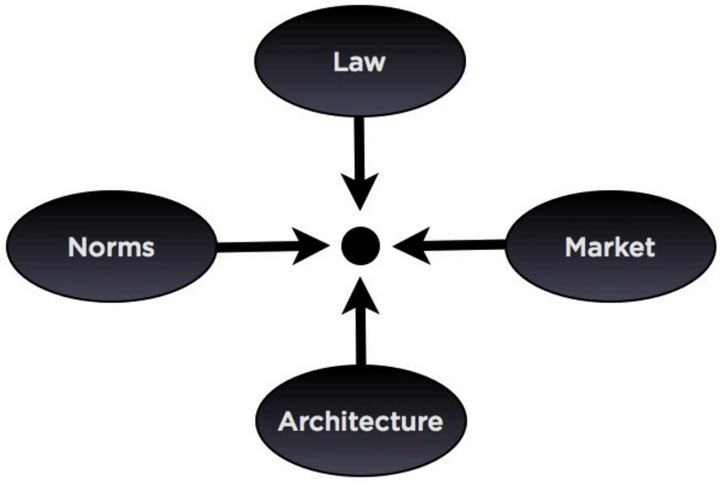

Figure 2. The four modes of regulation (Lessig, 2004).

Lessig (2004) explained that ‘At the center of this picture is a regulated dot: the individual or group that is the target of regulation, or the holder of a right’ (p. 121). While he acknowledges that these four modes can either constrain or enable knowledge creation, Lessig is largely focused on the regulation and inhibition of innovation (Lessig, 2001, 2004, 2006). In his book *Remix* (2008), Lessig introduces the concept of hybrid economies and uses SL as an example of how that hybrid economy encourages design innovation. It could be argued that rather than considering these four dimensions only in the negative sense of constraint, they could be regarded as neutral regulators or enablers in a cybernetic system that provide either positive or negative feedback flow, depending on their variables. In this way we can explain both the constraints and enablers of knowledge flow and therefore design innovation through a closer analysis of the four dimensions of control.

Control and the human–machine interface was a prime concern of early cybernetics. It has been discussed by a number of writers that Wiener’s cybernetics was developed in the context of the Second World War and the ‘control revolution’ which sought technological means to produce social homeostasis that would obviate violent conflict (Boellstorff, 2008; Turner, 2006). Government and cybernetics share the same root etymology, and engineering has used the technique of governors to control engines. Lessig discusses his four modalities could instigate an almost irrepressible form of control (Lessig, 1999, 2006), and Boellstorff considers how corporate governance by game and virtual world developers, such as Linden Lab in SL, can be all-powerful. Game developers are often referred to as ‘Game Gods’ for their omnipotence, and like developers, Linden Lab rely on their Terms of Service to ultimately decide the fate of their residents (Balkin & Noveck, 2006; Boellstorff, 2008). Many have commented on the liberal benevolence of the Linden Lab management, but they are still omnipotent and feared by those who transgress (Guest, 2007).

Mitch Kapor, the designer of the very popular spreadsheet program *Lotus 1-2-3* and also the founder of the Electronic Freedom Foundation, Chairman of the Open Source Application Foundation and Director and Former Chairman of Linden Lab, has said, ‘Architecture is politics’ (Mau et al., 2004, p. 91). Lessig’s four modes all interact in a dynamic ecology. The architecture of hierarchical organisational structure imposes a top-down approach that carries through into the software code, reinforced by the law, and backed up by the normative values of the organisation. The Open Source software movement, open innovation, user-centric design, and the social innovation movement by contrast are closely aligned to democratic principles that aggregate the wisdom of the crowd and challenges restrictive, command and control, proprietary closed systems (Hamel, 2007; Hippel, 2005; Leadbeater, 2000; Lessig, 2001, 2004, 2006; Mau et al., 2004; Sterling, 2005). Toffler (1980) foresaw this democratising of design innovation when he coined the word ‘prosumer’ to signify an individual that is a hybrid producer and consumer of products. Bruns (2008) has recently argued that there has been a radical change in the production chain. The industrial model of producer > distributor > consumer has become outmoded in the knowledge age of Wikipedia and user-generated content, giving rise to a hybrid producer/user who at different times both produces and uses the output, what Bruns calls, ‘produsage’. Kapor, in an interview about SL and open source, said:

> If you look at the history of disruptive technology platforms, like the PC, like the Internet itself, it appears that SL, or more properly virtual worlds, are going through that same type of explosive

> growth that happens when you have a very open platform, in which the barriers to entry and participation are low, in which there's a lot of entrepreneurial incentive, and also a lot of idealism. And when you make the system open the way it is, with the open source client and more opening to come, people will invent fabulous applications of things to do. (Kapor, 2007)

Linden Lab has gone from a proprietary closed source code to an open source General Public License (GPL) for the client. Their servers already run on the open source Linux software, and they have extended this through to the SL application and the client software. This gives corporations that want to use it the ability to further shape SL to suit their purposes, and to benefit from the many independent developers who can contribute to the code's improvement. It is important to measure the effects of openness and to identify barriers to innovation so that continual improvement to the design innovation process in SL can take place. Ghosh (2005a) asks how do you measure value in the free software community? He advocated two approaches:

- categories of motivation – suggested sources of value inflow
- studies aiming to quantify the output of developers and the extent of collaboration, mainly measures of value outflow.

> Several studies have shown that it is possible to identify, in addition to concentrations of individual contributions, change over time; group identification by project; dependencies between projects; exchange rate between value attached to groups of authors; assorted demographics; free-rider and guild pressures; lurker coefficient, and more (Ghosh, 2005a, p. 166).

One advantage of SL is that there are numerous ways to measure value and collaboration between and within teams. This knowledge flow and creation is central to the Lessig model with its implied cybernetic approach of control and regulation.

2.15. Enabling knowledge creation

In the field of KM and design innovation, knowledge creation is seen as one of the key issues (Klein, 2008). For self-organisation and design innovation to emerge there must be a free flow of information and knowledge (Halal, 2008; Johansson, 2004; S. Johnson, 2001; Lessig, 2001, 2004, 2006; Thomassen, 2003; Thomassen & Bijk, 2003). Structured, hierarchical organisation tends towards bureaucratic conservatism that acts as a brake on innovation and inhibits individual creativity (Bryan & Joyce, 2007; Hamel, 2007; Teece, 2000; Von Krogh et al., 2000). The creation of novel ideas is an individual act, yet a social context is important to its inception and development. However, before we consider what motivates individuals to share their very best ideas, we should recognise the strategic importance of knowledge sharing and creative collaboration in the innovation process (Von Krogh et al., 2000). The knowledge economy is premised on the social interaction of the actors. Even in the case of individual acts of knowledge creation, this does not occur in isolation and is embedded in a vast network of social relations from cradle to grave. Design innovation, as a strategic competitive advantage within the enterprise, is almost always dependent on shared competencies and collaboration amongst employees (Chesbrough, 2003; Dixon, 2000; Teece, 2000; Von Krogh et al., 2000). The social capital of the firm will convert into its intellectual capital and its design innovation quotient (Smedlund, 2008). The knowledge itself is said to be collective, and the value resides in ‘common knowledge’ as a company asset.

According to Nancy Dixon (2000), ‘common knowledge’ is essential to the future viability of the firm. Knowledge is not just a strategic asset located in a firm’s experts; it is dispersed across the entire enterprise. Dixon (2000) cites theorists John Seely Brown and Paul Duguid, who maintained ‘Experience at work creates its own knowledge and as most work is a collective, cooperative venture, so most depositional knowledge is intriguingly collective – less held by individuals than shared by work groups’ (p. 19). Intriguingly, research has shown that most co-creators or people outside an enterprise who participate in an open innovation project online recognise that the brand, and not themselves, will own the resulting IP (Bughin et al., 2008). Many companies who solicit ideas from the public are careful to include a Terms of Service that explicitly states that the company will own any IP that is shared with the community or company. Dell computers' IdeaStorm is one example of this. Its Terms of Service state:

> You grant to Dell and its designees a perpetual, irrevocable, non-exclusive fully-paid up and royalty free license to use any ideas, expression of ideas or other materials you submit (collectively, 'Materials') to IdeaStorm without restrictions of any kind and without any payment or other consideration of any kind, or permission or notification, to you or any third party. (Dell, 2007)

In both education and business there is often a tension between policies directed towards the individual as opposed to collective knowledge creation and sharing. In Dixon's (2000) opinion,

> Many innovative ideas could not have been created by an individual, it took the diversity of minds and the synergy of ideas to reach the prized goal. Yet often organizations, by their reward policies or individualized performance goals, induce employees to report ideas as their own – in fact, to think of knowledge as an individual phenomenon. (p. 157)

There has been little research into the effect of rewards, incentives and motivation into knowledge sharing in SL. As SL has a flexible digital rights management (DRM) engine it is an excellent virtual ecology to see how these tensions play out in an economy that allows many different approaches to IP and knowledge sharing (Bainbridge, 2007; Rive et al., 2008). Therefore, if knowledge creation and innovation are social activities, the question remains: How does a firm's management stimulate collective knowledge sharing and motivate an individual to give up private claims for the collective good? Could individual employees be motivated by self-interest with the creation of knowledge markets, as suggested by Hamel (2007) and Bryan and Joyce (2007)?

Using Lessig's four modes that regulate knowledge flow we can understand how motives can work to support innovation in SL. For example 'norms' can motivate by supporting and encouraging knowledge sharing; 'market' can motivate by profit goals and financial return;

‘architecture’ can motivate sharing through peer-to-peer design providing access to files; and ‘law’ motivates creation through the reward of limited monopoly in copyright and patents.

The social dynamics of groups can play a significant part in the ability of teams to work successfully on innovative solutions together. One of the strong motivators behind participation in MMOs and virtual worlds such as SL is the desire to socialise and collaborate on team projects, (Benkler, 2005; Book, 2004; de Nood & Attema, 2006; Dibbell, 2006b; Ondrejka, 2006; Panteli, 2009; Rive et al., 2008; Schroeder, 2002). A European study states that this is stronger in the group under 25 years of age, with 17 percent citing social reasons for games. However, there is no differentiation in the study between online games and virtual worlds (Nielsen, 2008).

Von Krogh et al. (2000) argue that the ideal micro-community for innovation would consist of five to seven people from across diverse disciplinary areas. Johansson (2004) supports this in *The Medici Effect*, which argues that cultural diversity generates more innovation. The political economist Scott Page (2007) in *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies* cites evidence that shows how cognitive diversity, training and experiential difference contribute to greater innovation in management teams. In SL there are numerous design experiments and projects that look to tap the large opportunity created by the collaborative design tools. The Studio Wikitecture project, for example, allows designers and non-architects to design and build 3D projects with a large number of dispersed individuals in SL. Diversity can help to avoid the pitfalls of ‘groupthink’ whereby the ‘wisdom of the crowd’ is replaced by herd mentality and diverse opinions and minority information are ignored (Sunstein, 2006; Surowiecki, 2004). Groups can polarise and reach an incorrect consensus due to ‘cascades’ that are caused by incorrect information and/or bias caused by reputation. Disastrous decision-making, such as that seen in the Bay of Pigs, the *Columbia* space shuttle disaster and 9/11 has been attributed to the problem of cascades. Cascades can occur when members of a group follow others believing they either have the correct information or that their status confers greater importance, and so influence, on what those high-status individuals have to say.

Sunstein (2006) and Surowiecki (2004) both support the economist Fredrick Hayek's (1945) argument that pricing and markets are a 'marvel' of efficiency and accuracy for aggregating and dispersing information, and ultimately innovation. Prediction markets such as the Iowa Electronic Market and the Hollywood Exchange have proven to be remarkably accurate at predicting outcomes of elections and box office revenues (Tapscott & Williams, 2006). Pricing mechanisms and market intelligence can also help to avoid some of the problems identified by Condorcet's Jury Theory which reveals how group deliberations can result in incorrect outcomes (Sunstein, 2006).

According to May (2007), individuals fall into one of four natural abilities.

- Strategy – you're an idea person, a *thoughtstarter*
- Tactics – you're an action person, a *playmaker*
- Logistics – you're a process person, a *taskmaster*
- Diplomacy – you're a people person, a *peacemaker*

In order to maintain diversity in a self-organising design team it is important that individuals can identify their own strengths and weaknesses and those of others.

The importance of face-to-face meetings for tacit knowledge sharing and design innovation presents SL with a significant challenge (Rive et al., 2008). Castronova (2005) points out that avatar appearance can separate and distance potential collaborators in virtual worlds. However, avatar anonymity can also remove inhibitions for those who might not like to question their boss or are shy to express their opinions (Suler, 2006). Thus, it is of strategic importance to the management of the firm to understand what motivates knowledge sharing and creative collaboration in order to support both daily operations and design innovations, (Teece, 2000; Von Krogh et al., 2000).

2.16. Motivating knowledge creation

Although both KM and design innovation are considered important aspects of the knowledge economy, knowledge creation is treated by some as something of a 'black box' (Klein, 2008). Some authors such as Von Krogh et al. (2000) have recognised the barriers of knowledge creation, however they focus primarily on the enablers. For them there are still so many barriers due to the limits of KM; the word 'management' implies control and 'knowledge creation is a fragile process, one that is not amenable to traditional management techniques' (p. 18). Teece (2000) is in agreement with Von Krogh et al. that organisations are challenging places for knowledge creation, and that bureaucratic control is a significant barrier to innovation and the generation of intangible assets. The barriers include the disapproval of a boss, or other executives, if an individual expresses an unpopular opinion or suggests an innovation path not officially backed by management (Bryan & Joyce, 2007; Chesbrough, 2003; Hamel, 2007; Von Krogh et al., 2000). Organisational care is seen as an important way to attempt to overcome barriers such as mistrust, fear and employee dissatisfaction. The importance of the company's ethical position and its articulation of its vision are also crucial in encouraging co-creation and commitment to company strategy (Bughin et al., 2008; Hamel, 2007; Von Krogh et al., 2000). Von Krogh et al. (2000) wrote that

> Knowledge creation puts particular demands on organisational relationships. In order to share personal knowledge, individuals must rely on others to listen and react to their ideas. Constructive and helpful relations enable people to share their insights and freely discuss their concerns. They also enable micro-communities, the origin of knowledge creation in companies, to form and self-organise. (p. 45)

Linden Lab is one example of a management style that seeks to democratise innovation by liberating the creativity of self-organising teams and promotes a very open approach to design innovation that encourages daily interaction with residents in the building of SL (Hamel, 2007). One of the biggest barriers that has been identified is knowledge hording – the possession of knowledge can be seen as an individual advantage. This is often reinforced by the actions of the

Human Resources department and the management (Liyanage et al., 2002; Teece, 2000; Von Krogh et al., 2000). The support and retention of both human and intellectual capital are seen as vital to knowledge-based enterprises and this has to be encouraged through trust and rewards related to knowledge sharing and building social capital (Lin, 2001). Research has shown that 40 percent of would-be co-creators in SL will not co-create with companies that they dislike or do not trust, and that brand affinity is the strongest motivator for individuals co-creating with companies (Bughin et al., 2008). According to Goman (2002), the five top reasons that people don't share what they know are:

- People believe that knowledge is power.
- People are insecure about the value of their knowledge.
- People don't trust each other.
- Employees are afraid of negative consequences.
- People work for other people who don't tell what they know.

All of these reasons are related to motivational issues that require more research and management solutions. Goman (2002) notes that education encourages students not to share and tends to emphasise individual pursuits over collaboration, and this was partially revealed in exploratory research in SL (Rive et al., 2008). She recommends a reward system that motivates knowledge sharing and teamwork, and points out that this does not have to be a monetary reward, as reputation can provide a powerful intrinsic motivation. The psychologist Csikszentmihalyi (2004) has shown evidence that money is not necessarily an indicator of happiness, and so by inference may not be an effective motivator in all cases. The motivation for participation in open innovation and co-creation projects will vary from individual to individual, and will also depend on the difficulty of collaboration, and the time required (Bughin et al., 2008). Research by McKinsey and others has shown that while rewards and fame are important motivators for some co-creators, many are strongly motivated by the desire to see their idea become a reality and to contribute (Bughin et al., 2008). Gell-Mann (1994) describes how incentives provide selection pressures in an economy and how computer simulations of markets can benefit from an evolutionary model. He argues that 'Human ingenuity will often find some way to profit by the incentives that exist, just as biological evolution will frequently manage to fill some vacant ecological niche' (p. 323). Motivation is a key component in the four modes of knowledge regulation and suggests a way forward in designing a new cybernetic model to interpret design innovation in SL based on biological feedback concepts.

2.17. The evolution of a new cybernetic model

This literature review has identified a current gap in the research with respect to design innovation models and a second-order cybernetic approach to knowledge creation in virtual worlds, specifically SL. The question of design innovation in a virtual ecology requires a reformulation of mechanical models to fit a biological second-order cybernetic systems model that can account for knowledge creation and creative collaboration in SL. Research is required to identify the cybernetic regulators that will enable the symbiotic knowledge creation necessary for design innovation, as well as the negative feedback inputs that are inhibiting this desired outcome.

The current models of design innovation and knowledge creation have been reviewed and gaps have been identified. Here begins a review of the theories that could be applicable to a new theoretical framework that adopts an ethnographic case study approach to the research. The relative strengths and weaknesses of the SL design innovation ecology are explored within a second-order cybernetic framework using an ethnographic approach. Historically, ethnography has placed great importance on travel, experience, and face-to-face interaction as a means of establishing the ethnographer's authority and the authenticity of their research (Hine, 2000). However, authorship and epistemological theory in qualitative research came under threat in the 1980s from fields that regarded ethnographic studies as 'soft' and non-scientific because of the subjective participation of the ethnographer (Denzin, 1997; Hine, 2000). 'Rather than being the records of objectively observed and pre-existing cultural objects, ethnographies have been reconceived as written and unavoidably constructed accounts of objects created through disciplinary practices and the ethnographers embodied and reflexive engagement' (Hine, 2000, p. 42).

Some anthropologists have denied that cyberspace is an appropriate area for ethnographic study, however there has been a wave of researchers who have recognised the profound importance of the Internet and the ability for participant observers to explore meaning in social networks such as Twitter and Facebook, and they have validated cyber-ethnography moving beyond these relatively simple social media into virtual environments such as *World of Warcraft* and SL (Boellstorff, 2008, 2009; Hine, 2000, 2005; Kozinets, 2002; Rybas & Gajjala, 2007; Shields, 2003).

2.18. Findings

This literature review has revealed a number of gaps in the research into design innovation, and in particular the cybernetic approach to a virtual design innovation ecology in SL. A second-order cybernetic model that considers the epistemological evolution of design innovation can reveal the regulators using Lessig's four modes that provide feedback in the virtual world SL and can consider what enables design innovation amongst design teams in a symbiotic virtual ecology. A theoretical framework supported by cyber-ethnographic research can provide models for understanding how the fidelity of a virtual simulation can regulate knowledge creation, and how cybernetic feedback regulators inhibit or enable knowledge creation and collaboration in SL during the life cycle of design innovation.

While there have been ethnographic studies of design and anthropology has been applied to participatory design, there are relatively few studies of how a virtual ecology can regulate the design process. The general ethnographic approach of researchers in SL such as Boellstorff (2008) and Malaby (2009) have been extended by more focused research into virtual social networks by Panteli et al. (2009). However, despite the importance of design innovation and a trend towards distributed, virtual design teams, there has been little research directly addressing the question of what regulates design epistemology and justified belief in a symbiotic virtual ecology. Nonaka and

Takeuchi (1995) and Von Krogh et al. (2000) signalled the way to understanding how tacit knowledge creation might be enabled highlighting the importance of context or as they described it 'Ba', and Hussi (2003) provided a framework for the recognition of intellectual capital within KM. Von Krogh et al. (2000) extended 'ba' to allow the formulation of knowledge theory that could include design innovation in a virtual world described by 'cyber ba', however, it remained for Lessig (1999, 2001, 2004, 2006, 2008) to apply an implicit cybernetic model to explain how his four modes could regulate knowledge creation in SL. The researcher found little explicit application of second-order cybernetics to the design innovation process in a virtual world, with the exceptions of Heylighen (2004) and the Global Brain movement; the biological metaphors of Kelly (1994); and the evolutionary epistemology of Matruana and Varela (1980, 1992); Margulis (1970, 1991, 1996, 1999); Montague (2007); and Lovelock (1979). This thesis attempts to contribute to the field of design innovation, and in particular how it is regulated in a symbiotic virtual design ecology such as SL, with three new and modified models: the spectrum of fidelity; indosymbiosis; and Lessig's four modes of knowledge regulation. The details of this new theoretical framework are explained in the next chapter.

CHAPTER 3
3. THEORETICAL FRAMEWORK

Every human being is interested in two kinds of worlds: the Primary, everyday world which he knows through his senses, and a Secondary world or worlds which he not only can create in his imagination, but which he cannot stop himself creating.

—W.H. Auden

3.1. Introduction

A number of researchers who have acknowledged the difficulties faced by the social sciences have nevertheless carried some of those difficulties over into cyber-ethnography, or the study of online cultures. While there are important differences that arise between a virtual world and human activity in a physical context, many of the theories and models for considering those differences are inadequate for the task (Guimaraes, 2005; Hine, 2000, 2005). The theoretical framework discussed here provides alternative models and extends existing theory to apply a theoretical perspective for differences between the actual and the virtual worlds. It involves a qualitative ethnographic approach that observes and records participant informants in case study research. This approach revealed that models that apply to physical presence could also be used to describe design innovation and knowledge creation in a virtual world.

There have been a number of different terms applied to the study of online and Internet behaviour and subtle variations between the schools who use them (Boellstorff, 2009; Hine, 2000, 2005; Kozinets, 2002; Rybas & Gajjala, 2007). In this thesis the preferred nomenclature is 'cyber-ethnography' as it implies a cybernetic discourse; suggests a field that can incorporate virtual worlds; and at the same time avoids the ambiguity of the word 'virtual'. This research focuses on design innovation and has followed the lead of other researchers by taking an ethnographic approach that borrows from the fields of ethnographic design and anthropology (Hine, 2005; Sanoff, 1990; Suri & IDEO, 2005). All technologies are cultural artefacts and are therefore appropriate subjects for ethnographic research (Hine, 2000, 2005; S. M. Wilson & Peterson, 2002).

The virtual versus the real is a false dichotomy that introduces problems into cyber-ethnographic methodologies, especially when the informants regard the virtual as more ‘real than the real’ (Fornas, 2002; Guimaraes, 2005; Heider, 2009a; Loke, 2009; Shields, 2003; T.L. Taylor, 2006). The emphasis is not on ‘truth’ but on understanding the meaning accorded the ‘social reality’ of the informants; we are strangers in a strange land, if you will, who must learn the ways of the digital natives while participating in their culture (Boellstorff, 2008, 2009; Denzin, 1997; Flick, 2006; Guimaraes, 2005; Heider, 2009b; Hine, 2000, 2005; Panteli, 2009; Wilson & Peterson, 2002). The culture of SL benefits from a cyber-ethnographic approach as there are many challenges and barriers to understanding the shared meaning of the residents and the resultant confusion of the ‘noobs’ (new residents) (Au, 2008; Boellstorff, 2008, 2009; Castronova, 2003; Guest, 2007; Meadows, 2008).

It is argued here that the dichotomies of the virtual versus the real, and online versus offline are problematic and artificial boundaries imposed by some ethnographers who attempt to delineate spheres of interaction and research which are often not recognised by the informants, and do not accord with either current epistemological or scientific theory. Even when the informants do use language that implies they believe in this dichotomy, such as when they talk about ‘RL’ (real life) as opposed to SL, they will also often mention a blurring, or some confusion, when one intrudes on the other (Au, 2008; Boellstorff, 2008; Fornas, 2002; Guest, 2007; Heider, 2009a; Loke, 2009; Meadows, 2008; T.L. Taylor, 2006). This thesis seeks to avoid this confusion by approaching SL as an alternative reality without imposing a value judgement as to which reality has more validity.

The qualitative ethnographic approach tends to eschew a formal scientific hypothesis, however this theoretical framework has adopted Yin’s (2009) formulation of a proposition that follows on from the research questions.

The gaps that were identified in the Literature Review (Chapter 2) encouraged three new and modified models based on earlier research, and then following the case studies provides the foundation for a new cybernetic model, *indosymbiosis*, for understanding what enables knowledge creation in a virtual design innovation ecology in SL. The early cybernetic emphasis on explicit knowledge creation and its close association with VR suggested the formulation of a model called the spectrum of fidelity which provides a framework for interpreting the perception of presence and its relation to social co-location as a prerequisite for design innovation. A more ambitious model, called indosymbiosis, is an attempt to consider a biological knowledge life cycle based on second-order cybernetics and ethnographic studies of knowledge creation within a virtual world using biofeedback models. Lessig's four modes of regulation also inform the theoretical framework and assume a central position in attempting to describe how architecture, norms, markets and laws regulate design innovation amongst cyborgs or cybernetic organisms in SL. All of this is subsumed under design theory and the reformulation of a relatively young discipline with the advent of design in virtual worlds.

3.2. Design theory

The design discipline is still relatively young and is undergoing massive change as previously unimagined technologies converge and almost every area of human endeavour comes under its purview (Mau et al., 2004). The Literature Review revealed a dearth of design theory that pertained to this area of research and suggested the formulation of new theories based on a second-order cybernetic approach.

In the 20th century design became a recognised discipline typified by the Bauhaus movement and the work of Raymond Lowey (Wolfe, 1993). The word 'design' has retained the original DNA of its 16th-century Italian ancestor and has further developed into numerous subtle derivatives (Mau et al., 2004). Art, modelling and purpose all find expression in the vast landscape of design disciplines as diverse as industrial design, digital design and biotechnology, and as different as architecture, the modelling of a physics experiment, virtual world construction and online games – yet these all share a fundamental approach that moves from conception, to planning, and concludes with execution. However, in all of these fields, by its very nature, design is essentially virtual.

Today the ability to design and construct at a molecular level is creating designs that can't be seen but can fundamentally affect life itself (Kurzweil & Grossman, 2004; Mau et al., 2004; M.C. Taylor, 1997). As hardware and software begin to cross-pollinate with human design we are encountering deep philosophical and political questions which will challenge humanity's identity, psyche and future (Broderick, 1997; Drexler, 1986; Garreau, 2005; Physorg.com, 2008; M.C. Taylor, 1997). From its primitive origins design has always been virtual and has been closely related to the communication and representation of the actual or transcendent (Grau, 2003; Heim, 1993; Wertheim, 1999). Modelling and directed action or planning is not something unique to humanity but something all living things do; even microbes model the world and simulate reality, and in a sense design (Margulis, 1970, 1999; Margulis & Sagan, 1991, 1997; Montague, 2007; Skoyles & Sagan, 2002).

The growing popularity of co-design and so-called Web 2.0, or the read/write web that is characterised by mass innovation or mass collaboration is simply the trajectory predicted by cybernetic homeorthetic evolutionary theory (Hippel, 2005; Howe, 2008; Laszlo, 1987, 2007; Leadbeater, 2000, 2008; Margulis, 1970, 1999; Margulis & Sagan, 1997; Montague, 2007; Sagan, 1977; Skoyles & Sagan, 2002; Surowiecki, 2004). Cooperation and collaboration, or symbiosis in evolutionary design, has effectively been going on for approximately 3.5 billion years, ever since microbial communities started cannibalising each other and sharing RNA through a process of endosymbiosis (Margulis, 1970, 1999; Margulis & Sagan, 1991, 1997; Skoyles & Sagan, 2002).

Design implies a directed, purposeful approach to modelling and this is just what cybernetic scientists have shown to be the case, even in simple cell organisms such as E. Coli bacteria, ever since life could move (Bateson & Donaldson, 1991; Margulis, 1999; Margulis & Sagan, 1991; Maturana & Varela, 1992; Montague, 2007). The deep laws of cosmic evolution are at work in human design through the aggregation of information and knowledge in complex adaptive systems and are, in turn, counterbalanced by the second law of thermodynamics which dissipates information through entropy (Capra, 1983a, 1983b; Gell-Mann, 1994; Kurzweil, 2005; Laszlo, 1987, 2007). Design in SL is inevitably shaped and influenced by these great forces and epistemologies. The creation of a virtual world and the design of virtual objects are connected to an ancient artistic and cultural history that stretches back to the first cave painters which used the 3D relief of the rock to give heightened realism to their art form (Grau, 2003; Ijsselsteijn, 2003). Rather than being an after thought, SL is just the latest art form resulting from a long search for spiritual, philosophical and pragmatic virtual expression and design (Grau, 2003; Heim, 1993; Wertheim, 1999).

3.3. Theoretical proposition

This thesis has formulated the following proposition:

> *In order to design a virtual design innovation ecology, cybernetic regulators must provide feedback, and will either enable or inhibit design collaboration, and knowledge creation in SL.*

This theoretical framework emerges from the research questions of this thesis and relates to the case studies and design innovation in the virtual world SL. It applies a second-order cybernetic approach to the case studies and considers the context of a design ecology within that virtual world. More specifically, it considers knowledge creation and the epistemological context of design collaboration in SL which has an important correlation to 'presence' and a sense of 'being there'. In this chapter the research question is tested against a proposition and acknowledges the contribution of models of presence and cybernetic biology, and the 'knowledge life cycles' from Nonaka and Takeuchi (1995), Hussi (2003), Lessig (2006, 2008) and Von Krogh et al. (2000). One approach to qualitative ethnography is to provide a theoretical framework at the beginning of the research in order to apply a theoretical lens to study the specific culture and behaviour (Flick, 2006; Sayre, 2001). This is not intended as a hypothesis, which would be challenged by the ethnographic tradition (Creswell, 2009; Denzin, 1997; Flick, 2006; Sayre, 2001), but as recognition of the problematic nature of any researcher's epistemology (Denzin, 1997; Flick, 2006). By making the theoretical framework explicit the reader will be provided with a reflexive model of the researcher in order to filter the results of the data collection and subsequent qualitative interpretation of the research. This explicit approach is preferred to disguising assumptions hidden beneath a narrative based on implicit empirical positivism. The theoretical framework under discussion acknowledges the crisis in social science identified by Denzin, and the political, moral, and value-laden nature of all ethnographic research exposed by critical theorists, postmodernists and cultural studies scholars (Denzin, 1997). The challenges for ethnographic research relate to authority, representation and legitimation; such research must avoid reflexive circularity, which can undermine the whole value of the research objectives and outcomes (Denzin, 1997; Flick, 2006).

Creswell (2009) quotes Kerlinger's definition of 'theory' as 'a set of interrelated constructs (variables), definitions, and propositions that presents a systematic view of phenomena by specifying relations among variables with the purpose of explaining natural phenomena' (p. 120). The framework used in this research is built up from earlier models such as Lombard and Ditton's (1997) theory of presence. This theory provides a psychological explanation of a subject's knowledge creation process,and is further supported by Nonaka and colleagues' theories of tacit knowledge creation and innovative design within a physical and virtual context (Nonaka & Takeuchi, 1995; Von Krogh et al., 2000).

Second-order cybernetics gives the framework the evolutionary epistemological theory of design innovation, and shows how theories of mind and biological science can support the theoretical life cycle of an idea (Bateson & Donaldson, 1991; Maturana & Varela, 1980, 1992). Bateson's theory of the 'ecology of mind' and evolutionary biologists such as Margulis provide evidence to support the theories of collaborative or symbiotic design innovation in the three case studies presented here (Bateson & Donaldson, 1991; Margulis, 1970). The framework of this research provides a synthesis of these earlier theories that are brought together to explain the design innovation process in SL by applying original models, and how they relate to the primary and secondary research questions. The models used are:

- The spectrum of fidelity: A model devised for this research that accounts for the perception of presence in a virtual world. It has been designed to fit the theoretical framework to illustrate and describe a new theory of presence based on earlier work by Lombard and Ditton (Riva et al., 2003).
- The indosymbiotic life cycle: This model has been created for this thesis and was conceived to explain the life cycle of a design innovation in the SL context. It is partly based on the epistemological biology of Maturana and Varela (1992), Bateson's 'ecology of mind' (Bateson & Donaldson, 1991), and the Von Krogh et al., 2000 and Hussi (2003) models.
- Lessig's cybernetic regulators. This model is an adaptation of Lessig's four modes applied to SL. It explains how the four modes can inhibit or encourage creative collaboration, knowledge creation and innovation in SL (Lessig, 2004, 2006).

The three models are explained in more detail below, together with how they relate to the case studies.

3.4. The spectrum of fidelity

The spectrum of fidelity is an original model that allows an examination of how the subjects in the case studies perceive their experience without arguing about whether it is real or not, or questioning the validity of SL in the first place. At one extreme there are the low-fidelity models, the simplest informational unit, whereby the observer will recognise it as a simulation or model of the actual object; at the other extreme is a high-fidelity copy of the physical object which is indistinguishable from the actual. Figure 3 shows how the fidelity of a model can be viewed along this spectrum.

Figure 3. Spectrum of fidelity (Rive, 2009).

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‘Fidelity’ is used here to mean ‘the exact degree to which something is copied or reproduced’ (*The Compact Edition of the Oxford English Dictionary*, 1971). The purpose of this model is to assist us in determining to what extent a simulation can represent the actual, and to assess how a simulation may approach the same informational density as the actual when it is observed or communicated. This simple model assists us in understanding where current virtual worlds such as SL sit on this dimension, and in appreciating its limitations when we compare it to the physical, such as face-to-face communications, for example.

This is not to suggest that any one test of fidelity will be conclusive; many dimensions of fidelity are likely to aggregate in the perception of the participant. For example, a SL resident may consider two dimensions of fidelity to be equally important, for example those of spatial audio and the uninterrupted flow of the 3D image being streamed to their screen. If that SL cyborg, the cybernetic merger of human and machine, were surveyed, and the spatial audio was convincing, or of high fidelity but the 3D image was of lower fidelity, then the aggregate response could be the average of both responses. Obviously, the temporal nature of participation means that an exit survey would be more likely to be an averaged perception by the subject over an entire longitudinal study, or perhaps more heavily weighted to their most recent experience. However, to avoid the possibility that the most recent experience in-world may create biased outcomes in this study, regular monitoring of informant responses was carried out. This consisted of participant observation, surveys and interviews. A cyborg's opinion about fidelity is unlikely to be conclusive but simply a perception that will fluctuate according to their 'suspension of disbelief', or presence at that moment. The spectrum of fidelity model allows us to assess to what extent an individual member of a team, and by extension the whole team, perceives the fidelity of SL to help or hinder their creative collaboration at a particular point in time.

In the common parlance of the residents of SL, the offline world is referred to as RL or 'real life'. While the SL vs RL dichotomy is commonly referenced by the residents, it is also common for them to discuss a liminal blurring between these psychological states or realms (Boellstorff, 2008; Heider, 2009a; Loke, 2009). Some cyber-ethnographers claim that the actual self and the digital identity can never be one, and that there is always a distance between them (Rybas & Gajjala, 2007; Sundén, 2003). What this approach neglects to account for is the liminal blurring that increases with a technologically enhanced presence in which the participant becomes a cyborg (Riva & Ijsselsteijn, 2003). Furthermore, there already exists brain interface technology that allows individuals to move an avatar in SL simply by thinking where they want their avatar to go (Emotiv, 2010). Experimental techniques have been developed that also allow the user to control their avatar with gestures that have been reported to be more 'natural' and to enhance a sense of presence in SL (Terdiman, 2008).

As optical and aural implants become more and more effective it has been predicted by technologists that future neural implants will wirelessly connect to the Internet and present full sensory verisimilitude in virtual worlds that are indistinguishable from actuality (Barras, 2008; Drexler, 1986; Garreau, 2005; Kurzweil, 2005). At that point the distinction between offline and online identities will be almost completely blurred. With the Spectrum of Fidelity model it is not necessary to draw sharp distinctions between offline and online identities, or separate the virtual from the actual; it is also not necessary to go through the existential angst or metaphysical pain of what is 'reality'. The spectrum of fidelity can still accommodate theories of quantum physics and the subjectivity of the observer. The participant observer has been recognised by second-order cybernetic anthropologists, as well as proven in quantum physics experiments. This model will assist us in understanding the subject's perception of 'reality' and their sense of presence and engagement in the virtual space. It is useful for understanding the sensory perception of presence, but it neglects the important cultural and social dimensions. As the psychologist Riva has pointed out, 'experiencing presence and telepresence does not depend so much on the faithfulness of the reproduction of "physical" aspects of "external reality" as on the capacity of simulation to produce a context in which social actors may communicate and cooperate' (Riva & Ijsselsteijn, 2003, p.9). The fields of psychology and anthropology provide another perspective on the common view that reality is somehow an objective truth. Alternatively, 'reality' is itself a 'consensual hallucination', and there is the 'perpetual illusion of non-mediation' (Riva & Ijsselsteijn, 2003, p.5). In SL it is possible to consider the 1D spectrum of fidelity as well as how the virtual has a transcendent quality which lifts it off the flat 2D page (which is conveying this information to you here), and moves it into a 3D simulation that can display three axes, sound, 2D movies, animations, and is on the cusp of haptic, olfactory and tactile sensory stimulation.

At the heart of this research are the arguments that design innovation matters, and that knowledge sharing and creative collaboration benefit the innovation process. There are also clear trends towards both globalisation, and the virtualisation of environments, whether the modes are social, play or work (Friedman, 2006; Shields, 2003). There has been a long tradition of immersive virtual art and so it can be assumed that the desire to overcome the technical and social limitations of virtual worlds and VR will remain an objective until advances in bandwidth, sensory stimulation, and computing make the virtual design studio of the future a reality (Grau, 2003; Mau et al., 2004).

3.5. Face-to-face fidelity

The spectrum of fidelity can also be useful with regard to the analysis of how close an SL experience can come to actual face-to-face communications, and by moving to a higher fidelity it might be possible to reap the benefits of tacit knowledge exchange as explained by Von Krogh et al. (2000) and Hussi (2003) within their theory of cyber ba, and shared knowledge creation. These assumptions are founded on a theoretical framework that has arisen from exploratory research and a literature review (Rive et al., 2008). It has been argued by Botella et al. (2003) that presence is not usually a conscious reflexive act and that an individual only becomes aware of the absence of presence when they return from a state of daydreaming. Lombard and Ditton (1997) suggested six concepts of presence: realism, immersion, transportation, social richness, social actor within medium, and medium as social actor. Riva and Ijsselsteijn further simplified this model of presence and described three states: social presence, physical presence and co-presence (the intersection of the first two) (Riva et al., 2003). This co-presence is similar to the 'co-action field' described by Tiffin and Terashima (2001). Riva and Ijsselsteijn also considered the importance of fidelity of media in relation to presence and how the more interactive, immersive and perceptually realistic something is, the more convincing the experience of presence is. The spectrum of fidelity is supported by the theories of Lombard and Ditton's realism, the co-presence of Riva et al., and the co-action field of Tiffin and Terashima. In each of the three case studies in this research an informant's perception of presence and their experience, according to the spectrum of fidelity, had an impact on their ability to communicate and convey tacit knowledge in order to achieve creative collaboration and ultimately design innovation in SL.

3.6. Biological models of innovation

Evolutionary biology and design innovation are entwined in this thesis and form the basis for a discussion of epistemology and normative regulators of knowledge creation and flow with respect to the case studies. The evolutionary biological theory of epistemology is a massive field of research that goes beyond the scope of this thesis (see the Appendix for more discussion and also Blackmore, 1999; Dawkins, 1976, 1986, 2006; Damasio, 1999, 2003; Gell-Mann, 1994; Kurzweil, 2005; Laszlo, 1963, 1974, 1987, 1991, 2004, 2006, 2007; Margulis, 1970, 1996, 1999; Margulis & Sagan, 1991, 1997; Maturana & Varela, 1992; Montague, 2007; Sagan, 1977; Skoyles & Sagan, 2002; Wolfram, 2002). This field underpins the very foundations of design innovation and predicates the sociological and ideological beliefs or paradigms about what enables design innovation and its models (Bateson & Donaldson, 1991; Benkler, 2005; Boyd, 2009; Clippinger & Bollier, 2005; Damasio, 1999, 2003; Ghosh, 2005a, 2005b; Kuhn, 1970; Kurzweil, 2005; Margulis & Sagan, 1997; Marinova & Phillimore, 2003; Tiffin & Rajasingham, 2003). Shared knowledge and knowledge creation are determined by, and also determine, an organisation's epistemological assumptions; they are the foundation of their knowledge vision, and norms (Christiansen, 2000; Dixon, 2000; Von Krogh et al., 2000).

According to Malaby (2009), the historical influence of technoliberalism shaped the Linden Lab CEO Philip Rosedale's approach to the architecture of SL, and that while acknowledging the social inevitability of the virtual world, it was still couched in terms of creative individualism. The founders of SL shared many of the same beliefs as the early thinkers at MIT, who were wary of bureaucracy and institutional control; suspected cybernetic computerisation; and emphasised the hacker as a technological hero instead of focusing on social collaborators (Brand, 1988; Levy, 1994; Malaby, 2009; Turner, 2006). It is worthy of note that the history of VR has also emphasised technical solutions and attention to the individual's user experience over social presence (Davies, 2003; Grau, 2003; Riva et al., 2003). In 1999, during the early days of Linden Lab and before the launch of SL, Rosedale had been experimenting with an individual VR device nicknamed 'The Rig' (Malaby, 2009). Malaby quoted Rosedale from an internal company wiki:

> Given my background there was always a tendency to focus a little bit on the technical because I found the technical problems to be so fascinating involved with creating this, but I think as a person

> who had a lot of passion for the idea, I was always struck by the expressive and not so much societal elements although I have to say: I think that a lot of the enthusiasm that I have now for the kind of social change or societal change that might result from something like SL getting global, or getting a lot bigger – to where it matters . . . I think a lot of that stuff I kind of came to understand more as we went along. (Malaby, 2009, p. 52)

Rosedale, in a cybernetic sounding discussion goes on to discuss how the social aspect of SL creativity emerged: 'I think that it was more emergent as we saw things start to happen.' The paradigm shift towards open innovation began with the realisation that knowledge sharing is an essential part of increasing the speed of design evolution and that requires an implicit belief in social evolutionary epistemology (Chesbrough, 2003; Ghosh, 2005b). Examples of this paradigm shift include the current popularity of social networks and the many writers who are the cheerleaders for user-generated content, Web 2.0, Enterprise 2.0, serious gaming, and the ReadWriteWeb (Au, 2008; Bryan & Joyce, 2007; Hamel, 2007; Howe, 2008; Leadbeater, 2008; Reeves & Read, 2009; Shirky, 2008; Tapscott & Williams, 2006).

The belief in user-led innovation and participatory design is beginning to hit the boardrooms and will influence a shift in norms towards open innovation that is premised on knowledge sharing and the hacker's ethic of 'information wants to be free' (Brand, 1988; Bughin et al., 2008; Hippel, 2005; Levy, 1994; Tapscott & Williams, 2006). Theorists such as Brand (1988) and Kelly (1994) influenced the founders of SL to incorporate biological theories into the architecture and norms of social networks on the Internet and within SL. These biological models have helped shape the evolution of the Internet and can assist in explaining the epistemology of design innovation in SL and the case studies in question.

3.7. The biological metaphor of indosymbiosis

In introducing the second model used in this research, indosymbiosis, which describes the life cycle of an inogism within a virtual design innovation ecology, it is important to clarify that this is a second-order cybernetic model based on biological theories, as opposed to the mechanical metaphors of design innovation. Evolutionary innovation is a biological model that provides the basis for this research's theoretical framework and enables the conceptualisation of these approaches. It is possible for design teams, within this model, to self-organise and constantly experiment, iterate, mutate and review designs in a less formal and evolutionary approach (Highsmith, 2004). The decentralisation and democratisation of innovation increases the diversity of the pool of ideas, assisting designers to adapt to change faster through greater engagement in the innovation process (Chesbrough, 2003; Hamel, 2007; Hippel, 2005). The symbiotic biological evolutionary model encourages a more dynamic, cybernetic approach based on the shared open innovation paradigm, as opposed to specialist R&D groups cloistered in a closed competitive mechanistic innovation process, such as Stage Gate (Chesbrough, 2003; Hamel, 2007; Hippel, 2005; Turner, 2006). The systems theorist Ervin Laszlo argues that the law of evolution affects everything from transformation of hydrogen into helium, to the outcome of societies, and that human evolution is no longer purely biological but sociocultural (Laszlo, 1987). Systems theory, second-order cybernetics, complexity theory, and homeorthetic evolution give a design innovation model the ability to account for a more symbiotic, dynamic, self-organising, self-replicating approach to shared, open-ended innovation (Hamel, 2007; Highsmith, 2004; Kelly, 1994; Nickles, 2003). Moving beyond the limitations of the 'black box' theory of innovation, epistemology can be viewed as a knowledge life cycle. or to coin a neologism, an 'inogism', that is, a symbiotic complex adaptive innovation organism. This can help to explain innovation and creative collaboration in a complex adaptive ecology. In biology organisms learn from their ecological interaction and design their world in terms of modelling it and in the sense of 'steering' or directing goals in an economic sense based on rewards and feedback within an ecology (Bateson & Donaldson, 1991; Montague, 2007). This biological metaphor is useful in terms of evolutionary epistemology and for understanding the design innovation in a symbiotic virtual ecology.

According to Maturana & Varela (1992) all we have in common as humans is a biological tradition, but our common experience means that we all share aspects of the world, for example how we design innovations; epistemology and knowledge are essentially social and symbiotic. In order to support evolutionary innovation the environment must nurture creativity and the sharing of knowledge, both tacit and explicit, and must be supported by those that regulate the necessary resources. This symbiotic epistemological evolutionary theory has described everything from simple cell organisms through to game design and abstract human thought based on cybernetic feedback, goals and rewards (Bateson & Donaldson, 1991; Damasio, 1999, 2003; Marinova & Phillimore, 2003; Maturana & Varela, 1992; Montague, 2007; Reeves & Read, 2009). The theory can also be applied to the design innovation case studies in this thesis. Evolutionary innovation can be imagined as a symbiotic metabolic pathway, and politics, psychology, economics and sociology can act as inhibitors or catalysts to design innovation. Just as a protein can inhibit the copying of a nucleic acid, so can office politics block an innovative idea in a virtual ecology (Hamel, 2007).

3.8. Symbiotic epistemology

When using a 'biologic' metaphor for design innovation, the concept of symbiosis can be seen as analogous to design collaboration, co-design and co-evolutionary user-led-design. Cybernetic theory and an understanding of symbiotic complex adaptive systems can explain how simple rules, random noise, and selections can interact with feedback regulators, and how by using a knowledge vision the evolutionary innovation process can be steered in the right direction. A number of writers have shown how the biological symbiotic model of innovation and the evolution of organisms relate to human epistemology and emergent technological innovation (Damasio, 2003; Kurzweil, 2005; Lazlo, 1987, 1991; Margulis, 1999; Maturana & Varela, 1992; Montague, 2007). The biologic metaphor argues that microbes are the essential ingredient for life on Earth and create a network of microscopic symbiosis that ties together the entire biosphere (Margulis, 1970, 1999). Humans are but one part of that network, and are more accurately described as a collection of microbial communities rather than the pinnacle of individuation. The metaphysical challenge to the 'self' has been taken up by cybernetic anthropology, biology and physics but our preconceptions are so deeply fixed in our psychosocial culture that the concept is unlikely to be overturned in the near future. Evolution and innovation are largely studies of informational complexity, derived from simple rules. Margulis claimed – and it is now widely accepted as mainstream theory – that the structure and function of all multi-cellular organisms are evolved from primitive microbes, and that organelles such as mitochondria in human cells can be traced to that primitive symbiotic evolution and live on in those forms (Laszlo, 1987; Margulis, 1970, 1999; Margulis & Sagan, 1991, 1997). She argued that the evolution of complex animals and plants could not have happened in such a short period of time through mutation and selection alone, but rather occurred by symbiotic co-opting of the functions of others by engulfing their organelles. The theory of endosymbiosis can be applied to innovation and ideation, and rather than totally relying on mutation and copy errors to produce random variety and novelty, innovative ideas or 'thought collectives' can arise though the consumption, integration, and combination of outside ideas, much like Kuhn's scientific paradigms (Kuhn, 1970; Margulis & Sagan, 1997). These symbiotic ideas, like bacteria, are dynamic and part of the greater ecosystem that provides the resources, energy and food for their growth, replication, and mitosis. According to Laszlo (1987),

> Out of the conditions created by evolution in the physical realm emerge the conditions that permit biological evolution to take off. And out of the conditions created by biological evolution come the conditions that allow human beings – and many other species – to evolve certain social forms of organization. (p. 4)

In *Making Virtual Worlds*, an ethnographic study of Linden Lab, Malaby (2009) applied a second-order cybernetic approach to explain how symbiotic self-organisation and the theory of emergence influenced the management philosophy of the lab's employees that in turn produced an effect and feedback in SL itself. The expression of ideas like physical phenotypes in this ideation ecosystem can appear in explicit forms such as 3D objects in SL, written text, movies or sounds, and can also be transferred though tacit knowledge transmission within the SL ecosystem.

The theoretical framework of this thesis places the designer in an important role in the innovation process but understands that the universal laws of evolutionary science govern them. Bruce Sterling, in his short manifesto on design *Shaping Things* (2005), traces an evolutionary history of human innovation from artefacts to product, to gizmo, to SPIME, to BIOTS. In this theoretical framework the design of an ‘innovation organism’ by cyborgs can be compared with the evolutionary transition that Sterling describes from unintelligent SPIMES to self-aware and biological BIOTS.

3.9. Indosymbiosis

Indosymbiosis (Rive, 2009) is a ‘biologic’ neologism that has been devised to describe an original theory that combines innovative ideas, computer networks, general AI and endosymbiosis, or the evolutionary theory of symbiotic life (Margulis, 1970; Margulis & Sagan, 1997). The biological theory developed by Margulis states that evolution occurred through a complex symbiotic union of primitive prokaryotes that engulf one another to evolve into more complex eurkaryotes, and that these microbes continued to support the evolution of complex organisms such as humans through symbiosis. Endosymbiosis describes an evolutionary theory that challenges the Darwinian view that evolution occurred through combat and conflict, and conversely argues it happened through symbiosis and networking. With indosymbiosis, one innovative design organism, an idea, or inogism, can consume or merge with another in an ecosystem that encourages and supports innovative evolution. According to Heylighen (2008), this does not have to be a conscious effort but is part of a cybernetic-evolutionary theory he calls ‘stigmergy’ in which one agent’s activities may inadvertently regulate the behaviour of another, increasing or decreasing friction. ‘If the change in the medium [ecology] brought about by this new action moreover happens to benefit another agent, that agent will tend to reinforce or support the change, thus in turn benefiting the first agent' (Heylighen, 2008, p. 294). Heylighen uses the examples of ants and termites to explain the paradox of cooperation: 'This mechanism is general enough to explain the evolution of cooperation even in the absence of any form of rationality or ability to foresee the consequences of one's actions' (p. 294). At a macro-level this evolutionary process, also known as emergence, can help to explain how primitive intelligence can contribute to the evolution of a higher order of complexity, and therefore design innovation (S. Johnson, 2001; Wolfram, 2002). This cybernetic regulation influences the ecology on a macro-scale and can partly explain the diffusion of innovation. However, it is limited from the point of view of individual behaviour, which may or may not be rational and could even include a conscious decision to cooperate on a design innovation project. A more complex model is provided by the consideration of other regulators such as Lessig's modes, which can enhance or diminish the flow of creativity and ideas, especially when considering a cyborg's explicit goal to design innovations.

This research defines 'indosymbiosis' as:

> An emergent innovation process driven by self-replicating ideas or 'inogisms' that evolve in a cybernetic virtual ecosystem, supported by micro-communities and an intelligent network of users, designers and leaders known as a hive or colony (Rive, 2009).
>
> An 'inogism' is a cybernetic design innovation organism or cyborg; a self-replicating innovative idea with a life cycle determined by a knowledge vision and final maturation described by a successful user ecosystem. (Rive, 2009)

The neologism 'inogism' is intended to suggest a biological metaphor and avoid 'memes', as this is already defined, if not loaded, with the analogies created by Dawkins, Blackmore (Blackmore, 1999; Dawkins, 1976) and the other neo-Darwinists. In other words, 'meme' already comes with a 'thought collective' which could confuse the reader. Fundamental to this concept is the recognition that the mechanical model is overwhelmingly dominant and pervasive, so much so that it often goes unrecognised as a metaphor at all, and remains implicit in KM and the innovation debate. A cyborg definition of the human–machine interface of SL and its cyborgs borrows from

Sterling's SPIMEs and BIOTS which describe the nanoscale living information agents who retain the metadata and history of their evolution (2005).

The theory of evolutionary innovation is underpinned by endosymbiosis; second-order cybernetics; homeorthetic system theory; autopoiesis; chaos theory; and the theory of a social evolutionary stable strategy. Core to this theoretical framework is the application of Margulis' serial endosymbiosis theory (SET) to evolutionary technological or human innovation as proposed by Kelly (1994). The benefit of the 'indosymbiotic model' is that it provides a number of features that are consistent with the common goals of the Agile innovation design process as described by Highsmith (2004).

Following Highsmith's (2004) recommendations, the features of indosymbiosis are that it is:

- creative
- agile
- emergent
- informal
- self-replicating
- self-organising
- lean and resourceful
- distributed
- plural
- symbiotic, collaborative, collective intelligence

In the Literature Review the current shortcomings of mainstream design innovation theory were described. In this section it is explained how the Nonaka/Hussi framework for tacit knowledge exchange and creativity in the innovation process may be improved. The mechanistic model of command and control management has been replaced by a knowledge vision and a leadership approach in which decision-making is devolved to micro-communities and distributed intelligence.

This approach also appreciates the effectiveness of Web 2.0, social media, and the wisdom of the crowd. This symbiotic cybernetic model can be seen in the context of the Semantic Web, a common framework that allows web applications to share and reuse data, and a quest for faster, more contextual knowledge creation and support with the ultimate objective of a merger of AI and creative design. This model is supported by Kurzweil's law of the accelerating pace of return and enables designers to 'sync' with the evolutionary homeorthetic trajectory to ensure faster design innovation.

3.9.1. The cybernetic regulators of indosymbiosis

According to Lessig (2006) there are four regulators of knowledge: norms; architecture; law; market. Lessig implicitly relied upon cybernetic theory with regard to concepts of feedback and control and these modes are explicitly reformulated here as the cybernetic regulators of feedback within indosymbiosis. Each of the modes can regulate the metabolic pathway and feedback of an inogism, or innovative idea. Here are some examples: the network neutrality of the Internet is an *architectural* ecosystem that supports the free flow of information and knowledge. The *norm* amongst hackers that 'information wants to be free' has supported innovation in the open source community. The copyright *law* can be argued by some to establish an incentive to create and by others to be a restraint on replicating ideas. And the *market* promotes and inhibits the sale of IP through pricing in a hybrid economy that can make a virtual object free, or it can be a 'sale item' that can be owned by an individual or a group.

An inogism, like an idea, is an abstraction that may be a discrete unit or a collection of supporting ideas, much like a multi-cellular organism is made up of diverse cells, RNA, DNA and supported by communities of microbes bounded by its outer semi-permeable membrane. Inogisms do not just appear out of nowhere; they are always born from the combination of older inogisms, descended from the most primitive encoding of life itself. Every inogism retains the 'DNA' of its parents and continues to consume other inogisms in a cannibalistic feeding frenzy. Mitosis, or the separation of an inogism into related but separate evolutionary paths, can happen at almost any step in the inogism's lifecycle. However, early branching (known as 'forking' in software development) or division can leave an inogism undernourished and prone to immature death or hibernation until conditions are more suitable for growth. Just as microbial organisms can survive for millions of years until the conditions are right for them to be reanimated, an idea can be stored and later revived before it continues to evolve.

Using Von Krogh et al.'s framework, the recommendation of micro-communities of five to seven people has been extended to the concept of the 'hive'. The hive is a member of the larger colony or 'hive mind' that can be made of numerous hives living symbiotically together and maintaining a cybernetic balance through a flow of resources, knowledge and information in a virtual ecology (Kelly, 1994). In the virtual world SL the presence felt by the cyborg is even more dependent on the social ecology of the environment than on the fidelity of the sensory perception. To quote Riva and Ijsselsteijn (2003):

> the criterion of the validity of presence does not consist of simply reproducing the conditions of physical presence (immersion) but in constructing environments in which actors may function in an *ecologically* valid way: in line with the emphasis that the ecological approach places on the primacy of action in perception; – action is not undertaken by isolated individuals but by members of a community who face ambiguous situations in a relatively coordinated way. (p. 12)

Many writers believe that there are underlying evolutionary laws that not only dictate the growing complexity of the cosmos but also steer humans through what Carl Sagan described as 'extrasomatic inheritance', or post-biological human evolution through culture and technology (Boyd, 2009; Heylighen, 2008; Kelly, 1994; Kurzweil, 2005; Maturana & Varela, 1992; Sagan, 1977; Skoyles & Sagan, 2002). The evolution of the human brain from primitive microbe through aquatic and reptilian ancestors has taken billions of years of building on the mistakes of the past. 'Evolution works by tinkering with what already works, with the result that new parts get built onto older ones even if the newer ones work in entirely novel ways' (Skoyles & Sagan, 2002, p. 13).

An inogism enters the innovation ecosystem via a host. All inogisms require a host and that host, in order to nurture and incubate their inogism, requires a supportive ecosystem. This could be something like cyber ba because inogisms cannot populate or metabolise alone for long. As discrete entities they are fragile, social and indosymbiotic. In other words, when you first create an inogism you must have all the necessary requirements of life to sustain it. What does an inogism require before it is born, and what are the significant stages and requirements of its lifecycle? The ecology for indosymbiosis is described on an abstract level below and then examples are provided to show how they might be regulated during the everyday design innovation process.

3.9.2. Indosymbiosis – the evolutionary life cycle of an inogism

Below is a summary of the key evolutionary steps in the recursive lifecycle of an inogism. It is worth restating that this is only a biological *metaphor* and a model for evolutionary innovation designed to describe aspects of collaboration and knowledge creation in design that are often neglected. The steps are not intended to suggest that this is a linear process, and are in fact recursive and can overlap with other inogism lifecycles at various phases of maturation. They should not be confused with the closed feedback loop of first-order homeostasis; they are more like the directed trajectory of homeorthetics. The following table summarises the different stages of an inogism's life cycle, describing the knowledge creation of a cyborg's design innovation and the ecological context for its regulation.

Life Cycle Stage	Description
1. Infection	A primitive inogism infects the host – an idea is born.
2. Recombination	The inogism combines with other inogisms and grows.
3. Incubation	The host incubates the inogism and nurtures it.
4. Hive	The host finds and rewards other cyborgs who feed the inogism.
5. Migration	The parents of the hive offer their own inogisms or design ideas.
6. Colonisation	The hive grows into a colony of hives; a new ecosystem.
7. Globalisation	The original inogism matures and the innovation goes to market.
8. Universalisation	New ideas consume and evolve with the original inogism.
9. Mitosis	Original DNA of the inogism replicates, mutates and evolves.
10. Population	The homeorthetic evolution and the complex adaptive cycle.

Table 1 – The life cycle of a design innovation organism, an inogism

Indosymbiosis describes the life cycle of an inogism within a virtual design innovation ecology. Prior to a review of the research data, this model provided a sketch (shown in Figure 4), or the initial theoretical framework of the research. This model provides a useful biological metaphor of how to enable design innovation in a virtual world such as SL. The numbered stages in Figure 4 are explained below:

1. **Infection** of a host by an inogism is similar to Dawkins' 'meme' (Blackmore, 1999; Dawkins, 1976) and can take place anywhere, either in SL or outside the virtual world, prior to the creation of their cyborg. A cyborg is created when a human logs in to SL. The idea that begins the indosymbiotic cycle may be either well developed or barely formed prior to the cyborg's infection.
2. **Recombination**: As in endosymbiosis, one inogism engulfs another, or as Kelly (1994), 'the membraned cells incorporated the bacteria and their informational assets as wholly owned subsidiaries working for the cells. They kidnapped the innovations.' (p. 371). The cyborg will then recombine the inogism with other inogisms in SL and will also draw upon ideas from outside SL. The membrane is semi-permeable; the virtual and the actual continually shift states.
3. **Incubation**: The phase when the cyborg thinks about and even plays with other inogisms that may contribute to the innovative design. SL is not a closed system but

like a biosphere or another ecosystem it has a semi-permeable membrane, with ideas flowing back and forth with the outside environment.

4. **Hive**: According to Kelly (1994), a hive mind is distributed but thinks as one, as if it was a superorganism. This self-organising emergent state would be the optimum state for a distributed design team but is more likely to occur in larger numbers. A hive can occur at a point when the cyborg feels ready to include others and may need help to progress the inogism; they can move on to build a hive of five to seven other cyborgs.
5. **Migration**: The group or hive feeds the inogism with their own inogisms and their DNA is swapped as ideas quickly evolve, mutate and co-create. This is an important phase in an innovation's life cycle as a hive or team must find support from the wider ecosystem and their self-organisation and direction will shape the survival rate of the inogism. An inogism is unlikely to continue to evolve as a discrete innovation without care, resources and constant feeding with other ideas (Von Krogh et al., 2000). The infant inogism will continue to adapt and evolve according to its ecology and this will eventually expand to include a migration to a larger ecosystem which could include others outside the hive, such as other groups, suppliers and customers.
6. **Colonisation**: In this phase a hive of inogisms may expand to consume other hives, becoming a hive mind or 'collective intelligence', and even engulf colonies of hives that freely share DNA and knowledge between each other in a swarm 'out of control' (Kelly, 1994). This can expand and evolve to such an extent that it defines an entirely new ecosystem or paradigm that is almost self-contained. This is equivalent to a paradigm shift; examples include electric power or personal computing and are said to be breakthrough or radical innovations (Highsmith, 2004; Hippel, 2005; Marinova & Phillimore, 2003; Teece, 2000). More modest innovations are defined by smaller

colonies and less self-containment, and are said to be incremental or modest innovations.

7. **Globalisation**: This step follows on from a runaway colonisation by a breakthrough innovation and is a hive mind ‘out of control’; the self-organising and expansionary phase of an inogism moves to globalisation. At this point the innovation attempts to spread throughout all possible areas of human endeavour. This phase is much like the behavior of a pan-global virus and could even have disturbing implications for general AI.
8. **Universalisation**: The original inogism is consumed, redesigned and adapted by the market. The original DNA of the inogism can be subsumed or remixed by other inogisms to become part of new inogisms which can adapt and evolve into unrecognisable descendants with only passing resemblance to their parents. Thus evolutionary innovations are irreversible (Chesbrough, 2003; Hippel, 2005; Rogers, 2003). The original idea may end up in a new industry, school of thought or embodiment through the demands of lead users in a novel design requirement.
9. **Mitosis** is the phase where a continually evolving inogism replicates itself by division. The new inogism may mutate, be consumed, or procreate with another inogism, or it might wither and die due to lack of resources in a new ecosystem. The copying of one inogism gives an opportunity for evolution through random influences, serendipity or simply informational entropy. The adaptability of any descendant inogism is dependent on how easily it can be reduced to bits and bytes and remodeled into a new species.
10. **Population** limits of any organism are determined by the ‘S’ curve of innovation and population growth, which predicts its diffusion into the larger ecosystem. Thus, the take up and evolution of an inogism by lead users can be followed by a rapid take-up

by the early majority and then by a tailing off and eventual decline, as the laggards are 'infected' by elderly inogisms (Hippel, 2005; Rogers, 2003). Meanwhile, in the final days of an innovation's life, when many would regard it as no longer novel, some will only just be discovering it. Meanwhile new inogisms spawned by the life cycle of previous generations will be infecting willing hosts in a new evolutionary cycle.

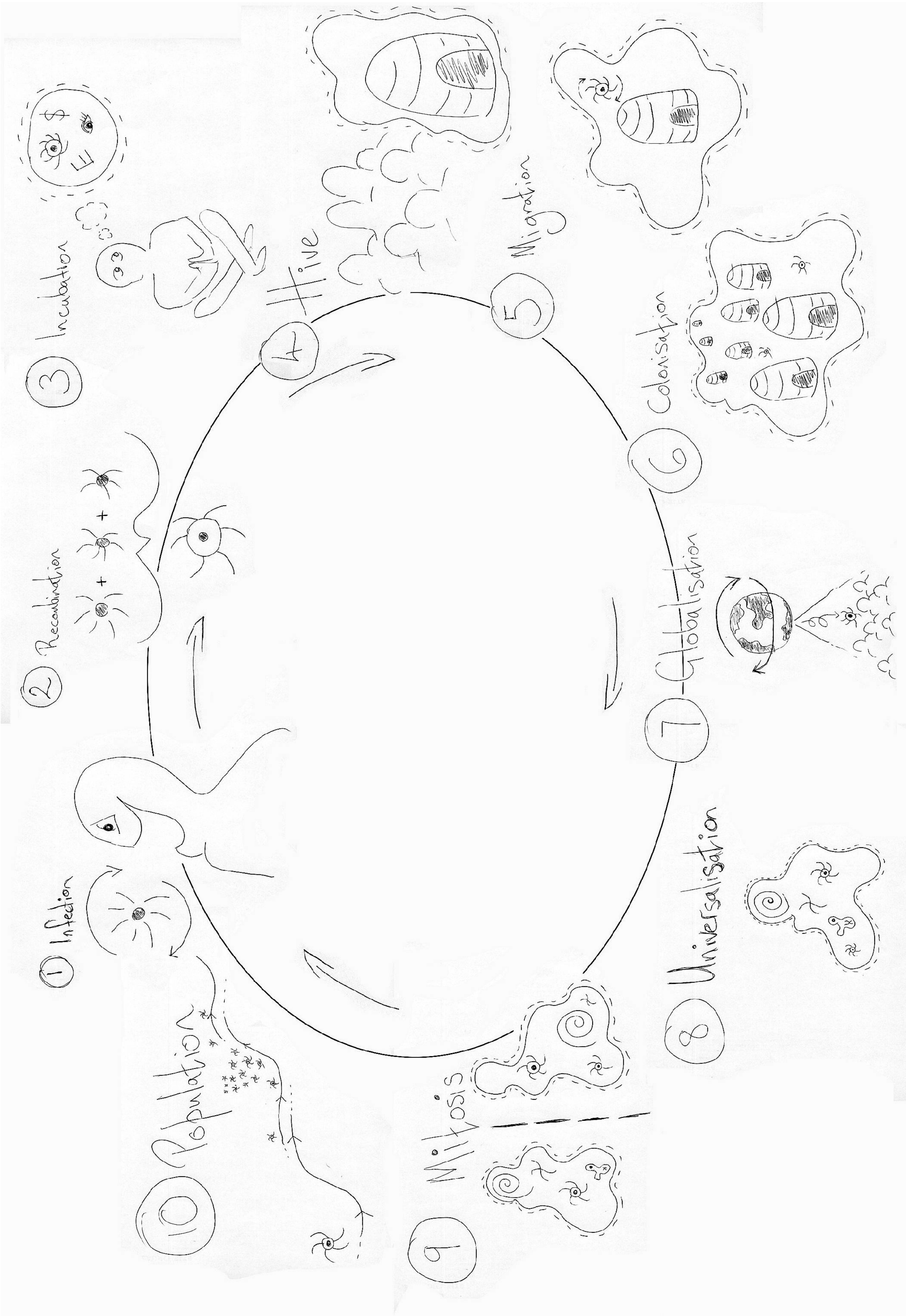

Figure 4. Indosymbiosis: A sketch of the evolutionary lifecycle (Rive, 2009).

3.9.3. Example of indosymbiotic regulation

Indosymbiosis describes a symbiotic social space or ecology inhabited by cyborgs in SL. Therefore, the description of a vibrant innovation ecosystem must entail an understanding of the social regulators and what can inhibit or catalyse creative collaboration and knowledge sharing through cybernetic feedback. Lessig assisted Linden Lab with understanding how modifications to the four modes of regulation could improve social dynamics, creative collaboration, innovation and ultimately customer numbers. Lessig's four modes – norms; architecture; law; and market – are remodeled in this research as cybernetic regulators in the process of indosymbiosis in SL. The four modes are interrelated and loaded with numerous assumptions, and even ideologies. In this theoretical framework an example will illustrate how each of these can impact on knowledge creation, sharing, and the evolution of design innovation. A number of people that were involved in the early set-up of SL and Linden Lab have claimed that it was Lessig's suggestion to allow the residents to own their own creations that turned the company around – it started attracting far greater numbers of subscribers (Au, 2008; Boellstorff, 2008; Malaby, 2009). Once the principle was agreed it became integrated in numerous ways into the SL experience, and became part of the architecture, norms, law, and market economy of the virtual world. The very concept of individual ownership of virtual objects is heavily rooted in a Lockean neo-liberalist approach to intellectual creations, and for Lessig this is paradoxical because of in that the virtual is recognised as a property, much like physical objects are.

In the knowledge economy it is the expression of ideas in both material and virtual form that determines value (Hamel, 2007; Porat & Rubin, 1977; Stewart, 2001; Teece, 2000; Von Krogh et al., 2000). Sterling's SPIMEs define the economics of the near future. As he argues,

> The object's virtual representations . . . can have stakeholders. For instance, it makes more sense to own shares of a company than it does to own physical pieces of a company. Like shares of stock, models of an object can be shown and distributed to a wide public. The models are more open than

real objects. The models can attract a huge amount of creative effort worldwide-if they can find a method to cluster human attention. (Sterling, 2005, p. 108)

Norms are one example of how Lessig's regulators can impact exchange in SL, and this is possibly the most powerful of all regulators in indosymbiosis. One particular norm that applies to this example is the incubation of SL around the end of 2003. The norm was based on the beliefs and values of the Linden Lab management, shareholders and Board of Directors and appears to have been deeply influenced by the 'Californian ideology', or that of 'creationist capitalism' (Boellstorff, 2008; Castronova, 2005, 2007; Dibbell, 2006a; Ondrejka, 2006; Turner, 2006). Briefly stated, this shared ideology believed that high-tech capitalist creativity was an important motivator and that its own ideology would be shared by their prospective customers (Boellstorff, 2008; Lessig, 2001, 2004, 2008; Ondrejka, 2006; Turner, 2006). According to this belief, creativity and innovation in SL would be driven by the customer's personal and intrinsic motivation to design, build, sometimes share, and sometimes sell the output of their creation. This *norm* that the residents *should* own their own creations flew in the face of beliefs held by other virtual world developers who had attempted to use their Terms of Service, and End User License agreements to say that the copyright of all creations in the virtual world would belong to the development company. The norm treated virtual objects as a hybrid, that is, part physical property and part IP (Lessig, 2008; Ondrejka, 2006). The *architecture* of the DRM engine, or server/client code of SL, allowed the residents to either sell or share their creations in a very flexible, permissions-based system. However, they were first forced to agree with the Linden Lab Terms of Service, backed up by contractual and copyright *law*. Thus, the *norms* of Linden Lab and the residents became embedded in the *market*, *architecture*, and behaviour of the residents, enforceable by *law* and backed up by an evolving quasi-legal system written into the software code (Lessig, 2008).

The indosymbiotic evolution of an idea, or inogism, in SL throughout its life cycle can explain how these regulators have a continual and dynamic interaction with the inogism under investigation. The normative background and ideology of the company founders is embedded into the SL Terms of Service; this contract is also based in copyright law and the US Digital Copyright Millennium Act (DCMA). The rules are enforced by the software's architecture and supported by the in-world market of virtual goods; ultimately these rules and laws combine to make Linden Lab unquestionably the 'Game Gods' (Hunter & Lastowka, 2003).

3.10. Summary

The life cycle of evolutionary design innovation can show how a design idea, in a supportive ecosystem, can become self-replicating and self-organising similar to the way a microbial organism can symbiotically co-exist with others. It should be noted that while some scientists and technologists continue to search for mechanical models of self-replication and artificial life, these models have only recently approached success through adopting biological emulation. Thus, the mechanical models of innovation are limited in their descriptions and as templates for creating knowledge and creative collaboration. The mechanical models with their reductionist, discrete components will have great difficulty explaining auto-copying, and self-replication without employing biological models. In many areas such as AI, and high tech manufacturing, theory has come full circle and rather than seeing evolution as a 'blind watchmaker' we are now delving deeper into the physical and biological laws of the universe that suggest that design innovation will succeed by emulating these biological models and not by inferring that the universe is some simplistic model of human-designed machinery.

The three models that have been adapted from earlier research and theory were designed to attempt to describe the gaps in the research with respect to design innovation; presence; the knowledge creation life cycle; and Lessig's cybernetic modality. Indosymbiosis is a second-order cybernetic system theory that attempts to explain a complex, non-linear and interactive ecology. This theoretical framework was tested on three instrumental case studies in SL: Sloodlers; Studio Wikitecture; and *Design 2029*. The theory requires close correlation between the life cycle of design innovation and the ecological context or cyber ba of the participant designers and teams. The suitability of this theoretical framework can only be inferred from the current research. However, supporting data and literature suggest that the future application of SL indosymbiosis could predict a design innovation life cycle in a virtual world and suggest ways to improve design innovation and creative collaboration. This relatively new area of research has encouraged an ethnographic research design and methodology based on second-order cybernetics.

CHAPTER 4

4. RESEARCH DESIGN AND METHODOLOGY

4.1. Introduction

The original starting point for this thesis's research question began almost ten years ago when considering a problem for a commercial client. They wanted to know, 'Why don't creative individuals share their very best ideas?' and how to fix what they saw as a very large problem. The client was an international advertising agency that wanted to maximise the network effect of their offices to generate more quality ideas for their advertisers. With the growing use of the Internet, the 'rise of the network society' and the globalisation of the knowledge economy, these issues have come to the fore for many who face the accelerating pace of change and ponder how to improve design innovation when their workforce is dispersed around the globe.

After conducting a literature review it became apparent that this was a new field of research that was only beginning to tackle the inherent problems related to the virtualisation of the modern design studio. That review informed the formulation of this primary research question, 'How to design a virtual innovation ecology?' Focus was then directed on the current frontrunner in 'non-game' virtual worlds, SL, from which emerged the sub-questions 'What enables knowledge creation during design innovation in SL?' and 'What enables creative collaboration amongst designers in SL?' These research questions have informed the research design and methodology of this thesis.

This chapter will outline the research design and methodology of this thesis, beginning with an examination of the benefits of an cyber-ethnographic case study approach. Cyber-ethnography has a close association with second-order cybernetics and an examination of other online methodologies shows that this research design shares many of the same features as so-called 'offline research'; many anthropologists argue that community and culture share the same characteristics as a virtual world ecology. The recursive nature of second-order cybernetics points to the importance of auto-ethnography and the inability of the research to step outside the participatory and reflexive characteristics of their research. This chapter reviews early testbeds that helped shape the research question and later research methodologies and design. This resulted in the construction of a methodology focused on the research question and the efforts to build *Design 2029* – The End Game (hereafter, *Design 2029*) within the formulated theoretical framework.

Flick (2006) has described research design as the means of achieving research goals: Those goals, '…link theoretical frameworks, questions, research, generalizations, and presentational goals with the methods used and resources available under the focus of goal achievement. The realization is the result of decisions reached in the research process' (pp. 140–141). Flick identifies case studies as a broad approach to research design and qualitative research used in the delineation and definition of a unit case study of analysis to narrow the scope of the research. Citing Miles and Huberman (1994), Flick (2006) suggests a loose research design 'when new fields are being investigated and the theoretical constructs and concepts are relatively undeveloped' (p. 139), based on 'broadly defined concepts and have, in the first instance, little in the way of fixed methodological procedures' (p. 138). According to Denzin and Lincoln (2005), an ethnographer can only hope for a fragmentary view of the world they are studying; the researcher is like a film editor assembling a montage in order to present their interpretation of the events to the audience. Ethnography is a 'messy' assemblage, a bricolage of evidence, and the researcher is the bricoleur who is piecing together tools and the data as they go along. This is a multidisciplinary approach that is also often used in second-order cybernetics and is an attempt to encapsulate the complexity of the ecology by providing diverse theoretical and philosophical approaches as opposed to a simplistic unitary explanation (Denzin & Lincoln, 2005; Kincheloe, 2001).

In the Literature Review there was little evidence of specific research into knowledge creation, creative collaboration, and design innovation in SL. This therefore suggested a 'loose' research design that casts around for the appropriate tools in order to assemble a bricolage of evidence that is pulled together as a narrative. The primary importance of the research question is emphasised by Flick when formulating a research design, and is the basis for assessing the appropriateness of the research methodology (Flick, 2006; Yin, 2009). Design innovation, the virtual, and the knowledge creation of designers are broad concepts which are addressed by the primary research question, 'How to design a virtual innovation ecology?' and the sub-questions, 'What enables knowledge creation during design innovation in SL?' and 'What enables creative collaboration amongst designers in SL?' A second-order cybernetic approach to the SL ecology has been adopted which performs a holistic systems analysis and explores how cybernetic feedback can enable or inhibit innovative design. This relies heavily on biological models and an evolutionary theory that supports a symbiotic cooperation and design collaboration within the context of ecological systems (Bateson & Donaldson, 1991; Bertalanffy, 1979; Boellstorff, 2008; Laszlo, 1987, 2004, 2006; Margulis, 1970, 1999; Margulis & Sagan, 1991, 1997; Marinova & Phillimore, 2003; Maturana & Varela, 1992).

The Literature Review revealed a significant gap in the research on innovation design with respect to virtual worlds. Creswell (2009) advises that when there is little previous data or research on the subject either a case study or ethnography is appropriate. This research design adopts a hybrid model which mixes the interpretive ethnographic methodology with a case study approach in order to interpret the meaning of the SL design ecology for participant designers (Creswell, 2009; Denzin, 1997; Yin, 2009).

4.2. Benefits of an ethnographic case study

Despite both Yin's (2009) and Creswell's (2009) arguments that ethnography and case study research are two distinct methodologies and should not be confused, a number of researchers have mixed these approaches (Flick, 2006; Hine, 2000, 2005; White, 2009). According to Robert Stake (2005), a case study is defined by 'interest in the individual case, not by the methods of inquiry used' (p. 443). What determines a case study are the boundaries and specificity of the unit of analysis being researched (White, 2009). White uses Willis (2007) to argue that case studies and ethnography are much more similar than dissimilar: 'Used within an interpretivist framework "researchers do not seek to find universals in their case studies. They seek, instead, a full, rich understanding (*verstehen*) of the context they are studying"' (p. 240). Writers such as Flick (2006), Sayre (2001) and Hine (2000) simply ignore the distinction between ethnographic and case study approaches that Creswell (2009), and Yin (2009) both insist upon. Hine (2000), in her description of her own research in *Virtual Ethnography*, wrote, 'The case study chosen to explore the Internet as both culture and cultural object is a media event: the case of Louise Woodward' (p. 10).

Without the case study framework a cyber-ethnographer could find that the research subject lacks sufficient boundaries or specificity to make the research project manageable (Flick, 2006). Flick advises that the researcher consider not only the reader but also the resources at the researcher's disposal, and specifically mentions the constraints on a writer of a student thesis. A case study approach has the benefit of narrowly defining an area of research within a large virtual world. SL is now a scale model bigger than Manhattan and also has a multiplicity of cultures as diverse as any large city, which encourages a case study and ethnographic approach (Boellstorff, 2008; Flick, 2006; Guest, 2007; Lessig, 2008; Malaby, 2009).

Three types of case studies have been defined by Stake (2005): intrinsic; instrumental; and multiple or collective case studies. The case study can either be qualitative or quantitative, or a mix of both (Yin, 2009). An *intrinsic* case study can be undertaken to provide a better understanding of a particular topic of interest, rather than for the purposes of building a theory or understanding a phenomena (Sayre, 2001). An *instrumental* case study is examined to provide an insight into an issue or to refine a theory; thus the case is secondary to our purposes of understanding something (Sayre, 2001). An instrumental case study could thus be applied in a secondary sense to an ethnographic project (White, 2009). The *collective* case study approach, which includes several instrumental case studies, could be applied to provide a better understanding of larger issues (Sayre, 2001). A case study can imply a more empirical positivist approach, but is less likely to when an ethnographic methodology is primary (White, 2009).

The instrumental case study in this research, *Design 2029*, will examine two design and development sub-groups, the Sloodlers and the Studio Wikitecture groups. The *Design 2029* case study was designed to incorporate the activities and participants from both the Sloodlers and the Studio Wikitecture groups. It was focused on the primary research question concerned with design innovation in a virtual ecology, and was a game that was conceived to provide designers with a cybernetic feedback response to knowledge creation and collaboration with other designers. The Sloodlers were another case study who included designers, educators and software coders. Sloodle was a learning management system in SL designed to provide students with a constructivist learning experience. The Studio Wikitecture case study included a group of designers who used the 'WikiTree' to assist with collaborative building and architecture. These case studies provided additional focus on design innovation communities in SL however as they were secondary to the ethnographic approach, participant observations of the wider ecosystem, both 'in-world' and 'out-of-world', were included when they supported further insights and meaning.

A case study approach is considered appropriate by Creswell (2009) and Yin (2009) when the researcher is looking for answers to 'how' and 'why' a social or cultural meaning is constructed. This thesis has followed Yin's (2009) definition of a case study: 'A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident' (p. 18).

Virtual ethnography has found this definition problematic as the 'real-life context' is thought to be somehow distinct and separated from the boundaries of the virtual online space. It is argued here that this is not necessarily the case and that 'being there' can apply to a virtual presence and not solely a physical space (Fornas, 2002; Hine, 2000, 2005). Clearly the boundaries between the real and the virtual are as indistinct as the online versus the offline categories (Fornas, 2002; Heider, 2009a, 2009b; Loke, 2009; M.C. Taylor, 1997; T.L. Taylor, 2006).

Yin (2009) continues:

> The case study inquiry copes with the technically distinctive situation in which there will be many variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis. (p. 18)

The literature review of this thesis underpinned the development of the theoretical framework formulated in Chapter 3. There are already a number of models and theories that have been applied to design innovation and tacit knowledge creation. The case study approach should not be confused with an experimental hypothesis; it is rather a proposition constructed around a game, *Design 2029,* that was designed to answer the stated research questions (Flick, 2006; Sayre, 2001; Yin, 2009).

Cyber-ethnography as it relates to anthropology suggests that the researcher take an immersive approach to the case study, which accords with a second-order cybernetic methodology (Bateson & Donaldson, 1991; Boellstorff, 2008; Heider, 2009b). Rybas and Gajjala (2007) argue that cyber-ethnography should be based on the ‘epistemology of doing’ in order for the researcher to appreciate the subtleties of the online space:

> We suggest that researchers studying the production of identity in technospaces must engage in the production of culture and subjectivity in the specific context while interacting with others doing the same in order to gain a nuanced understanding of how identities are formed and performed in such socio-economic environments. (p. 1)

According to the Gold typology, the participant role in this research sits somewhere between a ‘complete participant’ and a ‘participant-as-observer’ (Flick, 2006; Gold, 1958). The inevitable influence of the researcher’s personal experience and background suggests that this should be made explicit where interpretation of the case study appears to be relevant, and where it is acting as a co-producer of cultural meaning (Denzin, 1997). 'Self-reflection is no longer an option, nor can it be presumed that objective accounts of another's situation can be easily given. Truth is also always personal and subjective. An evocative and not a representational epistemology is sought' (Denzin, 1997, p. 266). Yet, how can the researcher avoid the recursive trap of never-ending self-reflexivity and justify their contribution to the sum of public knowledge in the field? Quality assurance in qualitative research is problematic (Denzin, 1997; Flick, 2006), however Denzin defends interpretive ethnography and the explicit exposure of the researcher's value system. He resurrects the relevance of the research programme by advocating the ethnographer as civic journalist. This action-oriented research does not flinch from the accusations of subjectivity – it confides in the reader and boldly stakes out the researcher's claim as a storyteller with his investigative journalist's hat on his head. Public journalism-as-ethnography helps to raise public consciousness of private issues and 'promotes interpretive works that raise public and private consciousness'; it can also 'help persons collectively work through the decision making process and help isolate choices and core values, utilize expert and local systems of knowledge, and facilitate deliberative, civil discourse' (Charity, cited in Denzin, 1997, p. 281). By characterising the researcher as a civic journalist, Denzin (1997, p. 283) attaches a normative responsibility to the role which he describes as non-negotiable, with the norms being accuracy, non-maleficence, the right to know, and making one's moral position public.

This position is similar to White who views the role of ethnographic researchers as normative, and whose objective is to improve the lives of those who are studied (White, 2009). It is no longer a question of scientific reliability and validity but one of trustworthiness and credibility (Denzin, 1997; Flick, 2006).

> The research report with its presentation of and reflection on the methodological proceedings, with all its narratives about access to and the activities in the field, with its documentation of various materials, with its transcribed observations and conversations interpretations and theoretical

> inferences is the only basis for answering the question of the quality of the investigation. (Luders, cited in Flick, 2006, p. 405)

4.3. Mediated cyber-ethnography

In cyber-ethnography computer communications are often characterised as 'mediated' in contrast to 'face-to-face' communication that can be mistakenly regarded as unmediated (Flick, 2006; Hine, 2000, 2005; Riva et al., 2003, 2008). Denzin described this ethnographic view as the 'triple crisis of representation, legitimation, and praxis' (Hine, 2000, p. 42). The crisis of representation, Denzin argues, challenged not just ethnography's methodologies but also the ethnographic theory of writing and interpretation. He wrote that 'self-reflexivity' is no longer a luxury and that the ethnographer works within a hybrid 'reality' writing an allegorical and symbolic tale, a vehicle in which the reader will discover moral truths about themselves. The realist view that 'ethnographers connect meanings (culture) to observable action in the real world' (Denzin, 1997, p. xvi) is challenged by Denzin who argues that 'They have no direct access to reality. Reality as it is known is mediated by symbolic representation, by narrative texts, and by cinematic and televisual structures that stand between the person and the so-called real world' (p. xvi). The inability of the ethnographer to extricate themselves from alternative realities in which they are implicated in effect makes all ethnography in some way auto-ethnographic. And yet, 'virtual ethnographers' like Hine, who acknowledges the crisis and heeds the warning, still continue to treat the online world as virtual and the offline world as real (Flick, 2006; Hine, 2000, 2005). Hine is caught in a cognitive dissonance that sees the virtual and the real as polar opposites and not metaphysically or socially contiguous. Rather than approaching the offline and online worlds as one and the same (i.e. they are both cultural artefacts, networked together) and therefore of equal validity to the ethnographer, Hine wants to artificially separate them for pragmatic reasons, because of the difficulty of researching an informant in their physical context as well as online (Hine, 2000, 2005; Wilson & Peterson, 2002).

This leads to the problematic ontological experience of the informant and to an ethnographer's discursive lapse that assumes the popular dichotomy of the virtual versus the real, and online versus offline. This is problematic and has led to 'virtual ethnographers' searching for clear boundaries between these dichotomies. These distinctions, however, can be seen as personal, artificial, and often unsustainable (Denzin, 1997; Fornas, 2002; Taylor, M. C., 1997; T.L. Taylor, 2006). 'One of the biggest lessons from Internet studies is that the boundary between online and offline life is messy, contested, and constantly under negotiation' (T.L. Taylor, 2006, p. 153).

In their review of the existing anthropological praxis, Wilson and Peterson (2002), formed the view that

> the distinction of real and imagined or virtual community is not a useful one, and that an anthropological approach is well suited to investigate the continuum of communities, identities, and networks that exist – from the most cohesive to the most diffuse – regardless of the ways in which community members interact (p. 456).

In the same paper Wilson and Peterson cited Agre (2004, p. 416), who stated that

> 'So long as we persist in opposing so-called virtual communities to the face-to-face communities of the mythical opposite extreme, we miss the ways in which real communities of practice employ a whole ecology of media as they think together about the matters that concern them.'

While anthropologists have largely arrived late to cyber-ethnography, those who have studied the field complain that social scientists outside of sociology have ignored the previous research that reveals the sociocultural nature of technology and the critical tensions embedded in virtual online spaces. Cultural Studies and Critical Theory have discussed the continuity of power relations online in the areas of class, gender and race (Wilson & Peterson, 2002). In defiance of the empiricist belief that technology is something outside of social behaviour, the postmodern cyber-ethnographer observes technology as a cultural artefact designed, built and used in a social context, (Denzin, 1997; Hine, 2000, 2005; Wilson & Peterson, 2002).

Identity is no more clear-cut and bounded than the concept of community, which is a social construct and not a tightly defined and spatially located ‘billiard ball’ (Fornas, 2002; Wilson & Peterson, 2002). ‘Flow’ more accurately defines the dynamics of an individual’s experience as their sense of presence moves backwards and forwards in a continuous cybernetic feedback loop of consciousness and presence (Csikszentmihalyi, 2004; Riva et al., 2003; Thomassen, 2003). This is a ‘boundary war’ (Fornas, 2002) with competing realities and identities fighting for conscious recognition; this is the boundary between the virtual and the real, or the animal and the machine and in this world the computer user is conceived as a cyborg (Haraway, 1992, 1993).

In *A Cyborg Manifesto*, first published in 1985, Haraway (1991) wrote:

> By the late twentieth century, our time, a mythic time, we are all chimeras, theorized and fabricated hybrids of machine and organism; in short, we are cyborgs. This cyborg is our ontology; it gives us our politics. The cyborg is a condensed image of both imagination and material reality, the two joined centres structuring any possibility of historical transformation. (p. 150)

The cyber-ethnographer must recognise both their informants and themselves as cyborgs; their avatar cannot be surgically removed without killing the online subject. This is truly a cybernetic life cycle. The inability of the ethnographer, either consciously or subconsciously to extricate themselves from the virtual or the narrative exposes their obvious presence in the story (Denzin, 1997; Hine, 2000, 2005; Okely & Callaway, 1992). The reader of this ethnography becomes drawn into the interaction and the ethnographic writer is compelled to give some account of their own meaning in the social context of their research, and hence detail their own auto-ethnography (Okely & Callaway, 1992). The narrative is commonly written in the first person to explicitly expose the ethnographer’s presence (Okely & Callaway, 1992). Auto-ethnography is a useful tool for researching cyberspace as it provides a narrative of the researcher’s personal experience and nuanced meaning and declares their hand in the unfolding of meaning through the research (Boellstorff, 2008, 2009).

4.4. Components of research design

This thesis follows Yin's (2009) outline of a research design. The 'blueprint' for this thesis is therefore comprised of the five components Yin recommends for a case study:

- a study's questions;
- its propositions, if any;
- its unit(s) of analysis;
- the logic linking the data to the propositions; and
- the criteria for interpreting the findings. (p. 27)

4.5. The proposition

The proposition of this ethnographic case study is that in order to design a virtual innovation ecosystem, cybernetic regulators must provide feedback, and will either enable or inhibit creative collaboration and knowledge creation in SL. Lessig's four modes are examined here as cybernetic regulators to determine if they act as inhibitors or enablers of knowledge creation and design innovation in SL (Lessig, 1999, 2006, 2008). This discussion will be followed by a synthesis examining the unique ecology of design innovation in SL.

An open innovation system, which includes trust, will accelerate and enable design innovation based on cybernetic feedback from rewards and penalties for collaboration. Attention to personal/collective motives such as creativity and rewards; knowledge creation; and a virtual 3D ecology are likely to enhance innovative design by providing a rich digital medium and communication bandwidth. The limitations of this virtual ecology are explored in relation to the theoretical advantages of face-to-face communications, without technological augmentation, in a physical design innovation context.

4.6. Instrumental case study – the unit of analysis

According to Stake (2005) an instrumental case study subordinates the strict boundaries of a case study to the understanding of the subject. Specific case studies are therefore only a means to help to elucidate the bigger picture, and in this thesis the bigger picture is SL. SL is a fast-growing virtual world that includes a complex history; there were approximately 1 million active residents within the last month; there is over 270 terabytes of user-created content; and there are up to 70,000 concurrent residents, all in-world at once (Linden Lab, 2010b). SL has evolved from the experience and knowledge of previous virtual world designs and yet differs in a number of important aspects (Bartle, 2004).

One of the most important ways that SL differs from the majority of previous virtual worlds is that it is not a game, and almost everything seen and experienced in-world has been designed by the residents and not the designers employed by Linden Lab (Au, 2008; Bartle, 2004; Boellstorff, 2008). This is not to argue that SL does not have game-like qualities, as suggested by Malaby (2009) and Reeves and Reid (2009), and it can incorporate games within the SL ecology. However, it is not designed to be a game and has no goals, levels or explicit game rules.

The client, or user interface, of SL provides the tools for the residents to landscape, design and build the virtual world which was once almost empty, except for the terrain designed by Linden Lab. The primary research subjects of this thesis are firstly residents, and not Linden designers, although some discussion of company policy and approach helps to also appreciate the ecology and enablers of design innovation. The difficulty of studying all the residents of SL suggests a requirement to limit the unit of analysis to residents who are most engaged in the research question, ‘How to design a virtual innovation ecosystem?’ There are two active SL groups who are most engaged in this question: the Sloodlers, a group who use and develop a learning management tool to enable knowledge creation known as Sloodle; and Studio Wikitecture, a group who use and develop a collaborative design and building tool they refer to as a 3D WikiTree. The users and designers of these tools provide a manageable unit of analysis to consider the wider implications of the research question and to understand the meaning that imbues their innovative design experience in SL.

The first research sub-question of this thesis relates to the problem of designing a virtual innovation ecology is ‘How to enable knowledge creation in SL?’ As a learning management project located in SL, Sloodle is also focused on this problem and its designers and users can provide insights into how they have addressed the cybernetic enablers and limiters of knowledge creation in SL. Knowledge creation is not an individual activity and requires creative collaboration between more that one individual (Maturana & Varela, 1992; Von Krogh et al., 2000). This introduces the second research sub-question, ‘How to enable creative collaboration in SL?’ The Studio Wikitecture group is focused on enabling this sort of creative collaboration in design innovation and architecture in SL (see its website, http://studiowikitecture.wordpress.com/). The third case study, *Design 2029*, encompasses both of these instrumental case studies and provides a unit of analysis that explores how two distinct communities can work together in order to achieve mutually beneficial outcomes. The Sloodle project is more advanced than Studio Wikitecture as an open source development project, and has a number of solutions that would be of benefit in terms of web integration and peer ranking of designs. At the same time, the Studio Wikitecture project provides a tool that enables creative collaboration in 3D design in SL that the Sloodle toolset is missing. The Studio Wikitecture WikiTree could provide a useful design innovation tool for knowledge creation and could be used as a learning management tool. *Design 2029* explored what enables and what limits design innovation within the Sloodle and Studio Wikitecture projects and also considered the cybernetic activities of an ecosystem that included two distinct communities. This collective instrumental case study provided a defined unit of analysis with which to understand ethnographic meaning in the cyberspace of SL.

4.7. Logic of data and proposition linkage

It is highly unlikely that any research design can hope to show a direct causal link between the research proposition stated here and the data collected, however using triangulated evidence and ethnographic field research some meaning can be linked to the proposition. The three case studies will provide evidence of how designers in SL attempt to create an innovative design project and what has enabled and limited their success. SL can be discussed as a cultural whole even though there are many sub-cults and groups that make it up (Au, 2008; Boellstorff, 2008; Guest, 2007; Meadows, 2008). The virtual 3D environment differs markedly from other Internet tools and sites of cyber-ethnography. An 'adaptive ethnographic' (Hine, 2000) methodology has been used to allow for the pragmatic use of any data that could be useful. In addition, the challenging approach of 'action research' or participatory research design has also been used (Denzin, 1997; Hine, 2000, 2005; Jankowski & Selm, 2005; White, 2009).

As noted earlier, Denzin advocated interpretive ethnography in which the researcher declares their value system and actively pursues their research, much as a civic-minded journalist. According to Hine (2000), action research 'is an adaptive ethnography which sets out to suit itself to the conditions in which it finds itself' (p. 65). Action research aims at both taking action and creating knowledge or theory about that action (Coghlan & Brannick, 2005; Denzin, 1997; White, 2009). Action research works through a cyclical process of consciously and deliberately (a) planning; (b) taking action; and (c) evaluating the action, leading to further planning and so on. The second dimension of action research is that it is collaborative, in that the members of the system that is being studied participate actively in the cyclical process (Coghlan & Brannick, 2005, p. xii). Once again this is in accord with the second-order cybernetics of Maturana and Varela's (1992) epistemological theory, which holds that all knowledge comes from action: 'All doing is knowing and all knowing is doing' (p. 26). In order to provide further triangulation and supporting evidence, websites, blogs and email lists have been examined to complement data accumulated from ethnographic observations, field notes, interviews, focus groups and surveys (Denzin, 1997; Flick, 2006; Hine, 2000, 2005; Kozinets, 2002; Yin, 2009).

This ethnographic case study explores the process of design innovation and creative collaboration in SL, while at the same time extending the existing research carried out in physical and so-called ‘offline’ environments. The application of an ethnographic case study in a virtual world has its own specific issues, however. There are common ethnographic procedures that influence the researcher’s participant observation and these include:

- making cultural entree
- gathering and analysing data
- ensuring trustworthy interpretation
- conducting ethical research
- providing opportunities for culture member feed-back. (Kozinets, 2002, p. 63)

Case studies and ethnography are commonly used in researching contemporary events and provide the researcher with the tools of observational field notes and an unstructured interview technique (Creswell, 2009). One variation on the case study approach is to mix qualitative and quantitative data in order to further triangulate the results (Yin, 2009). A theoretical framework was formulated prior to undertaking the case study based on the literature review. The ethnographic case study of an in-world game, *Design 2029*, was undertaken to extract data from the design teams and individuals as sub-units of the research and analysis. An adaptive methodology was designed for the qualitative data from the competition participants through recorded observations, scripted interactive virtual objects, wiki entries, and blog documentation, machinima (movie making using the 3D engine of a virtual world or game), interviews, and surveys (Hine, 2005). This mixed data collection methodology was intended to illuminate different facets of the design innovation process and to provide interpretive theoretical conclusions from a triangulated approach (Creswell, 2009; Hine, 2000, 2005; Yin, 2009). Regrettably, the research met with difficulties in implementing this adaptive methodology as *Design 2029* faced internal barriers to knowledge creation and creative collaboration. This action-based research therefore provided further evidence of enablers and inhibitors of knowledge creation and design innovation.

Due to the specific focus on SL this thesis incorporates a cyber-ethnographic approach which used unstructured and semi-structured interviews to extract subjective meaning from the participants and 'why they do what they do' (Hine, 2000, 2005; Rybas & Gajjala, 2007). *Design 2029* was used as action research and involved a participatory research design to examine the meaning that the participants in the game attributed to their actions and the actions of others. There were a number of stages in the design and development of the game that provided evidential opportunities to collect data on the design innovation process. The design of *Design 2029* was consciously recursive. The key design phases were:

1. The first phase involved planning the design of the game in order to achieve the research objectives and to satisfy the requirements of 'game play' for the participants.
2. The resources to complete the build of the game were obtained.
3. The documentation and hosting of the necessary software components had to be performed before they could be integrated into a game interface.
4. A prototype of the game was completed, tested and improved.
5. The launch and marketing of the game.
6. Analysis of game data.

The research was discontinued at Phase 4 due to a number of inhibiting factors that are recorded and analysed later in this thesis with regard to Lessig's four modal regulators. In this case study the participants – and how they interacted as part of their design process – were observed as part of the game's design (Boellstorff, 2008; Creswell, 2009; Heider, 2009b; Hine, 2005). The participants included the researcher and game designer; a senior research technician; Victoria University of Wellington's School of Design stakeholders; research supervisors; SL stakeholders; software developers; and Slooders and Studio Wikitecture participants.

Field observations and unstructured interviews with participants were intended to support theoretical interpretations and theories about how to design a virtual innovation ecology in SL. As well as participant observation and interviews, a number of focus groups were conducted to test the proposition that design teams in SL can collaborate in a creative sense and share knowledge in a deep and meaningful way. Exploratory research and an initial online survey were conducted with design students to explore base beliefs and assumptions about knowledge sharing and design innovation. While this data collection was not the primary method of research, it did serve as a useful means of triangulating the final results and conclusions.

4.8. Design 2029: The research path

Exploratory research was undertaken to help to identify relevant issues and suitable case studies. Preliminary results were obtained from initial research into creative collaboration and innovation in SL, and the results informed the design of this thesis. There were two separate research projects conducted in 2007 and 2008 at Victoria University's School of Design. In 2007 the researcher remotely co-taught a year 2, digital design class called 'Machinima Creation in SL' and in 2008 jointly taught a year 4 industrial and digital design course that explored design 80 years in the future. The methodology for both these research projects used direct observation, blogs, forums, email, machinima and surveys to collect qualitative and quantitative data. While the different data collection methods helped to triangulate and validate different data, there was a fundamental weakness in the survey numbers and the size of the sample for each project. It should be noted, however, that the objective of the surveys was not to discover a representative sample of SL users but instead to provide greater detail and insight with two exploratory research projects, Machinima Design Research and Design Led Futures.

4.9. Machinima Design Research

In 2007, the researcher co-taught 33 undergraduate digital design students how to design and build in SL, and then how to create machinima, or cinematic productions made using a 3D graphics engine. The students were taught in an open plan media lab with their own workstations and a large, three-screen, data projection system, which also allowed the students to share another virtual space from the point of view of one of the teachers who had a physical presence. Each week of the course one of the teachers would facilitate the class from a remote location using their avatar and voice to communicate with the students in SL. In SL the class took place on the Design School's virtual island, MediaZone.

Persistence is the continuation of a virtual world beyond the presence experienced by a cyborg. In other words, after a user has logged out of the virtual world, and shut down their computer, the virtual world persists, maintained on a server at Linden Lab. In-world physics are the physical attributes of that virtual world, such as gravity, collisions, speed and even weather, and what are the day time hours? This persistence and in-world physics that this virtual world provides adds to the sense that when you 'visit' a place in SL you are virtually there; you experience presence. The virtual building and objects on MediaZone Island gave the students a tangible sense of actual objects. The default settings for these 3D objects give them physical properties such as collision detection, which prevents avatars from walking through walls. If they did walk into these objects, a collision noise was heard. Pseudo-reflections on shiny objects and water reflections contribute to the ambience of the virtual environment, as did the sun and weather conditions, including wind speed. The time of day and surface reflections are built into the SL viewer and further enhance the fidelity of the scenes. For those that require a specific time of day or position of the sun, these can be manually set to suit their purposes.

During the initial set up of the student's projects they were required to self-organise into teams of three for the production of their machinima. MediaZone Island was turned into a 'sandbox' or play and experimentation area, while the students learned to build using the 3D tools in SL. As a result the island became extremely cluttered, and so a platform was built 150 metres above the land to allow the class to share an uncluttered space to help organise the teams. A large 10 x 10 metre platform with a grid provided a workspace to help organise the teams. The platform and grid helped to provide shared visual and virtual spatial cues to the students, and guidance was provided by the teacher. Each design team was required to assign three roles to each team member: producer, director/editor, and cinematographer. The roles were not strictly prescriptive and the design and build of the movie sets were shared. It was determined that this role assignment was self-selected based on the assumption that individual interest and assessment of capability would be more effective than assignment by a teacher or team leader. In order for each of the students to choose their role the teacher's avatar went and stood at various positions on the platform's grid and each student chose their role and stood in that location. The ability to quickly see where each avatar stood enabled the class to see at a glance if there were too many in each of the roles, and there was some re-assignment as there were too many directors.

The next use of this virtual space was to determine the teams. Eleven platforms were arranged with different textures and named; these then became the names of the groups and the shared location of each team. This co-presence illustrated how quickly a virtual space and virtual objects can assist in enabling self-ogranisation in a virtual environment. MediaZone Island was then sub-divided into different property parcels according to the various groups. One of the teachers, the researcher, erected an office in the sky with a 'teleporter' and movie screen to assist in the review of each student project. During the course of the 14 weeks some of the students were physically remote from the class, either overseas or at home, and at one time a teacher was able to teach from Korea while attending the Pusan International Film Festival.

In addition to sharing a co-presence on MediaZone Island the students were encouraged to document their projects on a blog. This in turn added a shared textual base for more extensive text, as the 3D virtual environment proved to be not particularly good at sharing text. There was the ability to create 'notecards' (small text files) in SL and to add web links to objects or communicate with external databases. It was noted at the time that SL had some communication limitations, and other virtual worlds had more file sharing functionality. With some preparation (using a graphics application), it was possible to present a slideshow in SL, but at that stage each slide required uploading, and cost 10 Linden dollars each. That was also the cost of uploading textures that are mapped onto 3D objects, and animations and sounds could also be imported into the world.

The virtual space of MediaZone Island had its own reality and became the context for 14 weeks' work in which the students shared a co-presence and the common context of their projects. While many technologists have concentrated on fidelity to try to enhance the immersive experience, and this is the undoubted goal of most game and virtual world developers, the sense of presence that a resident feels in SL is more determined by psychological affects such as interpersonal communications, attention, emotion, and interactive engagement (Riva & Ijsselsteijn, 2003; Yee et al., 2007). The students could choose whether to only meet together in SL or to physically meet in the media lab at the Design School. Interestingly, some only communicated in SL, while others met face to face, suggesting that they found communications in-world limited. Overall, all the student teams worked well together and shared information in order to complete their machinima projects. However, as there was some course assessment the students had a clear motivation to succeed in their creative collaboration.

The students used a variety of ways of communicating with each other in-world and outside of SL. In a survey conducted in SL the students were asked: 'Are ideas easier or harder to share in SL compared to a physical studio working with other people?' The response of a director in one of the teams was:

> Yes, we tried do it all in SL and even brought headsets to talk over SL with but they didn't work. So in the end we moved closer to each other. I would guess that if the headsets worked it would have been better.

The class experienced technical difficulties with using voice chat in SL due to the policy of the IT services at the Design School and so a majority were limited to text chat only. This contributed to 60 percent of students responding that ideas were harder to share in SL compared with working in a physical studio environment. It also must be noted that almost all the students were novice SL users and that they had to learn how to use SL, as well as cinema theory. In addition to learning the basics of SL, which has many levels of complexity, the students had a short amount of time to learn the basics of cinema and machinima production in SL, which are demanding and complex enterprises in themselves.

Initially, the class was given public domain software in SL in order to control their virtual cameras. This decision was revised due to the difficulty of use and lack of functionality of the first camera, and the teams were provided with a proprietary virtual camera system that was easier to use. Most teams were forced to use text chat, the class blog, email and face-to-face meetings to improve communications. There were a number of students for whom English was a second language.

A sample response to the question ‘Discuss your experience of working as a team and sharing ideas and virtual objects’ was:

> its weird to collabrate with ppl in a virtual world, which is so diffrent then working face to face in class, i think is a lot harder to collbarate in SL as you cant [sic]

And to the question ‘Are ideas easier or harder to share in SL compared to a physical studio working with other people?’:

> as i said above, SL is a lot harder [sic]

However, there were notable exceptions, and 59 percent of the students reported their team worked well together, and were able to share ideas (using any means including face-to-face), and virtual objects in SL.

One example of an enthusiastic response to working in SL was:

> We made all our objects editable by each other, and so it was fun working with each other's designs. One person made an object, then another improved it, then another had their hand at making it look better, until the final product was a really impressive. [sic]

The same participant (a director) added:

> SL has the advantage of you actually being able to build an object that demonstrates what you're trying to get across, and this helps, but it seems to be a human reaction to prefer to discuss ideas face to face, so you can read what the person is [sic]

One team expressed that despite finding communicating harder in SL the 3D graphics helped to communicate their intentions:

> It's a little bit harder, but not too much of a barrier at all, especially in SL which is a very visual world so its easy to produce a mock up of an idea using blocks for example. [sic]
>
> Partial anonymity was seen as helpful in sharing ideas:
>
> I think some people are nervous to share their ideas in the physical studio because they are scared as to what people will think of them, in SL it is pretty much anonymous so people will be more willing to share their ideas, because people dont necessarily know who they are. [sic]

Another individual expressed the limitations of having limited facial expressions in SL:

> The ability to express your ideas to people are quite restricted in SL because of the inability to show physical gestures and expression. Although you don't feel as much pressure to express yourself because you don't have the others glaring at you. [sic]

One of the teams consisted of close personal friends who all sat physically together in class. They expressed their enthusiasm for SL as a collaborative virtual environment:

> I think it is working brilliantly, we are all contributing our own skills and learning from one another whilst still fufilling our roles in the production. A very successful method of learning and effective work! [sic]

One team, which consisted of students for whom English was a second language, found SL easier to communicate than face to face, despite them all speaking the same language and being friends. One member responded:

> I should say, it is easier to share ideas in SL. I can unlimitedly express my idea without thinking about what response I would get if I say so. [sic]

The students used a number of additional communications channels as well as SL, such as a class blog, email, and face-to-face meetings (DMDN206, 2007). The research findings suggest that if the students had been able to use the in-world voice communications they would have found the experience easier, and more like working together face to face. This data is supported by other research: 'In relation to shared VEs that support audio communication, one finding that has emerged again and again . . . is that the quality of the audio communication can be a major obstacle to collaboration and fluid interaction (Schroeder, 2002, p,6).

4.9.1. Machinima Design Research – summary results

A summary of the findings, with reference to the Von Krogh et al. (2000) framework, breaks down into the following areas:

- The class's knowledge vision provided a theoretical framework for the students to then experience the 'knowledge space' of SL firsthand and enabled their knowledge exchange.
- Conversations are the essential means of enabling knowledge creation and technology should be seen in that light. SL required augmentation with other technologies and face-to-face meetings.
- The students acted as 'knowledge activists', as did their educational facilitators, as they came into contact with other cyborgs in SL promoting their projects and encouraging creative collaboration.
- Both the virtual and physical knowledge spaces were effective knowledge enablers, however neither were sufficient as standalone solutions.
- SL is an effective means of globalising local knowledge as students share a common virtual knowledge space with other SL cyborgs physically located in different cities and countries.

In conclusion, SL is a highly creative and collaborative environment with levels of participation far in excess of many other virtual worlds. Many of the limitations of SL relate to the spectrum of fidelity and the virtual world's ability to simulate face-to-face communications. As an early example of a virtual design ecology, SL can successfully engage individual designers. In research carried out by Linden Lab in 2006 it was found that:

> Forty-two percent of SL users create objects from scratch using the built-in modelling system, and more than forty four percent have successfully sold an object to another user. Seventy-seven percent have bought one or more objects from other users, and ninety percent have modified their avatar. (Ondrejka, 2006, p. 8)

4.10. 'Design Led Futures'

Design Led Futures , (DLF) was a course that explored 'digital migration' in which 'our bodies are primarily moored in the physical world (1st Life) while our minds are free to explore and expand in the virtual world (2nd Life).' (DLF). The students were free to choose their design medium for this research and Linden Lab was a suggested sponsor for the course. However, sponsorship was not forthcoming from Linden Lab and most of the students did not choose to experiment with SL, mostly due to the steep learning curve required and the relatively crude graphical capability of SL. Only one student adopted SL for their research, the course did, however, provide exploratory research into futurism within a virtual environment, design innovation, and knowledge sharing. Specifically with respect to the student's SL research they highlighted the evolution of a knowledge economy and using SL to predict the future, the student quoted Jamais Cascio who wrote:

> Bit world economies based on scarcity are inherently fragile, and cannot survive. To the degree that Second Life is a test bed for a future of abundance, then, the way that the Second Life community (both the builders and the players) responds to this reality will give us an early indication of how the real world will respond to the economic challenges of nanofactories and distributed fabrication. (http://ieet.org/index.php/IEET/more/cascio2006117/).

Alan Kay once said that 'The best way to predict the future is to invent it' (Saffer, 2009). Future scenarios are useful mind experiments for design innovation, and this was the basis for the DLF course for final-year industrial and digital design students. Design education is a discipline that is a rich area for researching innovation, knowledge creation, and creative collaboration

(Thomassen, 2000; Von Krogh, 2000, Weick, 1991). In the first trimester of 2008 the researcher participated in a class that mixed industrial and digital design students in a professional praxis course. The course, known as 'Design Led Futures' (DLF), had the international mobile phone network provider Vodafone as a corporate sponsor and was described as follows:

> DLF is an initiative aimed at connecting final year design students with world leading companies to produce provocative visions of the future. This exposes students to the broader leadership role of design while stretching the participating company's perception of its long term business objectives and operating environment.
>
> The goal and scope of the project is to extend beyond iterative predictions based in the near future (ten years) to preconception shattering visions sited in the distant future (eighty years). In some ways similar to science fiction but with the specific intent of revealing an achievable and aspiration pathway forward into the future, Design Fiction. (http://www.mediazone.co.nz)

The far horizon of the course encouraged the students to push beyond the assumptions of the class from the previous year and to devise radical innovations in advance of current technological capabilities. Radical or breakthrough innovations require an imaginative or creative leap into a future where the innovation could be imagined to exist (Von Krogh, 2000). Many commentators have placed innovation at the centre of wealth creation in the knowledge economy (Teece, 2000; Von Krogh, 2000; Peters, 1997), and it continues to be a core focus of KM projects. The ability to unlock creative collaboration and knowledge sharing is seen by many to be an essential component in innovative design. Futurism is seen to be a useful tool in activating knowledge creation and was observed to be a powerful catalyst by the student teams. In a relatively short course, considering the scope of the vision and the ambition of the projects, four teams of approximately nine designers were faced with a challenging brief for Vodafone. This provided useful exploratory research into radical innovation and knowledge sharing within creative teams. It was decided to survey the students to uncover triangulate observations that were made during the period of the course. An online web-based survey was designed in order to understand and support observations of how the students worked together in teams to create knowledge, share knowledge, and design and prototype radical innovations. As knowledge creation is a learning process (Weick, 1991; Thomassen, 2000), design education provides a useful research environment for understanding the wider implications of innovation, knowledge creation, and creative collaboration within the enterprise. The survey was informed by the theoretical framework of Von Krogh et al. (2000).

While the course intended to teach professional practice in a design environment, the organisational structure of the university, the Design School, and the DLF course were markedly different from a commercial context. The students were not subject to management controls and incentives, and instead had academic expectations and assessments. The requirements of the university curricula were that individual assessments had to be clearly achieved and this was observed to sometimes counteract teamwork and collaboration.

Von Krogh et al.'s (2000) observation that the creation of new knowledge must start with an individual was supported by the individual students' research projects, and the sharing of tacit knowledge in regular face-to-face meetings. However, Von Krogh et al go on to say that innovation is not generally a solitary activity and that cross-functional teams improve innovative outcomes. This was seen as essential ingredient for breakthrough insights and intersectional ideas by Johansson (2004), who called it the 'Medici Effect' (Johansson, 2004). Johansson stressed that teams and people from interdisciplinary backgrounds and cultures provide a creative context for innovations.

In the survey of DLF students they were asked about gender and nationality to help establish whether these were possible influences on knowledge creation. Teece (2000) argued that the ease and effort of converting tacit knowledge into codified knowledge represented the transactional cost of knowledge sharing. In the DLF course a web-based forum assisted in sharing explicit knowledge and helping to convert some tacit knowledge to codified knowledge. The emphasis that many writers have placed on tacit knowledge for innovation and on the importance of face-to-face meetings was reflected in the observation of various means of communication used by the students and prompted explicit questions aimed at uncovering their experience of virtual worlds. On the forum, and within the class, inter-team rivalry and competition was observed and some teams added password protection to their video work, or set up extraneous websites with security to prevent other teams viewing their progress or discussions.

This also resulted in a suggestion from one team that the third assessment should not be presented to the whole class, and that only the tutors and team members for each project could be present. In the survey this was further examined with regard to each team member’s perception of collaboration, competition and knowledge sharing. In the information economy tacit knowledge – a set of justified beliefs and feelings – rather than information, facts or data, that holds the true value for management when pursuing strategic advancement and future competitive advantage (Von Krogh et al., 2000). The challenge of setting the right context for small teams or micro-communities of five to seven people in order to enable knowledge creation in business has occupied the imagination of a number of companies that have sought a sustained competitive advantage through innovation by making it part of their company strategy. The make-up of the student teams was casually determined at a shared dinner, with the only requirement being that the smaller number of digital design students should be spread evenly amongst the industrial design teams. The size of the teams was set arbitrarily at nine, which was above Von Krogh et al.’s upper limit of seven for effective micro-communities. The students were later asked what their perceptions were of the team size and its effect on knowledge creation. In the Von Krogh et al. analysis of cross-leveling or sharing knowledge across organisational boundaries and the process of globalising local knowledge, the authors recognise that dispersed teams can have difficulty meeting regularly face to face.

While this was not an issue for the DLF students who were all collocated at the School of Design, they did have at their disposal other forms of communication, and all projects used digital content tools to visualise their concepts. Due to the intensity of the work on the projects, with some students working in the Media Lab late into the night and during the weekends, some students were presented with a challenge to coordinate efforts and collaborate. The DLF survey asked about their methods of communicating on the project.

4.10.1. Design Led Futures results

The researcher's involvement in shaping the course and the structure of the teams was minimal. As I was located in Auckland and the course was taught in Wellington, I was often not present when course decisions were made. It was therefore interesting to observe issues such as team size and competition. The first difficulty observed with the design teams was their size. This was partly as a result of the number of tutors available to assist the teams – a question of available resources. Most of the teams were around nine people in size with a smaller number of digital design than industrial design students in all teams. There were problems with a general lack of team cooperation, and management difficulties with the teams, with some individuals being left out of team decisions; in some teams a small number of designers assumed leadership of their teams.

22 out of 24 survey respondents thought that the teams should have been between four and six members. This suggests that the students would have agreed with Von Krogh et al's (2000) suggestion that a micro-community of between five and seven individuals is the optimum size for knowledge creation and creative project management of innovation. Figure 5 shows the outcome of the survey results followed by some qualitative responses.

8. What were your teams barriers to creativity and innovation?

	Response Percent	Response Count
There were no barriers	4.2%	1
Lack of time	37.5%	9
Lack of research	20.8%	5
Lack of team cooperation	**62.5%**	**15**
Interdisciplinary challenges	29.2%	7
Skills	29.2%	7
Resources	20.8%	5
Others (please specify)	view	11
answered question		**24**
skipped question		**0**

Figure 5. Survey of creativity and innovation in Design Led Futures

Here are the comments of two respondents:

Huge amount of research being done quickly is probably the most effective part in working in a large group. As for creativity i work better with smaller group of 3 people who shares similar vision, view and ideas [sic]

Fri, 8/22/08 12:57 AM

The team was a mixture of a whole lot of leaders. Very strong minded people which [sic] of many have a developed sense and taste for aesthetics and working ethics. One person could never blend in, and another person dropped out - apart from that the team members were passionate about the work. Three of the team were very dominating and took over the creative decisions. That demotivated some of the team members, but was of inspiration for others. There was not enough trust between the team members to work independently, we cared a bit too much about every detail of the work. [sic]

Fri, 8/22/08 12:45 AM

our team had 9 members this was too many for the scope of the project. this made it difficult to move forward as there was to many opinions [sic] Thu, 8/21/08 3:02 PM

In response to the question about team's perceptions of competition, this particular response seemed to sum up the diversity of approaches in the course:

The reason both secrecy and openness between teams are marked as high is because certain individuals took different stances. There was a fair bit of tension between certain teams, and certain individuals, though overall I think the amount of openness was helpful and beneficial to all. There were of course sub-groups who perhaps had secrets within the team, but that was probably more a result of the fairly sensitive subject matter of shooting and filming than malice. [sic]

Thu, 8/21/08 3:32 PM

Overall the students appeared to be very pleased with the outcome of their projects and believed that as a team they had come up with a more innovative approach than if they had been working alone. OthersSome, however, were unused to working in teams and believed competition within and between teams was a positive contribution to an innovative solution, this was in spite of the fact that all teams had to cooperate to complete their projects.

Coming from a very individual mentality I felt many people struggled with the openess of team work and found it hard to share and trust fellow team mates, and also realising that it wasnt just their work they were doing but also they couldnt let others down. Felt that athough competition between teams was a great motivator and certainly bonded the teams closer however at times it was unnessasary. [sic] *Sat, 6/28/08 4:29 PM*

3. Please rate each of the following

	Very Low	Low	Average	High	Very High	Response Count
Competition between the teams	0.0% (0)	4.2% (1)	37.5% (9)	**41.7% (10)**	16.7% (4)	24
Competition within your team	8.3% (2)	20.8% (5)	**50.0% (12)**	16.7% (4)	4.2% (1)	24
Cooperation between the teams	8.3% (2)	29.2% (7)	**37.5% (9)**	20.8% (5)	4.2% (1)	24
Cooperation within your team	4.2% (1)	12.5% (3)	29.2% (7)	**33.3% (8)**	20.8% (5)	24
Secrecy between teams was	0.0% (0)	4.2% (1)	25.0% (6)	**58.3% (14)**	12.5% (3)	24
Secrecy within the team was	**41.7% (10)**	25.0% (6)	20.8% (5)	12.5% (3)	0.0% (0)	24
Openness between teams was	0.0% (0)	41.7% (10)	**50.0% (12)**	8.3% (2)	0.0% (0)	24
Openness within the team was	0.0% (0)	8.3% (2)	29.2% (7)	**37.5% (9)**	25.0% (6)	24
					Any further comments view	9
					answered question	**24**

Figure 6. Survey of cooperation and secrecy in Design Led Futures.

23 of 24 respondents believed that the competition between the teams was average to very high. There was also a surprising degree of competition within the teams, with 71 percent

perceiving that this was average to very high. This was the response of a couple was typical of a few team members:

> I felt like people were not willing to listen to others ideas. At first the group was working out quite well, until we had to hand in individual projects, then everyone started to be competitive and were in their own corner, doing their own design. I found our group worked a lot harder at the end when we thought about the project as being a competition between the teams. [sic]
>
> *Fri, 8/1/08 6:33 PM*

This would tend to suggest that competition is a complex area and can either inhibit or encourage greater effort in the design process. Counter to these perceptions is the growing professional practice of distributed design teamwork across large geographical areas and between designers, suppliers and customers (Highsmith, 2004; Mau, et et al., 2004; Von Krogh, et et al., 2000). Overall, the student's lacked enthusiasm for virtual worlds, such as SL, and other MMO's, and this seemed to contradict a media perception of youth bias in games and social networks, often referred to as 'Gen Y'. Linden Lab provides regular user statistics and the average age was around 34 years old, with a slightly greater male proportion presence. 16 out of 24 respondents claimed to have an experience of SL, however, their lower -than -SL -average in terms of times they spent 'in-world' would suggest that they were not that keen on the experience or had only dabbled in it. Only 13 out of 24 responded to the question of how long they spent in a virtual world, and 63.6 percent said it was only one to three hours a week. The average user in SL spends over 20 hours in-world, and surveys have shown that unless a user spends more than two hours when they initially try SL they are unlikely to return. Mitch Olson, CEO of the browser -based virtual world, Small Worlds,, characterised SL as highly customised but also one of the most difficult virtual worlds due to the creative flexibility of the tools, (personal communications at Digital Media Summit, Auckland, 2009).

4.10.2. Initial conclusions from Design Led Futures research

The initial conclusions suggest that smaller teams would be more productive and creative. Clearer directives and alignment to a tighter brief could have helped as the teams spent a long time exploring options, however it is also acknowledged that a more prescriptive brief could have inhibited innovation. Time is considered another resource when considering design innovation, and the lack of resources were seen to inhibit design innovation (Hunter, 2008). The results of the Machinima Design Research suggest that the self-organisation of teams in Design Led Futures could have been more conducive to better team dynamics and innovation, and that some training in conflict resolution and collaboration at the outset of a project could have helped. The competition between and within the teams could have been avoided by expressing a knowledge vision that promotes sharing and unites team members with a common purpose, as was discussed in Machinima Design Research. Paying closer attention to motivation with relation to sharing and assessment could be considered, and the biggest drivers for the students were the desire to complete successful projects and foster friendships. University assessment provides a set of different motivational drivers in contrast with design praxis.

4.11. Further research

The initial exploratory research helped to show the strength and weaknesses of various approaches to the research methods to be used in the case studies in SL. These initial research studies encouraged an ethnographic approach to the later case studies and were less concerned with sample size and survey collection than preparing an in-depth ethnographic approach to informants. Team size is important, and as pointed out by Von Krogh et al. (2000), and so is ‘managing the conversations’ and actively promoting knowledge sharing and openness. Student informants and observations suggest the limitation of their design experience with regard to design praxis and encouraged the researcher to pursue a wider cross-section of SL designers who have also willingly entered and actively participated in SL. These designers were also intimately familiar with the tools, norms and rules of SL that can really only be learned after spending a considerable amount of time in-world. Another limitation that arose from student subjects was the difficulty of assessing student motivation in their participation in design and innovation due to the primary motivation of their course work assessment. Competition is a reality in business and secrecy is common to design, however communal projects such as the Studio Wikitecture designs can encourage greater knowledge sharing and creation.

4.12. The methodology of Design 2029

This thesis is predicated on the theoretical proposition that a design innovation ecology will succeed when it is open and provides feedback to the participants, regulated by Lessig's four modes of law, market, architecture and norms, and furthermore enabled by Von Krogh et al.'s (2000) methods of knowledge creation. Von Krogh et al. describe five programs that can enable knowledge creation:

- instill a knowledge vision
- manage a conversation
- mobilizise knowledge activists
- create right context
- globalizise local knowledge (Von Krogh, et al., 2000)

Hunter (2008) describes the seven pillars of innovation, and these give the research analysis another theoretical lens with which to interpret the experience of the informants with respect to design innovation. They pillars are: Vision; Creativity; Knowledge; Time; Resources; Focus; Persistence (Hunter, 2008). The methodology of this thesis takes a qualitative approach using an ethnographic case study of the design innovation ecosystem surrounding the game, 'Design 2029*Design 2029*' in SL (Creswell, 2009; Yin, 2009). The research project , 'Design 2029*Design 2029* – The End Game', has been was based on an ethnographic methodology that acknowledges the participant role of the researcher, using and uses a second-order cybernetics approach (Bateson & Donaldson, 1991; Boellstorff, 2008; Creswell, 2009). This case study employed direct observation of the game designers and interviewed them (Creswell, 2009). The game was not an experiment, as such, but was designed to generate relevant data to the research question in a recursive and collaborative dialogue with the game participants (Coghlan & Brannick, 2005). During the different phases of the game design the participants confronted the challenges and possible solutions to the innovation process, and addressed the secondary research sub-questions 'What enables knowledge creation during design innovation in SL?' and 'What enables creative collaboration amongst designers in SL?' of what is the potential for creative collaboration in SL? And, what is the requisite ecology to enable knowledge creation in SL?

4.13. Research data collection

There was an opportunity for both qualitative and quantitative data collection from this research project. This occurred through the following methods:

- Unstructured interviews with the participants in the Slooders,; Studio Wikitecture;, and Design 2029*Design 2029* groups.
- Focus groups: both physical and in SL.
- SL 3D wiki -– the upload and recording of artefacts in SL including 3D objects explaining their research and developmentR&D. This was analysed for contributions, rich communication, and effectiveness.
- SL rewards and reactions to knowledge sharing and creative collaboration. Some research participants maintained a team blog about their SL experience and their reactions.
- A student survey of Design Led Futures, survey to compare teamwork, creative collaboration, and the design process of co-design.

The interpretation and analysis of the data collected took a number of forms. The main body of the analysis took place in the narrative of the ethnographic case study that includes direct observations of designers in SL, the design teams, and the individual participants. MediaZone, a virtual island owned by Victoria University's School of Design, is the headquarters of the game, *Design 2029,* and had areas set aside to encourage teams to build on the island,. hHowever, other teams who chose to build elsewhere in SL, including the Sloodlers, and Studio WikiTree groups were also observed. Due to the difficulty of observing multiple teams, in multiple locations in SL, the research also explored documentation of the design process through blogs, production diaries, and machinima. In addition to this documentation, informants were interviewed and asked to participate in focus groups to discuss their design process, creative collaboration, and knowledge creation. An online survey was used to assist in the triangulation of observations and comments from informants.

4.14. Quality assurance

Yin (2009) suggests that the following principles will assist a high-quality case study: '(a) using multiple, not just single, sources of evidence; (b) creating a case study database; (c) maintaining a chain of evidence' (p. 101). Multiple sources of evidence were used such as blogs; interviews; participant observation; previous ethnographic studies in SL; machinima; focus groups; and field notes. In addition to these the following virtual artefacts were observed: Studio Wikitecture WikiTree; Sloodle objects; and *Design 2029* artefacts and how the participants interacted with them. Unstructured interviews were used to build relationships with the research subjects. This is an approach that is more collaborative and based on an action research methodology that places them in the role of 'informant rather than respondent' (Coghlan & Brannick, 2005; Yin, 2009).

Any ethnographic research cannot help but be fragmentary, subjective, and allegorical (Denzin, 1997; Hine, 2000, 2005). Denzin's (1997) "The 'final rule' must always be kept in mind: 'No text can do everything at once. The perfect ethnography cannot be written"' (Denzin, 1997, p. 287). The *Design 2029* case study, Design 2029, was designed to help interpret and reveal aspects of design innovation in SL that would in turn reveal other fragments of ethnographic understanding of a complex adaptive system.

CHAPTER 5
5. THE CASE STUDIES

5.1. Case study introduction

The three case studies were chosen to help describe and interpret the design innovation ecology in SL. In addition to the *Design 2029* case study, there were two supporting case studies, Studio Wikitecture and Sloodlers. This chapter will begin with an overview of each case study, the numbers in each group, the purpose of the groups and the characteristics of the memberships. There follows an analysis of the case study data including an introduction to Lessig's four cybernetic regulators. This is concluded with an wider analysis of SL as a design innovation ecology and Lessig's cybernetic modality. The original intention of the *Design 2029* project was to fill a research gap unanswered by the existing SL groups or case studies. *Design 2029* was designed as a game; a 'mashup' or amalgamation of the two applications at the core of Sloodle and the Studio WikiTree. The difficulties in successfully concluding this mashup informed the research analysis into design innovation in SL in a number of ways that are examined in the reflections on the case studies. Linden Lab intended that the group architecture or software in SL would provide the infrastructure to build community culture and norms. There are a number of mechanisms that can assist this process including the ability to create a group insignia and a charter. Each of the case studies consists of groups with sub-groups. A theoretical framework (see Chapter 3) was applied to assist the analysis of the design innovation ecology of *Design 2029* using a biological cybernetic model; the spectrum of fidelity model; and Lessig's four modes of regulation. The case studies are all introduced here prior to a more in-depth reflection on how they contributed to the answering of the research question analysed through the theoretical framework.

5.1.1. An overview of the Sloodlers case study

- Group title: Sloodlers
- No. of members in SL: 1,485

- Group charter: The community group for anyone interested in the integration of virtual worlds and Learning Management Systems.
- Website: www.sloodle.org

Sloodle is an acronym for Simulation Linked Object Oriented Dynamic Learning Environment (see http://www.sloodle.org/moodle/) and is a tool designed to extend the reach and capability of the web-based Moodle education toolset. Moodle is an open source, web-based, learning management toolset that is internationally popular with a large educational base. This group was selected as a case study because preliminary research had identified three important aspects of the Sloodlers community that spoke directly to the research question. Sloodle was a successful design innovation in itself; it included a novel user interface and a thoughtful approach to the needs of the users and had received positive feedback from a substantial number of users. It had attracted a large community of developers, educators and students who were remotely, and creatively, collaborating with each other all around the world. Sloodle was also designed to enable knowledge creation and learning using SL – another area of research interest for this thesis. Of the three case studies, Sloodlers was by far the largest. Within the membership there were professional and academic software developers and a larger group of educators and students who used the Sloodle tools. The toolset was sophisticated and benefited from multi-generational versions of the software modules. According to the Sloodle website,

> Sloodle provides a range of tools for supporting learning and teaching to the immersive virtual world; tools which are fully integrated with a tried and tested web-based learning management system used by hundreds of thousands of educators and students worldwide. (Sloodle, 2011)

The Sloodlers group also included developers who supported and extended the capability of the Sloodle toolset. This sub-group was of particular interest as *Design 2029* was designed to integrate some of the Sloodle tools and attract the Sloodler community at large. Because Sloodle also interfaced with the web-based Moodle learning management tool which was used in physical classrooms, it also provided an opportunity to bridge the communication between the online and offline world, further blurring this arguably artificial boundary.

Some of those tools included:

- A 'web-intercom' that brought together Moodle and SL chat sessions, archiving them in the Moodle database for later access.
- A registration booth that handled identity management of students passing information between the Moodle registration and the student's SL avatar.
- A choice tool that allowed students to vote.
- A multi-function Sloodle toolbar that enhanced the SL user interface
- A presenter tool that enabled large-screen presentations to be easily loaded into Moodle and then presented in the SL classroom.
- The award system which could be used in a game show environment where students could be rewarded for correct answers.

There were many other Sloodle tools, but this thesis was focused largely on the award system because that was identified as a valuable module for the *Design 2029* project.

5.1.2. An overview of the Studio Wikitecture case study

- Group title: Studio Wikitecture
- No. of members: 380
- Group charter: Studio Wikitecture is a group composed of a diverse spectrum of individuals interested in exploring the potential of applying an Open Source paradigm to the design and production of both real and virtual architecture and urban planning. We have over the 3 years been conducting 'Wikitecture' projects within SL to tease out the procedures and protocols necessary to harness the 'Wisdom of Crowds' in designing architecture.

- Website: http://studiowikitecture.wordpress.com

From 2007 until 2009 the WikiTree software development was funded by Studio Wikitecture and originally developed by i3D Inc. In 2009 it became an open source project that released the source code and began a supporting group in SL called Open WikiTree. According to their website, the objective of the Studio Wikitecture projects is:

> Improving Architecture and City Planning by Harnessing the Ideas behind: Web 2.0, Open Source, Mass Collaboration, Social Networking, Crowd Sourcing, Crowd Wisdom, Social Production, Open Platforms, Open Innovation, Collective Intelligence, Decentralized Collaboration, Participatory Culture and the like. (http://studiowikitecture.wordpress.com/)

Studio Wikitecture was selected as a case study because it exhibited a number of features that were considered useful in answering the research question. The group project was regarded as an innovative design and methodology for creative collaboration by Linden Lab and was awarded their Founders Award. The philosophy of the group supported open innovation and recognised how an open approach to design innovation encouraged creative collaboration and enabled knowledge creation. These features of the group spoke to the primary research question concerning how to design a virtual design innovation ecology and the sub-questions relating to creative collaboration and knowledge creation.

Compared to the Sloodlers group, Studio Wikitecture was smaller and seemed to lack the critical mass to attract software developers who could support and extend the WikiTree tool. However, the WikiTree was the most prominent and well-thought-out approach to open design innovation and creative collaboration in SL. Studio Wikitecture projects often started with large numbers of designers who were interested to collaborate, however it was as easy to opt out as it was to opt in, and participation on projects quickly declined after their launch. The 3D WikiTree and the ability to design architectural projects in a 3D environment in SL presented a powerful tool that offered significant benefits to those designers who were passionate about design innovation, and

Studio Wikitecture successfully completed and won an international open architectural award for their work on a Nepalese medical centre.

The SL user interface already presented a relatively complex and steep learning curve for those who wanted to use SL as a design innovation tool and environment. The WikiTree added another layer of complexity and required some learning before it could be used by a designer. In addition to a virtual island in SL, Studio Wikitecture experimented and implemented various web-based solutions to support the group and the projects. This included videos and wikis on how to use the WikiTree and social network tools such as Ning to encourage knowledge sharing, crowdsourcing, and participation in the design innovation process. The metaphor of a tree assisted the participating designers and reviewers to render or ‘rez’ iterative designs that showed the progress of an architectural design. A reviewer could ‘rez’ a design by clicking on a leaf that would then build the design version for them to either participate in by contributing to the build or allow them to vote with a thumbs up or down to a design. The WikiTree in SL was the most successful example of a collaborative design innovation tool, however the founders of Studio Wikitecture also identified a number of weaknesses. The small number of designers and reviewers who participated in each project was one. Another challenge was the maintenance and future development of the WikiTree software. It has been recognised that without the critical mass of a dedicated user base open source software will struggle to attract developers (Goldman & Gabriel, 2005).

The decision to open source the code of the WikiTree followed in the wake of the Linden Lab decision to open source the viewer client software. The formation of a further sub-group, Open Source WikiTree, was intended to support software developers who could contribute time and expertise to the WikiTree development:

- Group title: Open Source WikiTree
- No. of members: 31

- Group charter: A group for folks interested in using or modifying the (now open-source) WikiTree.
- The WikiTree is a collaborative building tool that has been used by Studio Wikitecture for group projects in architecture aimed at both RL and SL.
- Website: https://SourceForge.net/projects/wikitree3d/

The Open Source WikiTree group was not particularly active and struggled to enlist support from the wider SL and SourceForge community of software developers. The Open Source WikiTree group has made little progress in advancing the software or addressing WikiTree's problems.

5.1.3. An overview of the *Design 2029* case study

The literature review and preliminary research into design innovation in SL had revealed a number of gaps in the existing research and the methodology. The Sloodlers and Studio Wikitecture case studies went some way towards answering the research questions. However, it was determined that an action-based ethnographic case study could strategically pinpoint some of the issues not easily illustrated in the existing SL groups. The theoretical frameworks provided by Von Krogh et al. and Lessig were augmented with two new models that were created by the researcher to assist in examining and understanding the design innovation ecology of SL: the spectrum of fidelity and the indosymbiotic life cycle of design innovation. The missing elements of the other two case studies were designed to be addressed by the *Design 2029* case study within a game context. The case study unit of research included the game developers and competition entrants of *Design 2029*, Sloodle designers and users, and participants of Studio Wikitecture, with the design teams and individuals as sub-units of the research and analysis.

Three groups were established to support the knowledge vision of the game:

1. *Design 2029* – The End Game (hereafter 'End Game')
2. *Design 2029* – The Guardians (hereafter 'Guardians')
3. *Design 2029* – Dark Forces (hereafter 'Dark Forces')

- Group title: End Game
- No. of members: 18
- Location: MediaZone
- Group charter: End Game is open to all in SL who believe we can build the foundations for the future based on openness and knowledge sharing. It is a thought experiment to build tools to assist creative collaboration.
- Website: http://www.launchsite.co.nz/secondlife/design2029/2029wiki

End Game was designed to be an SL game in-world that would attract teams of five to seven designers who would creatively collaborate to create a self-replicating design innovation organism, or inogism. The inogism would include the Sloodle Award System and the Studio Wikitecture WikiTree that would be integrated into a design tool that would provide the cyborgs with cybernetic feedback and rewards for design innovation and knowledge creation. The Creative Commons rights machine was also intended to be integrated in the *Design 2029* inogism in order to provide a clear description of copyright ownership. The game's objective was for the team to achieve the highest score as awarded by the 'wisdom of the crowd', who appreciated the team's design innovation and used it. The top team would receive 100,000 Linden dollars. The first group, End Game, was open to anyone in SL, and the other two *Design 2029* groups were intended for the developers and through invitation only. Several wikis (see http://bit.ly/54FtDx) were established and written to provide more detailed information on the project for game participants and software developers. A short story, 'Creating Shiva' (Rive, 2009), was written to describe a hypothetical scenario.

Innovation and futurism are closely linked as innovators attempt to imagine future scenarios in which their designs will be useful and wanted (Boyd, 2009; Von Krogh et al., 2000). Kurzweil (2005) studied futurism to assist his design innovation and stated, 'I realized that most inventions fail not because the R&D department can't get them to work but because the timing is wrong' (p. 3).

Kurzweil predicted that by 2029 humanity will have evolved a human-level non-biological intelligence that for US$1000 will achieve the computation of one thousand times the human brain. Kurzweil wrote that while biological intelligence is in essence ‘fixed’, non-biological intelligence will continue to increase exponentially and will combine the pattern recognition abilities of human intelligence with the speed, memory and knowledge sharing of machine intelligence. Based on that premise, the entrants to the competition/game were asked to imagine a design studio in the year 2029. In that futuristic scenario the human brain is augmented, networked, and very powerful; there is full sensory VR; nanotechnology has created cyborgs that blur the lines between hardware, software and ‘wetware’ or humans; and general AI that is capable of passing the Turing Test roams the virtual world.

According to Kurzweil and others, virtual worlds will be commonplace within two to five years and indistinguishable from physical reality before the end of the next decade. The convergence of hardware and software will continue apace with the combination of GRIN (Genetics, Robotics, IT and Nanotechnology) (Garreau, 2005). SL provides a tool to imagine that future and to speculate about possible design scenarios, such as *Design 2029*, and the process of working together in the virtual design studio of the future. End Game was created as a players’ group that was dependent on the development of the game tools that were necessary before the game could be launched and players recruited. It was intended that these game tools would be developed by the researcher with expertise funded by a research grant. The challenges faced by the *Design 2029* team provided direct evidence of inhibitors identified by Von Krogh et al. (2000) and, more particularly, Lessig’s modalities. The sub-group Guardians was a closed group of game developers.

- Group title: Guardians
- No. of members: 5
- Location: MediaZone

- Group charter: *Design 2029* Guardians of the End
- Website: http://www.launchsite.co.nz/secondlife/design2029/2029wiki

The Guardians group was conceived to be a closed group of game designers and developers who worked to establish all the necessary requirements to build and run the game. It was a closed group to try to prevent opportunistic gamers who might seek to find exploits in the game in order to win outside of the rules. As evidenced by the other case studies and reported by Goldman et al. (2005), open source projects require seed software development prior to marketing the project to the open source development community. Guardians faced a number of challenges including time and resources that inhibited the progress of the design innovation required for the game toolset for End Game. Another element of the game development was introduced to present the game players with a challenge: the sub-group Dark Forces, which introduced a threat to make the game play more interesting.

- Group title: Dark Forces
- No. of members: 4
- Location: MediaZone
- Group charter: [This was deliberately blank to add mystery and a sense of menace.]
- Website: http://www.launchsite.co.nz/secondlife/design2029/2029wiki

The Dark Forces group was conceived to provide an external challenge to the game participants. It consisted of a small number of game developers who would provide fun and challenges for the game participants. Dark Forces had a secret base on MediaZone Island hidden beneath the sea just off the coast. This group was never active, however, because End Game never launched and so there were no players.

One of the wellsprings of innovation and creativity is imagination and the ability to imagine possible futures (Hunter, 2008). SL provides all residents with the tools to visualise possible designs in a virtual world where almost anything that can be imagined can be designed and built. The by-line of SL is: 'Your World, Your Imagination'. The ability for a designer in SL to go beyond the usual limitations of physical materials and into the realm of imagination where the physical and the virtual blur vastly expands the designer's palette for experimentation and design innovation. The *Design 2029* case study aimed to provide a future scenario in which this creativity and experimentation could be exploited by the designer's imaginations. However, even with these minimal constraints, there are cybernetic regulators affecting design innovation in SL.

5.2. Analysis of case study data

Following the data collection of the three case studies they were all analysed according to the Von Krogh et al,'s (2000) and, more particularly, Lessig's theoretical frameworks, as well as according tothe original models, the spectrum of fidelity and the indosymbiotic life cycle of design innovation. Each of the case studies was examined to attempt to understand the cybernetic regulators that were affecting design innovation within that ecology and that analysis is presented here. This analysis was confined to case study data only; a further analysis of SL data that pertains to the research question is presented later in the chapter.

5.2.1. Introduction to normative regulators

Design 2029 set out to test the proposition that SL can enable knowledge creation and creative collaboration in a virtual design innovation ecology. *Design 2029* examined the normative regulators surrounding the knowledge creation process and how norms inhibited or enabled creative collaboration amongst design teams. According to Von Krogh et al. (2000),

> Knowledge is a construction of reality rather than something that is true in any abstract or universal way. The creation of knowledge is not simply a compilation of facts but a uniquely human process that cannot be reduced or easily replicated. It can involve feelings and belief systems of which one may not even be conscious. (p. 6)

Of Lessig's four mode, *norms* would seem to be the largest, most intangible and yet most powerful regulator of the design innovation life cycle. It could be argued that all the other mode are subservient to the norms of the design innovation ecology. Norms are the precursor to the formalisation of the *law* (M.F. Schultz, 2006); the assumptions and rules of the *market* (Reeves & Read, 2009; Tapscott & Williams, 2006); and the design of technological *architecture* and code (Lessig, 1999, 2006). Normative cultural regulators have shaped the evolution of the other three modes and continue, in a recursive cycle, to participate in the cybernetic evolution of itself.

There are four norms that are important to knowledge creation and teamwork within the SL design innovation ecology:

- Trust
- Reputation
- Reciprocity
- Value systems

These norms can be considered as a sub-set of cybernetic regulation and feedback during the indosymbiotic design innovation life cycle. If there is no trust between cyborgs, or no trust in the architecture, laws, or markets that enforce expected behaviour between cyborgs, then there is unlikely to be a free flow of knowledge, knowledge creation, and creative collaboration. The importance of community and the norms of self-governance in virtual worlds has been the subject of a number of studies (Boellstorff, 2008; Dibbell, 1998; Panteli, 2009; Schroeder, 2002). There is an ongoing tension, both inside and outside SL, based on the normative assumptions of what the essence of the knowledge economy is; what drives it; and what the determinant of value is. Is value determined by the embodiment of a product or service, or is it the intangible ideas baked into the design? This tension is played out daily in SL as cyborgs negotiate, trade, sell and give away virtual objects, code and notecards. There is an unresolved normative paradox that is common amongst cyborgs in SL that relates to attitudes towards virtual objects and IP in SL. Virtual objects can be treated just as a physical object to be sold within the SL design ecology or can be perceived to be digital content that can be readily replicated and shared.

The flexibility of the SL architecture obscures this unresolved normative paradox that contributes to the ideological confusion of some designers in SL; Lessig (2008) calls SL a 'hybrid' economy, where information is partly commercialised and partly shared. The permissions system, or DRM has hard-wired the ambiguity of this paradox into the virtual world. For example, a cyborg can decide whether to make a virtual object totally open, free for anyone in SL to take, or share it with a friend, or share it with a group, or give one person a free, non-modifiable version, and still sell it to someone else. The flexibility of the system is both architectural and normative as it acknowledges that norms are context sensitive and can change depending on the group and the circumstances. Von Krogh et al. (2000) claim all knowledge creation is context sensitive.

5.2.1.1. Trust as a normative regulator in the case studies

The three case studies relied on trust to first establish the projects and then develop them. Design innovation in a virtual ecology faces an added challenge due to questions of identity which present an additional barrier to trust and therefore design innovation. During the establishment of *Design 2029* the researcher and the senior research technician had the advantage that they had physically met each other and were both members of the School of Design at the same university. This was also the case for some of the academic members of Sloodlers who had met at conferences or worked together. For cyborg designers who had only met in SL there was often a process of identity verification. Cyborgs such as 'Theory Shaw' from the Studio Wikitecture project volunteered their legal name and their background to encourage trust amongst the other designer cyborgs. This was also a common practice amongst professional educators such as those involved in the Sloodlers group. Without some means of actual verification of identity outside of SL, cyborgs would have to build up a reputation over time within SL to attain levels of trust. It should be noted that as all three case studies were defined as 'open', the disclosure of actual identity was common, however in SL it was considered impolite to push for this information. Also, because the design of most projects within the case studies were not considered to be valuable in a commercial sense, the level of trust between the design teams was not so critical. In education groups such as the Sloodlers and *Design 2029* it was almost expected that a cyborg would reveal their actual identity, their institution, their physical locality, and their area of study. In SL many educational instructions required full disclosure as a prerequisite to entry into an SL group. The Sloodle toolset provided additional identity and security measures to verify students on the Moodle websites and to allow for student assessments and entry to courses.

The DRM system of managing permissions was trusted by most designer cyborgs in SL, however sometimes the complications of the system encouraged cyborgs who trusted each other to remove all protections. This happened on one occasion when a Sloodle developer wanted to give the *Design 2029* team a virtual object that contained a script that needed to be modified by the new owner. This required trust by the Sloodle developer and a verbal undertaking by *Design 2029* that they would not sell the object or give it away.

The conditions of all three case studies required that cyborg designers agree to open source copyright licensing. In this way the cyborg designers trusted in the legal protection of those copyright licenses and so they did not have to rely solely on the means of identity verification of their team members, and the threat of unauthorised use of their shared design was removed. Low levels of trust and the high-perceived value of a design significantly inhibited design innovation in the case studies. Cyborg designers in SL who were not solely focused on one of the three case study groups were participating in the wider SL market economy. There were two examples of how trust and a cyborg's value system interacted to regulate design innovation. A member of the Studio Wikitecture group expressed concern about contributing designs to projects that could then be sold in competition to their own ventures. However, the designer discounted the concern when they mentioned that their designs were not selling very well anyway. The research technician of *Design 2029* originally contemplated selling the Sprinkle Server component of *Design 2029*, however they decided to give it away with a Creative Commons license with attribution. Their motivation was not discussed but this could have been because they philosophically agreed with the open source approach and/or considered that the software would not make a lot of money. Trust was also closely related to reputation, and reciprocity helped to build up trust between cyborgs within the case studies.

5.2.1.2. Reputation as a normative regulator in the case studies

The reputations of both the Sloodlers and Studio Wikitecture projects helped to attract designers who had read about their achievements and status. *Design 2029* set about to build a reputation using marketing and attracting cyborgs with impressive reputations. Awards were useful in establishing the Studio Wikitecture reputation and encouraged cyborgs to trust in the legitimacy of those projects. The attachment of cyborgs to well-known educational institutions helped the Sloodlers attract large numbers of members and international educators. The underlying popularity of the Moodle system that supported Sloodle also helped to boost the reputation of the project.

A positive reputation helped to enable knowledge creation and encourage design collaboration amongst cyborgs who had only met in SL. The past performance of Studio Wikitecture attracted designers who contributed months of work to projects without commercial reward. *Design 2029* attempted to leverage this reputation using a Leader Board and a Hall of Fame on Mediazone to encourage participation in the design project. A poster advertising the University of Wellington, New Zealand, and its School of Design used the reputation of the institution to encourage trust and leverage reputation for the project.

A Sloodle freelance developer had built up a considerable reputation through their involvement in the project, running workshops and posting YouTube videos. The cyborg’s avatar was better known than their actual name. The ability of any cyborg to find an avatar quickly and either IM them or initiate a voice chat helped enable knowledge creation and design collaboration easily, without the physical limitations of travel. A cyborg designer could begin a conversation with a total stranger and, despite being on the other side of the world, within a few seconds teleport to their location to begin a simulated face-to-face meeting about a design. Membership of one of the three case study groups increased the likelihood that the stranger would reply and invite the designer to join them on their virtual land. IMs that were not qualified by the cyborg explaining who they were or what their mutual interest might be were ignored by some cyborgs in SL.

5.2.1.3. Reciprocity as a normative regulator in the case studies

Design 2029 was designed to encourage knowledge sharing and reciprocity, rewarding teams that shared designs and created knowledge as a result. Studio Wikitecture was also founded on the principles of reciprocity whereby design teams shared virtual objects and ideas to attempt to create an innovative design. The virtual ecology of SL helped to enable reciprocity and design innovation by making it relatively easy to give permission to other cyborg designers to share designs. That reciprocity was regulated by the normative approach to the value system and the conditions of design collaboration outlined in the group charter or the copyright license of the project. Members could only participate in Studio Wikitecture projects if they agreed to share their designs, and fostering reciprocity was the intended purpose of the *Design 2029* game.

Sloodlers were less explicit about reciprocity in their everyday activities and reciprocity was not a condition of participation in the group. However, all the Sloodle tools were licensed under an open source GPL and so any Sloodle developer was aware that they were expected to reciprocate if they used the Sloodle code. It was a requirement of the Sloodle PrimDrop tool that students must allow all permissions so educators could assess their course work. A developer for Sloodle enhanced their reputation amongst the Sloodlers by freely giving away new Sloodle tools that they had developed, and this was often matched by reciprocity, enhancing trust between group members. This was all founded on the socially accepted value system of the Sloodlers, and an open source philosophy.

5.2.1.4. Values as a normative regulator in the case studies

The developers of *Design 2029* attempted to build a new value system into the game based on knowledge sharing and design collaboration. This proved a challenge as value systems can often compete and SL had a dominant and active market economy that competed with the *Design 2029* values. *Design 2029* attempted to artificially overcome this by advertising a $100,000 Linden dollar reward for the winning design team in the game. The value systems of all three case studies fundamentally coincided, which was an important prerequisite for a ‘mashup’ of their toolsets. However, subtle differences in open source copyright licenses and philosophies caused complications and inhibited a shared knowledge vision which slowed design innovation. The market economy of SL also challenged each of the three groups and their value systems, and commercial rates of software development crept into all three projects. In the wider SL design community there was a popular movement for designers to try and build their business to the point that they could resign from other work and earn a full-time income in SL. Therefore, in all projects there were occasions when there would be a huge disparity between micro-payments for virtual designs and the market rates paid for software development outside of SL which were paid to SL consultants and bigger corporate projects. The three case studies were all regulated by these four common norms of trust, reputation, reciprocity and value systems that underpinned other normative challenges for their projects.

5.2.1.5. Normative challenges faced by *Design 2029*

Norms are defined by community and community-building was considered one of the most important aspects of all of three case studies identified by their respective organisers, and all projects acknowledged the difficulty of achieving and sustaining their community. The case studies were all not-for-profit and had a community culture that supported open knowledge sharing and open innovation. During the establishment phase of *Design 2029* effort was applied to building a knowledge vision that could attract support and resources to the project; this vision was based on

Von Krogh et al.'s (2000) framework. A proposal was written and research funding for the project was successfully obtained. The researcher's design school funded MediaZone Island in SL to enable the designing and building of the *Design 2029* world. It included a number of public exhibition buildings; pods for design teams; a conference centre; a Hall of Fame; an office and research lab in the sky; and a secret underwater location for the Dark Forces of the game. Figure 7 is a sketch completed by the research of the layout of MediaZone Island design prior to the more detailed design and build for *Design 2029*.

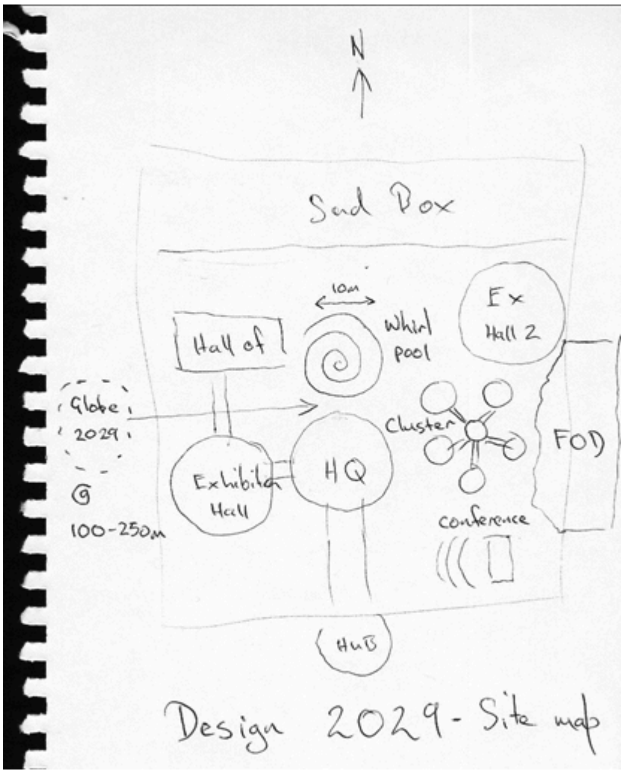

Figure 7. Rough site plan for design of the island for Design 2029

Following the initial establishment, the *Design 2029* project faced a number of challenges regulated by the norms of the groups and the wider SL community. Community-building was considered the most important step in establishing a design ecology.

5.2.1.6. *Design 2029*: building a community

With *Design 2029* the difficulty of motivating individual SL designers who were not already part of a team and lacked a common knowledge vision was identified, and this was also observed as a barrier in the Studio Wikitecture and Sloodle projects. Corporations that hired consultants in SL to develop projects in SL, such as Pontiac, employed experienced cyborgs to build communities and actively promote those projects. One such cyborg was spending well over 40 hours a week in SL and had successfully built up a significant community as a result. As noted earlier, a prize of $100,000 Linden dollars was offered in *Design 2029* to help overcome this initial barrier. This considerable prize money was intended to attract attention to *Design 2029* when the various components of the game were completed. The *Design 2029* game components such as rules, scoreboards, permission tools, and voting software required extensive resource allocation before the game could be widely advertised and promoted prior to launch. Ensuring that these game components were designed and constructed required all stakeholders to agree on the knowledge vision in order that the resources for the components were correctly allocated.

The process of building a community with a shared knowledge vision and norms began in SL with a managed conversation by the researcher acting as a knowledge activist. A background notecard was written and distributed in SL to potential supporters and participants, and a large interactive sign advertised the game (see Figure 8). The prize money was on display at the entrances to MediaZone Island and Innovation Info Island in SL. When a cyborg clicked on the sign it provided them with an interactive notecard that contained hyperlinks in SL.

Figure 8. *Screen grab of advertising poster for Design 2029 on MediaZone*

5.2.1.7. *Design 2029* and knowledge activism

Promotion of a knowledge vision and mobilisation by knowledge activists are necessary requirements of any design project (Von Krogh et al., 2000). Von Krogh et al. describe the role of knowledge activists as actively promoting the knowledge vision and encouraging the normative values of knowledge creation and sharing. The knowledge activists, who also 'manage the conversation', must first buy into the knowledge vision and seek to promote the normative values of that vision. In order to promote *Design 2029*, a short machinima movie trailer advertising the game and the *Design 2029* group was produced and posted on YouTube and embedded in the wikis (http://www.youtube.com/watch?v=9EbCqzi86HU&feature=player_embedded). There were two knowledge activists who actively talked to SL residents about *Design 2029*. They used the background notecard; the interactive sign; Twitter; Facebook; wikis; and the YouTube video to promote the game during the build-up to launch. All of these preparations took several months to create and were intended to support the knowledge vision when the project was eventually launched. However, the launch of *Design 2029* never took place and this was largely due to limited commitment to the knowledge vision from the stakeholders and those that allocated the necessary resources of time and money.

5.2.1.8. *Design 2029* and the Innovation Info Island experience

During the early stages of the project *Design 2029* was accepted by the Innovation Info Island project in SL in August 2009. This was part of an impressive archipelago of over 50 virtual islands under the management of Alliance of Library Services, a university librarian system researching and developing library science in SL (Bell & Trueman, 2008). ALS had the resources to offer space on their island for free to successful applicants, and began with an open day including panels, presentations, and musical performances. All participants donated their time, skills, and own resources for free as they shared the vision for the island, and were often employed by universities. In epistemological terms a community must also have a shared common understanding and language in order to support the knowledge vision of the leadership (Dixon, 2000; Von Krogh et al., 2000). As a concept, 'innovation' is often ill-defined or its meaning is simply assumed, and so on Innovation Info Island the academic librarian community assumed a loose definition for 'innovation' which was never made explicit but seemed to refer to something that was novel, inventive, and specifically applied to librarian science. This did not totally agree with the innovation definition adopted by *Design 2029*, that of OECD (2005). The live musical events on Innovation Info Island, for example, were seen as enjoyable entertainment but did not focus on innovation, although they did provide useful community-building opportunities. On the launch day of Innovation Info Island the musical entertainment was followed by presentations and panel discussions relating to innovation and library science in SL. The purpose of the open day and musical entertainment were to encourage outside engagement with the project and to help foster a community. One presentation began with a slide presentation:

> [14:39] Valibrarian Gregg: Slide 1: 'Hi! I'm Esther Grassian, Information Literacy Librarian in the UCLA College Library, UCLA's undergraduate library. I've got about 10 minutes to talk with you about innovative information literacy in SL.'

The *Design 2029* project did not fit well with the vision of this community, so after an initial flurry of activity to get ready for the open day, *Design 2029* did not maintain a regular presence on Innovation Info Island. Lack of funding and resources meant that by April 2010 ALS were forced to sell the island to another cyborg who offered to rent or sell the land to the existing residents. The new owner made a miscalculation about resident reaction to their plans when they removed – and later returned – the buildings and virtual possessions to the inhabitants of a virtual space known as New Orleans. This had been a popular place modelled on the original look and feel of 19th century New Orleans, and was used as a social hub for dancing and chatting. The new owner was forced to request Linden Lab to roll back the server, which meant that all the buildings and virtual objects were returned and re-established on the island so that the owners could make a planned exit. Thus, community spirit and norms are of vital importance to the culture of innovation and creative collaboration in SL.

5.2.1.9. *Design 2029* resources and shared visions

The *Design 2029* project required resources to complete the development of code to enable a scoring feature for the game that combined the WikiTree and the Sloodle Awards System. Various earlier attempts at implementing other research projects had run into difficulties due to lack of resources, and so the *Design 2029* project was proposed as a research grant application. The application was successful, however a requirement of the grant was that work was to be carried out by in-house research assistants and a senior research technician in order that Victoria University should own and retain the knowledge created during the *Design 2029* research project. At that juncture there were at least two normative constraints that limited the cybernetic knowledge flow and ability of designers to work together on the *Design 2029* project:

- Lack of a shared knowledge vision (Von Krogh et al., 2000).
- A closed innovation paradigm that believed in 'owned' knowledge as a competitive advantage, i.e. Lessig's market modality (Lessig, 2006).

It is possible to identify a number of norms regulating the indosymbiotic life cycle of knowledge creation and innovation in the *Design 2029* project. The Von Krogh et al (2000) enablers have each been examined to analyse *Design 2029* and show how the lack of normative support regulated the indosymbiotic innovation life cycle. The lack of a shared knowledge vision amongst the various stakeholders regulated knowledge creation and inhibited it in the *Design 2029* project. This also impacted two other important pillars of innovation identified by Hunter (2008): time and resources. The amount of time and resources that can be dedicated to a design project can have a substantial impact on the degree of innovation and knowledge creation that will result (Hunter, 2008). Many years of experience are generally required before a designer can come up with a design innovation that has not been thought of before and is a novel solution to a design problem (Gladwell, 2008; Hunter, 2008).

5.2.1.10. *Design 2029* normative life cycle

To assist with the resources and time to establish the *Design 2029* project, support was requested through the research grant process. The research grant application was successful and the project began with urgency at the end of 2009. The researcher and the senior research technician began to work to clear MediaZone Island of the exploratory machinima research project. The funding was provided to the researcher via a scholarship that paid for the design and construction of the *Design 2029* environment on MediaZone Island. These resources, as well as enthusiasm and passion, quickly contributed to the design of a new world look on MediaZone to support the narrative of the *Design 2029* knowledge vision. Other potential collaborators were also recruited to the *Design 2029* project. However, progress on *Design 2029* began to decline when resources were withheld due to normative changes surrounding the project. This could be attributed to a failure to 'instill a knowledge vision' that was shared by important stakeholders, and the inability to 'manage the conversation' (Von Krogh et al., 2000). The experience of the *Design 2029* project and a similar impact of lack of resources and time were also seen in the case studies by Christiansen (2000). The initially benign and supportive context surrounding the *Design 2029* changed as soon as the research funding was announced. Outside influences began to slow progress. As the lead researcher, who was also the 'knowledge activist', was not able to be physically present during this important phase, *Design 2029* found that virtual communications within SL, telephone, Skype and email lacked the bandwidth of face-to-face meetings. There was very little SL contact or communications used by decision makers and stakeholders in deciding the allocation of resources after the funding announcement. There was a poor understanding of the project or the potential of SL. The senior research technician was asked to spend most of their time on other end-of-year student projects and School of Design projects, and was asked to stop work on anything related to SL after only two weeks of research funding. Eventually, a compromise was negotiated between the lead researcher and the school to allow one day, and eventually two days, a week on the project. However, this provided insufficient time and resources to complete the *Design 2029* project, despite unused funds. It is important to recognise how these normative regulators can not only impact academic research and design collaboration but also inhibit creativity in design practice studios. Competition for resources without an effective knowledge vision can work against creative collaboration and innovation (Christiansen, 2000; Dixon, 2000; Von Krogh et al., 2000). Without effective knowledge activists and an ability to manage the conversation based on the knowledge vision, an innovative project is unlikely to succeed. *Design 2029* also suffered from an institutional IP policy that adhered to the closed innovation paradigm, and believed that innovation must be tightly controlled to afford the opportunity for commercial exploitation. This can be seen as the regulation of innovation by Lessig's modes of law and market.

Von Krogh et al. (2000) noted that the ability to localise global knowledge was another important enabler of knowledge creation and design innovation. The original *Design 2029* proposal requested an international expert, a previous winner of the Linden Lab Founders Award, to develop the project, however the research grant was only agreed on the proviso that research be carried out in-house. This was despite the fact that there was a lack of extensive experience in SL in-house. The closed innovation paradigm, despite *Design 2029* being an open source design project, inhibited international creative collaboration (Chesbrough, 2003; Von Krogh et al., 2000). The ability of a global expert to transfer knowledge to local members of the *Design 2029* team was disputed by those that allocated resources. The political imbalance between the researcher and those that controlled the allocation of resources decided the outcome of the *Design 2029* project. This scenario can be likened to the Stage Gate innovation process, in which successive funding rounds are decided by increasingly senior decision makers who decide how to allocate resources, and decide whether to GO or KILL a project (Sebell, 2008).

5.2.1.11. The norms of a Sloodle knowledge activist

The Sloodle case study and community provided insight into the difficulties faced by *Design 2029* and how the Sloodle normative values regulated it. One leader of the Sloodle development team described how important it was to build a community and highlighted the difficulty of maintaining engagement and dialogue with a virtual community. This implied that the Sloodle group could find the integration and dialogue with other groups such as Studio Wikitecture and *Design 2029* a challenge due to competing norms and could increase the difficulty of maintaining the original Sloodle knowledge vision. This cyborg reported that it was one of the most important functions that the existing team needed to focus on. The normative motivation of individuals in peer production can contribute to the net gain or loss of the community and is based on the ability of the designer and the qualitative assessment of their contribution by their community. The inability of *Design 2029* to infect the Sloodle developers group with its inogism meant that an important part of the *Design 2029* incubation did not occur and there were insufficient resources applied to the integration of the Sloodle Award System into the *Design 2029* game.

In the Sloodle community a significant contribution to Sloodle's design was contributed by a freelance developer. The freelancer had built up a reputation with a popular Facebook application which had attracted the lead developers to hire him. The Sloodle community is a complex adaptive system, it is open source and yet it also includes paid developers. The freelance developer continued to work on the Sloodle project after their contract was concluded and continued to work hard to promote it. *Design 2029* struggled to find a way to encourage the participation of this freelance developer without resources or a clear reward for the integration of the Sloodle Award System with the Studio Wikitecture WikiTree, even though all three case studies shared similar normative value systems. Other contributors to the Sloodle code base did so when they were not paid directly for their services. This part of peer production may at first seem unusual, however their motivation was revealed in unstructured interviews. Closer analysis and comparison with other open source projects reveals that this situation was not unusual (Goldman & Gabriel, 2005).

Sloodle and its web-based parent application Moodle are both open source, peer production projects which are often poorly understood as some commentators fail to appreciate the motivation of the contributors (Ghosh, 2005b; Hippel, 2005; Lessig, 2008; Raymond, 1999; Tapscott & Williams, 2006). The Sloodle application conforms to a common model of peer production that suggests that those who are offering their services to the project for 'free' may receive other rewards that enable and encourage design innovation based on community norms such as reciprocity, reputation, and personal creative fulfilment (Goldman & Gabriel, 2005; Ondrejka, 2006, 2008; Tapscott & Williams, 2006).

After the conclusion of the freelancer's Sloodle contract the developer continued to seek out other Sloodle-related project opportunities and worked to promote the Sloodle toolset by providing free introductory workshops to educators every Wednesday in SL. The Sloodle developer continued to promote the Sloodle knowledge vision as a knowledge activist and managed conversations in SL via his workshops and YouTube videos. The Sloodle developer would openly solicit for freelance work with educators who had Sloodle projects and localised his knowledge for educators from around the world including Korea, Japan, Italy, Australia and Spain. The Sloodle developer conformed to the norms of the Sloodle community by giving away his IP in order to build his reputation and gain contract work. However, he continued to seek paid contracts such as *Design 2029* but became less motivated when it was apparent there were no financial resources to support his integration of the Sloodle Award System into the WikiTree.

This conversation with the freelance cyborg outlines how the Sloodle Award System and the WikiTree could have been integrated:

> [14:08] Freelance developer: where do I fit into this? ie: how shall we get started?
>
> [14:09] Zonn Ellison: i would like to have a meeting with [our research technician] and you next week to discuss where we are at
>
> [14:09] Zonn Ellison: he has been working on the wikitree
>
> [14:09] Zonn Ellison: and i am looking at making a wikitree module for Sloodle
>
> [14:10] Zonn Ellison: which would be where you come in
>
> [14:10] Zonn Ellison: so it could be a mash up of your award system and an auction on the wikitree
>
> [14:11] Zonn Ellison: so at the moment when you build using the wikitree it has a voting system - vote up vote down
>
> [14:11] Zonn Ellison: i would like to replace that with a point system
>
> [14:14] Zonn Ellison: so it would go something like this: 1) an originator starts a wikitree 2) invites friends or creates an open auction for the core wikitree 3) those that like it or want to be part use their points to bid to be a part of the build - the team is a max of 7 min of 2
>
> [14:16] Zonn Ellison: 4) others can be subcontributors or supporters of that wikitree project - further auctions take place 5) the team that aggregates [sic] the most points for their build wins!
>
> [14:18] Zonn Ellison: Game participants will start with our alpha build using the wikitree / sloodle design - if they want - OR they can start from scratch or submit a new design but it must incorporate our points system otherwise their points won't be counted - it must be open source

[14:19] Zonn Ellison: SO...

[14:19] Zonn Ellison: does that sound feasible?

At that point in the conversation the freelance developer suggested working closely with the *Design 2029* senior research technician. The ability for *Design 2029* to pay the freelance developer was not discussed at that point, however subsequent conversations confirmed that the freelance cyborg wanted to be paid his standard developer rate of around CAD$40 an hour. This illustrates how competing value systems can coexist and can overrule each other according to the perceived rewards and punishments of conforming to that value system. The norms of the Sloodle knowledge activist were competing, and in this instance the market mode was prominent. At this point in the project there were still considerable resources available to *Design 2029* in the form of a research grant, however due to the inflexible criteria applied by the research grant, these resources could only be spent in-house and there was no time available for the senior research technician to carry out the required development. Research policy and poor communication channels prevented a reallocation of resources that meant that research funds remained unspent.

5.2.1.12. The WikiTree and normative cybernetic feedback

Feedback on a design was recognised as an important means of achieving design innovation in the Studio Wikitecture project. The developers incorporated a ratings system that recognised the ‘best’ design as voted by anyone who has registered on their website. The lead developers of Studio Wikitecture and the WikiTree decided to begin with a simple system by borrowing the Flickr photo sharing site and using their photo comment function.

> In this early version one of the projects originators wrote:
>
> Ultimately in later phases of the Wikibuild experiment we would like to write a LSL script of some sort that would allow contributors to quickly rank and comment on what aspects of the project are working or not, but in the meantime let's develop a rudimentary ranking system with the technology that's currently available—a mashup of sorts. (Shaw, 2007, p. 9)

Individuals could write either positive or negative comments and the organisers later helped to sort them. To assist, they suggested using the ‘Fave’ button on Flickr to include designs that they liked. This is an Agile approach to development which quickly comes up with a solution that can be iteratively improved, rather than continuing to work on it until it is perfect (Highsmith, 2004). This approach also borrows the philosophy of open source and open innovation by explaining the project and requesting suggestions for those improvements to be posted on the wiki webpage.

The wiki explained:

> As you can tell, this is not the most ideal method for tallying the thoughts and opinions of the group, but it’s a start. As hinted at before, please use this Wiki to offer any suggestions or ideas you may have to improve this process, such as other mashups or possibly even a ranking script. (Shaw, 2007, p. 11)

The WikiTree subsequently evolved into a voting system and website using a ‘thumbs up’ or ‘thumbs down’ feature. However, this attracted minimum feedback on the wiki website and this is consistent with the small percentage of contributors to the Wikipedia project (Tapscott & Williams, 2006). In general, the personal feedback that many of the designers received in SL also provided an incentive and pleasurable experience that rewarded their creativity. It is through this cybernetic feedback that norms influence the behaviour of the participant cyborgs in SL. The three case studies sought some means of cybernetic feedback. The Studio Wikitecture project provided a voting and comment procedure that was intended to tap the ‘wisdom of the crowd’ and to promote quality of design through feedback. The WikiTree was explicitly designed to provide this feedback through software and a voting module. This cybernetic feedback was recognised as important to the designers in the Wikitecture projects, even though there were only a small number of people voting and commenting on the design process in the Treet TV and Safe Trestles Wikitecture projects.

The low level of engagement bothered the organisers of the various Studio Wikitecture projects and became a topic of discussion during the course of the design of the Safe Trestles project. It was pointed out that while the project started with about 20 cyborgs, who said they wanted to be involved, as the project progressed this dropped off dramatically to around four or five active members. It was recognised by participants in the Studio Wikitecture group that cybernetic feedback can encourage engagement in a project and promote innovation. Conversely, one designer mentioned that as an ecologist she felt she had much to offer the Safe Trestles project, however once the project was under way she found it hard to find a way in to contribute. It appeared that while there were comments and documentation on a Ning social networking site set up to assist with networking and feedback, this did not substitute for synchronous conversations and debate about the next iterative design. A discussion occurred around the voting mechanism, and how the WikiTree thumbs up or thumbs down approach (see Figure 9) did not provide sufficient feedback for the designers to feel they could give a quality response. There were often only a few respondents who used the voting and so a designer who had worked hard on a design could find that one vote against them, without any positive responses, was enough to be discouraging.

Figure 9. Screen grab of voting module on WikiTree

The voting was sometimes accompanied by comments, however this feedback was often not seen as particularly helpful by the designers (Figure 10).

Figure 10. Screen grab of voting Studio Wikitecture website with voting

In design innovation it is important to keep the participants engaged and active, and to allow ideas to continue to develop (Osborn, 1963; Sanoff, 1990; Sunstein, 2006). Votes were often not accompanied by a comment and so the WikiTree voting module was not sufficiently granular to determine whether the respondent did not like one aspect of the design or simply disliked the whole approach. Voting ‘good’ or ‘bad’ is a binary system that has limitations with a small number of participants and fails to engage the wisdom of the crowd because so few are participating (Page, 2007; Sunstein, 2006; Surowiecki, 2004). Norms and community opinions are seldom black and white, and a designer will only recognise the validity of cybernetic feedback if it is seen as representing enough users to constitute an expression of a community norm. Many of the Studio Wikitecture projects faced this difficulty because there were only a few cyborgs collaborating and voting. The developers of the WikiTree continue to evolve new means of voting and progressing quality designs in new iterations of the WikiTree software.

During a design review process and a discussion of how Safe Trestles had developed to date, an active Studio Wikitecture member, who was also a professional software developer, led the discussion. This cyborg chose to use three screens set up on the Safe Trestles island next to a scale model of the design in SL (see Figure 11). To view the content on the screens all the participants were required to use the SL Viewer 2 client and therefore architecture regulated their knowledge creation and creative collaboration. The cyborg tried to encourage the other cyborgs to not only discuss the project using text chat but to insert notes in the Google Docs document on the webpage. The meeting began as follows:

> [13:18] Omei Turnbull: I had pulled out 3 specific issues I would like to talk more about.
>
> [13:18] Omei Turnbull: The first is 'What concrete steps can we take at the project kickoff meeting and the first few weeks to integrate newcomers into the group and our collaborative process?'

Figure 11. Screen grab of screens supporting Studio Wikitecture in SL

There are a couple of interesting points to note about this discussion that included this researcher, the lead Studio Wikitecture member, and two other cyborgs (one an ecologist, and the other a philosopher). A live text conversation produced a lot more detailed feedback in a short one-hour meeting than the Studio Wikitecture website, wiki, or Ning pages had. The Google Docs document had only one comment, and it was agreed that the chat log would provide more valuable feedback to the WikiTree developers. While this text conversation had a lower spectrum of fidelity than speech, it did suggest that this simulated face-to-face experience increased the tacit and explicit knowledge creation. The added benefit was that the text could be copied and archived. However, this required a manual exercise and was only partially carried out.

In all three case studies informal discussions gathered more feedback rather than formal forums, wikis and websites. The SourceForge site set up by the *Design 2029* senior research technician to help developers create a 'tree from scratch' had in July 2010 not attracted any discussion. It appeared that simulated face-to-face discussions or IM text chats were more effective at managing knowledge conversations than asynchronous website forums and shared documents using Google Docs. The cybernetic feedback in SL requires close attention and has the potential to create a positive feedback loop whereby design innovation is rewarded and encouraged.

The senior research technician who was introduced to the Sloodlers group attended a number of Sloodle Developers meetings and contributed their thoughts on how to improve Sloodle and build the community. They met the lead Sloodle developer and the two began a managed conversation encouraged by the researcher, as a knowledge activist. However, limited resources restricted the amount of time and attention that the senior research technician could give to the Sloodle integration while they were primarily focused on the Studio Wikitecture WikiTree. *Design 2029* had a clear knowledge vision, however this was not shared by all the stakeholders and this norm clearly regulated the amount of resources that were applied to the project. *Design 2029* required the integration of a scoring tool for the game competitors and Sloodle offered a number of advantages to the project. The Sloodle Award System was developed by the lead Sloodle developer to make education exercises fun learning games, and this supported the theory that learning was knowledge creation (Reeves & Read, 2009; K. Weick, 1991). The research grant policy for *Design 2029* made no provision to allow the project to hire the lead Sloodle developer to complete the integration, and the senior research technician had insufficient time to learn another application. This was despite the fact that Sloodle was open source and better documented than WikiTree. The Sloodle group norms of openness and knowledge sharing within the community did not extend to how Sloodle might evolve by integrating outside applications such as the WikiTree. This required a prolonged conversation, and a well-resourced knowledge activist to infect the Sloodle community with the *Design 2029* inogism. The conversation was being managed, however, until documentation of the WikiTree was completed the application was not ready to be fully presented to the Sloodle community.

Without the Sloodle Award System the WikiTree did not have a suitable scoring system to launch the *Design 2029* game. The WikiTree code also required complete documentation before the Sloodle developers could begin to approach how to integrate the two applications and communities. In this way the norms of the three case study groups did not coincide, or share a knowledge vision, and so knowledge creation was inhibited.

5.2.1.13. *Design 2029* and the WikiTree

The original design objective of *Design 2029* was to achieve cybernetic feedback by integrating two other open source projects in order to provide a scoreboard feature (Sloodle) and a collaborative design and build feature (Studio Wikitecture). One designer from the Studio Wikitecture group working on the Safe Trestles project explained that the voting system using the WikiTree was limited because of the small number of individuals involved in feedback on the designs. Many of the designs had no votes and the largest number of votes, for or against designs in the Trestles project, was three or four. Another participant of the Safe Trestles project went on to explain that, as there was no cost to voting it created a voting system that had little sense of comparative quality between the designs. It was too easy to vote up or down without real thought about the benefits or downside of a design. Studio Wikitecture has since limited the number of votes to three positive and three negative.

> As is currently designed, if after placing your allotted 3 positive/negative votes, the next positive vote you cast will replace your oldest vote. In other words if the 1st vote is the oldest, placing a 4th vote will replace this 1st vote.
> (We do realize, however, that your oldest vote might not be the one you would like to replace. We are currently working on a way, via the website, to allow you to designate the vote you would like to replace. We hope to have that functionality up in the next stage of development.)

> In addition, you can only vote for your fellow contributor's design. We feel if members are able to vote on their own designs, there's a greater likelihood of watering down the 'wisdom of the crowd', so to speak. (Studio Wikitecture, n.d.).

The Sloodle toolkit includes a tool called the Sloodle Award System that is designed to encourage and reward students based on a leader board and the concept that reputation and metrics will encourage more effort and engagement in a project or class. A philosopher cyborg who contributed to the discussion about the level of engagement in the Safe Trestles project believed that more participation could be encouraged by making the projects more fun, and more like a game. This cyborg suggested to the team that they view a YouTube video of Jesse Schell's presentation at a game developers conference in which Schell argued that the most successful games were using virtual currencies in a fun way that motivated millions of participants.

Design 2029 intended to integrate the Sloodle Award System with the WikiTree in order to provide more granularity to the voting process, and to use reputation as a motivation for design collaboration. Figure 12 shows the *Design 2029* Hall of Fame with portraits of high-scoring designers; it was designed and built on MediaZone Island and included a stage for awards. Two Exhibition Halls were also built to house designs with high scores and the SL architecture was designed to show who the original creator of a design was.

Figure 12. *Screen grab of scoreboard in Hall of Fame on MediaZone*

The *Design 2029* senior research technician concentrated on the Studio Wikitecture WikiTree component, however it was found that the software was poorly documented and the software badly designed. This was not revealed until extensive research was carried out on the existing WikiTree. As a result, most of the senior research technician's time allocation was taken up trying to understand the code, reorganise it, and document it for other developers who might later contribute to the code. Following the decision to open source the Studio Wikitecture WikiTree, the founders of the project posted the source code on SourceForge, an open source developers' website with a liberal Berkeley Software Distribution (BSD) software license that permitted commercial use of the code. The original developers of WikiTree had been commissioned by the founders of Studio Wikitecture to write the code, however a successful open source project requires thorough documentation, and as it was not the original intention to open source the code there was no existing prior documentation.

The final outcome of the *Design 2029* project was a well-documented website instructing how to set up a WikiTree from scratch, however there was no real progress towards the final *Design 2029* 'mashup' with Sloodle. The WikiTree had not changed in appearance or functionality, and it is likely that only a developer who compared the source code might detect an improvement to the

WikiTree. This could be regarded as an incremental, as opposed to a breakthrough, innovation. One important contribution to the project was the 'Sprinkle Server' that the research technician wrote to make it easier to modify parts of the WikiTree code and make it more modular, similar to object-oriented programming. The WikiTree was complex as each layer of the tree was a component module that had to work with the whole. Before the Sprinkle Server it was easy to 'break' the WikiTree because of these dependencies. However, there were significant delays in getting to this stage, and once again the limitation of resources compromised the objectives of *Design 2029* due to a lack of a shared knowledge vision and normative agreement between those who controlled the resources and those who required them.

In SL the relative ease and low cost of starting a group and joining a group means that the first step in forming a self-organising design team is not a big inhibitor. However, what is more difficult is maintaining a cohesive group who share the passion and emotional experiences that bind them together through shared experiences and norms. Cybernetic feedback can provide group members and teams with a way of maintaining coherence and normative agreement. It appeared that the low fidelity of *Design 2029*, the Sloodlers and Studio Wikitecture inhibited the cyborgs' sense of presence and SL's ability to simulate face-to-face meetings. The low fidelity experienced by the cyborgs in these groups regulated the groups' ability to form motivational knowledge visions. This in turn acted as an inhibiter on the normative regulation of these design innovation ecologies. Von Krogh et al. (2000) recommended managing the conversation around the knowledge vision, and the background notecard on *Design 2029* encouraged conversations as the project was promoted and members were recruited to the initial design team as knowledge activists. One such conversation illustrates the difficulties of communicating tacit knowledge and enabling knowledge creation from an explicit knowledge source. The cyborg was given a notecard explaining the background to *Design 2029* and describing self-replicating inogisms that prompted the cyborg to warn of an out-of-control explosion of virtual objects. Nanoscale technology was also discussed.

[18:34] Latha Serevi: Billionth of a millimeter -- heyy, that's too small to be made out of molecules.

[18:34] Zonn Ellison: yes it is a mind experiment

[18:35] Latha Serevi: Should'nt we stick with nanotech molecular machines style stuff that we know works due to the ‘life on earth’ example?

[18:35] Zonn Ellison: well that is not saying it will be 1 billionth just the scale

[18:35] Zonn Ellison: a mind experiment not a design plan:)

The conversation illustrated a number of the difficult aspects of building a shared knowledge vision with complex concepts. Firstly, in SL there is the ability to write programming scripts with the Linden Lab Language that will create self-replicating virtual objects. There have been numerous cyber attacks caused by ‘griefers’ who attempt to bring down a server through loss-of-service attacks that overwhelm the server of a region as simple objects, such as boxes, multiply out of control. This sort of design is banned according to SL’s Terms of Service, however the knowledge vision for *Design 2029*, which incorporated a self-replicating innovation organism that created self-sustaining innovation, would have been acceptable under the Terms of Service, given some designed regulation of the inogism’s replication. The concept of a self-replicating virtual innovation organism, based on a biological model, proved to be too complex to be easily explained in a short notecard, and while a wiki may have assisted in this task, it was apparent that this was most likely tacit knowledge that required a sustained and managed conversation amongst *Design 2029* participants with a high degree of simulated face-to-face fidelity.

Secondly, the concept of nanotechnology in Eric Drexler’s (1986) *Engines of Creation* required participants to be familiar with the scale and future vision of technologists writing on the subject (Kurzweil, 1999, 2005). The *Design 2029* notecard included suggestions of further readings, however these complex concepts required a shared knowledge vision that could only be attained through extensive knowledge of the subject matter. Nanotechnology applies to a scale starting at a billionth of a millimetre and is beyond the comprehension and imagination of most designers unfamiliar with the work of Drexler and Kurzweil work. As the above conversation illustrates, even those familiar with the ideas required deeper explanations and sustained conversations.

The unplanned events in the development of *Design 2029* contributed to the case study and provided a deeper appreciation of the importance of resources and time, and of Von Krogh et al.'s (2000) regulators, with respect to the impact of norms on creative collaboration and designing a virtual innovation ecology. In the final analysis of the norms of the *Design 2029* case study, it must be concluded that it suffered from a lack of a shared knowledge vision that undermined the allocation of resources sufficient to launch it in time. Without a shared knowledge vision the *Design 2029* project was inhibited by competing resource allocation and lack of commitment to the project's completion. A design innovation team must subscribe to a shared knowledge vision, and that knowledge vision must be promoted by knowledge activists within a design innovation ecology. In SL the promotion of *Design 2029* never completely eventuated as the project stalled due to lack of resources and stakeholder commitment to the original knowledge vision.

5.2.2. Architecture and cybernetic regulation

Various forms of architecture affect the cybernetic regulation of design innovation, knowledge creation and creative collaboration in SL. According to Lessig, this mode can take a number of forms such as the architecture of hardware and software. In SL the simulation of physical space and virtual objects is controlled by the architecture of both hardware and software. Virtual land is regulated by the Linden Lab servers and the software that determines what can and cannot be done on that land. The owners of an estate of land can impose their own limit on the number of cyborgs that can be present at one time, but are restricted by the upper limit of the server. However, this regulation of cyborg activity was generally not a limiting factor in any of the case studies. The only times that the numbers came close to the upper limits of the server performance was when there were student exercises involving whole classes and this was mostly limited to the Sloodlers case study. *Design 2029* encouraged micro-communities or design teams of five to seven people and

Studio Wikitecture projects often started with 20 or more cyborgs but concluded with four of five. The WikiTree was also designed for one person to work on the design at once, while others could be present when the design was being reviewed.

The normative values of the founders of SL and Studio Wikitecture were both encoded into the software of the Linden Lab servers, the client viewer, and the WikiTree (Lessig, 2001, 2006). The 'technoliberalism' that pervaded the Linden Lab ideology also informed the WikiTree, in that while the founders of Studio Wikitecture intended that their design should be open and collaborative, the architecture of SL and the WikiTree reinforced the design workflow and the norm of individual designers working alone, before bringing in collaborators.

5.2.2.1. The software architecture of the open source WikiTree

The architecture of the Studio Wikitecture WikiTree was originally closed and was protected by the SL DRM system that prevented cyborgs from viewing, copying or modifying the source code of the various components of the WikiTree. The original design of the WikiTree had to work with the SL code and servers and that had certain restrictions, and required that only one WikiTree could be established on one 'sim' at one time. The different components of a build in SL used the LSL dialogue function and therefore two WikiTrees would compete and create cross-talk between the two builds. This meant that there were technical limitations built into the architecture of the WikiTree that discouraged the developers from creating a totally open source project; thus the architecture regulated design innovation in SL.

For specific projects, such as Safe Trestles, the WikiTree was 'rezzed' on a dedicated island and certain components of the WikiTree were closed to prevent inadvertent or deliberate destruction of designs. This was in spite of the open source nature of the WikiTree development and the 'open architecture' philosophy of Studio Wikitecture. The other feature of this architecture that regulated creative collaboration and the design innovation ecology within the context of Studio Wikitecture projects was that 'hackable' WikiTrees had to be requested from the senior developer cyborg who controlled the development of the WikiTree. That cyborg had to deliberately modify and open the components of the WikiTree to allow other developers the ability to read and modify the source code. The architecture of SL and the cost of establishing a 'sim' regulated how many WikiTree projects could be run within proximity of each other. The complexity of this aspect of the architecture and the active management that was required meant that only one project was ever launched at one time by Studio Wikitecture, and there were no known cases of independent WikiTrees. This feature of the WikiTree architecture slowed down design innovation and the ability for more than one project at once.

Design 2029 struggled and failed to establish its own WikiTree on MediaZone Island. *Design 2029* conceived of multiple design teams working on MediaZone Island simultaneously, in close proximity to their own development pods and a public 'sandbox' for further experimentation. This required further R&D of the WikiTree by the lead developer, and while they looked into the problem, and some ideas were discussed, there was no solution completed largely due to a limited number of developers and other resources. Even with a philosophy of open access to land and design by Studio Wikitecture and Sloodle, these groups were constrained by the SL design ecology that assumed that virtual land could be bought and sold for Linden dollars. The ability of SL to simulate face-to-face meetings and to share co-locations with other cyborgs is regulated by the architecture, which is founded on the normative values of virtual property rights and the analogy with physical space. The permissions system of land ownership and a cyborg's right to build on a particular piece of land in SL is tied to the normative values and marketplace established by the regulations of Linden Lab. The business model of Linden Lab, which had to build an expensive infrastructure with servers, was baked into the architecture and regulated who could build what and with whom in SL. Thus the WikiTree was still regulated by the architecture that placed limits on the degree of openness available to the projects.

The WikiTree, much like SL in general, was designed with a physical metaphor in mind. As a result of the normative values of the architects who built the WikiTree, and due to the value systems of Linden Lab which imposed a metaphor of physical land ownership upon SL, the architecture of the WikiTree software and the hardware that it resided on meant that only one WikiTree could be commissioned on a virtual estate at one time. Thus the virtual land in SL is regulated by both the architecture of the software and the hardware, and this regulates the free flow of knowledge, and the inogism of design innovation.

5.2.2.2. *Design 2029* and the architectural regulation of virtual land

The virtual location of a design innovation project such as *Design 2029* was therefore regulated by the architecture of SL, Sloodle and the WikiTree. The high cost of owning an island, or a sufficiently large area of land in SL, and the market mechanisms for buying it, determined who would initiate a project and who would participate. The openness of the project and the architectural means of regulating knowledge creation and collaboration were influenced by the values of the founders and the market conditions established in SL. *Design 2029* was established, and the MediaZone Island bought. through university funding. The SL architecture regulated the roles of the *Design 2029* cyborgs and their ability to create, modify and sell virtual land. As MediaZone Island was owned by the university's School of Design, and only an individual could be named as the owner, the owner of the island was an employee of the school. This in turn determined how much the researcher could regulate the *Design 2029* land, buildings, and access to the project by other cyborgs. The wider ecology of SL regulated the activities on MediaZone Island as the cost of creation related to the value system of the economy and was regulated by the architecture of access to the land, and the permissions controlled by the owner of the island.

For example, on one occasion the owner of the MediaZone detected unusually high traffic on the island. On closer examination they found that there were numerous virtual objects that had been created around the island, and that cyborgs were coming to the MediaZone because there were no restrictions on the number of cyborgs who could build. SL places a limit on the number of objects that can be built in an area, and the owner of that land can also control how much and who can build. The owner of MediaZone changed the permissions on the island to limit building to only members of certain groups, including *Design 2029*, and returned the virtual objects that had been created by the visitors. This raises the question of whether more design innovation could have been enabled with a more open policy, however even software design can suffer from resource pressures, and on a virtual island the space could have been filled with virtual junk that used up the limit on the island. *Design 2029* established a sandbox on MediaZone Island and had planned to attract designers by providing pods and land to teams at no cost. Land gifts and temporary grants were one way that cyborgs attempted to encourage design innovation in SL. The ALS awarded land to *Design 2029* and other projects to encourage innovation on Innovation Info Island. With the Studio Wikitecture WikiTree and the Safe Trestles project there were four or five designers working on the project at once. The WikiTree architecture regulated flow and impeded knowledge creation and creative collaboration in the SL design innovation ecology, as illustrated in the following chat transcript:

> [14:31] Melchizedek Blauvelt: we agreed on a general design
>
> [14:31] Zonn Ellison: i saw that - does it mean you don't need to use the tree
>
> [14:32] Melchizedek Blauvelt: and a general style for the design too
>
> [14:33] Melchizedek Blauvelt: nah, the problem is that the tree interferes with the more detailed submissions at the moment
>
> [14:33] Zonn Ellison: oh i see how does that work - do you mean if someone clicks a leaf
>
> [14:33] Melchizedek Blauvelt: we had 4-5 people work on it, each with their way of doing things

The real-time architecture must complement a collaborative process that sustains flow. The WikiTree, like the SL architecture, has been built on a foundation of values that emphasises the individual's design process over the real-time activity of a group, and there was much discussion about how to overcome these limitations on the Safe Trestles project. The flexibility of the DRM also contributed to the complexity of design innovation and this was a common cause of frustration and confusion amongst cyborgs in all three case studies who were attempting to share and collaborate on a design. *Design 2029* attempted to improve on this complexity by designing a 'Permission Tester' that would examine an object and all of its contents to ensure that it could be shared and was fully open before the object was presented to the rest of the team. The Sloodle student 3D assignment dropbox also attempted to help cyborgs with the complexity of the DRM architecture by providing a warning when a student submitted an object that did not have 'copy and transfer' enabled. Sloodle provides a virtual object, known as PrimDrop, for students to submit assignments when they have constructed a design for class. However, for a teacher to be able to assess designs the permissions must be set to enable them to copy and transfer them, making a design innovation open to be freely distributed. When the permissions are incorrect the PrimDrop generates this message: '[16:34] PrimDrop: ERROR: invalid item permissions. Please ensure copy and transfer are enabled.'

5.2.2.3. Sloodle version control

The Sloodle development community was bigger and better organised than the WikiTree's and the *Design 2029* project's. There were two groups that supported Sloodle: 1) Sloodlers, who were Sloodle users, and 2) Sloodle Developers. The Sloodle Developers met regularly and the *Design 2029* team attended their meetings in SL. At one such meeting there was a discussion about the use of Subversion, the version control software, and SourceForge. The Sloodle Developers discussed the most effective means of version control and their preferred method of project management. This was an open community that actively encouraged more members and greater involvement. The freelance developer who had developed the Sloodle Award System also presented an API (application programming interface) system that provided a set of rules and specifications that a software program could follow to access services and resources of another piece of Sloodle software. The benefit of this API system was that it would allow other developers to more easily write new features and toolsets for the Sloodle project. This architecture was thought to be very useful for the proposed integration of the WikiTree in the *Design 2029* project, and was an attractive model for creative collaboration and further design innovation.

5.2.2.4. *Design 2029* version control

All three case studies used some form of version control outside of SL for the code to support documentation of and collaboration in the open source projects. The question of what version control tool to use and the issue of hosting and maintenance of the software projects required roles and responsibilities to be defined. In the case of the WikiTree, the cyborg in charge of this area was a volunteer. A senior developer with the Sloodle project openly discussed their version control system with the Sloodle Developers group. SourceForge offers built-in version control to developers and the *Design 2029* team and WikiTree developers used this. The version controls that existed for both the WikiTree and Sloodle were relatively weak in-world and was seen as a development requirement for *Design 2029*. The degree of sophistication of version control that supported the code developers was also needed for the design teams to enable greater efficiency in design innovation and knowledge creation in the SL ecology. A discussion with the senior research technician around the integration between the WikiTree and Sloodle raised some of the difficulties faced by developers when it came to the existing architecture. In the following chat log about the Studio Wikitecture WikiTree, how important conversation flow is to creative collaboration is illustrated. Server difficulties disrupted the flow of a group conversation about the voting system as bandwidth issues impacted the ability of the cyborgs to read what the other cyborgs were saying:

[13:53] Zonn Ellison: lost my last comment lol

[13:53] Omei Turnbull: Hello?

[13:53] Zonn Ellison: yeah

[13:53] Omei Turnbull: I haven't been getting a chat log.

[13:53] Melchizedek Blauvelt: yes Omei? I see you typing but not getting anything in chat...

[13:54] Omei Turnbull: Yeah, things are a little screwy.

Another point to be made about text chat is that while it can introduce a casualness that is similar to a conversation, the time taken to write, read and consider a text chat can cause comments to be out of sync and behind the previous comment. In larger conversations it is common for cyborgs to miss comments as the text scrolls up the screen.

5.2.2.5. WikiTree version control

Design 2029 discovered that the architecture and design of the WikiTree required substantial examination and documentation before the WikiTree could be easily examined by a developer. This is a common problem with many open source software projects in that the code is often monolithic rather than modular, and requires a long period of study before developers can fully understand it. It is often necessary for an open source project to first establish resources and infrastructure to encourage others to join the project. Goldman and Gabriel (2005) recommended that 'You can work to make innovation more likely by making your project a safe place to experiment. It is important to remove as many barriers to collaboration as possible: social, political, and technical' (p. 88). As part of *Design 2029*, two wikis and a SourceForge site were set up to support the Open WikiTree project. However, like many open source projects, the WikiTree failed to attract a critical mass of developers who would contribute code and innovations to the project. There were only two active software developers collaborating on the project. Many software projects fail because they fail to account for users' needs (Goldman & Gabriel, 2005). There were attempts to engage users in the design discussions, however there was a two-fold problem:

- Only one developer was present at the WikiTree users' meeting.
- The other users suggested innovations that required too much work for only two developers to complete.

SourceForge did provide the developers with a number of version control tools and the ability to document changes. However, the WikiTree consisted of a large number of scripts all contained in different modules that talked to each other. Therefore, it was a complex and fraught task to update each module if the software had changed. *Design 2029* attempted to simplify the update problem, and make it easier for other developers, by designing an in-world tool known as the Sprinkle Server. This automatically updated every module that required an update.

In the actual 3D build process the WikiTree was conceived as a 3D wiki that could provide an easy visual representation of different versions of a design. There were elements of version control with the WikiTree, such as when a new design was completed by an individual designer they could submit their design to the WikiTree. The WikiTree would then rez a leaf of the tree. Subsequent designers could then click on that leaf to rez the submitted design. Discussion about the merits of a new design iteration were intended to be decided through the voting mechanism on the WikiTree. If a new design attracted more negative votes than positive votes, the leaf would turn red as opposed to green, this would suggest to the design team that they should return to a previous concept, and thus create an iteration branch in the WikiTree where new concepts will grow from that previous iteration. Safe Trestles and other projects were also supported by an integrated web interface that enabled remote voting, commenting and project management using the Ning social network platform.

Design 2029 noted weaknesses in both the version control system and the voting mechanism that only allowed for a small number of WikiTree projects, typically not running concurrently. The Sloodle Award System was seen to be a more granular approach to version control and provide motivation for the voters and designers. However, the integration of the two projects required more resources of time, expertise and funds to attract a community of developers and designers to support this suggested improvement. It can be seen from the analysis of three case studies that architecture regulates design innovation in SL and can both inhibit and enable knowledge creation and creative collaboration, which in turn effects the design process.

5.2.3. Introduction to the regulation of cybernetic law

The law is a powerful and explicit regulator of knowledge creation and the design innovation ecology of SL. Linden Lab and SL are governed by the jurisdiction of the US (California) and Lessig, as a Stanford law professor, rests his argument on the original intent of the Founding Fathers (Lessig, 2001). Copyright, trademarks and patents were all legal devices originally designed to explicitly regulate ideation, and encourage innovation (Abramson, 2005; Lessig, 2001, 2004, 2006). In the US copyright was seen by the Founding Fathers as a way to motivate and enable the sharing of knowledge, and to encourage innovation and novel ideas that others would find useful. Lessig (2008) argues that new technology, like SL, has given individuals enormous innovative potential. Digital technologies make it feasible—for the first time in history—to do what Jefferson dreamed of when he founded the Library of Congress: 'to sustain and preserve a universal collection of knowledge and creativity for future generations' (p. 262).

5.2.3.1. Copyright and the WikiTree

The cyborg, Theory Shaw (2007) one of the founders of Studio Wikitecture, republished on its official website Dennis Kaspori's essay, 'A Communism of Ideas: towards Architectural Open Source Practice'. In the essay Kaspori cited David Garcia:

> The digital revolution thoroughly upset prevailing Western ideas about intellectual property. Thanks to the Internet there is an extensive network in which ideas are not so much protected by copyright as developed collectively. Ownership is not what counts, but use. (cited in R. Schultz, 2007)

Oddly, this is the only explicit reference found on copyright on the Studio Wikitecture website or wiki, apart from a logo and link to 'Support Creative Commons'. However, the specific projects that Studio Wikitecture entered, which were initiated by the Open Architecture Network, included guidelines on 'Ownership and Copyright'. All entries in the Safe Trestles competition were required to license all their materials submitted under the Creative Commons Attribution license, and to adhere to the terms of that license. The rules stated all entrants:

> shall own all design concepts, drawings, images, renderings, sketches, photographs, models, and/or text, documents, information or other materials submitted in association with the competition provided.
>
> Notwithstanding AFH's and Nike SR's rights as Licensors, competition entrants shall retain full rights to use the documents in other projects for commercial and for-profit purposes.
>
> By entering this competition entrants warrant that all materials submitted by them are their own, that nothing in the submission of these materials will infringe the copyright or any other right of any person and that they have full authority to submit the materials for such purposes. (Open_Architecture_Network, 2010)

Despite being open source, neither the WikiTree nor Sloodle had any explicit support for Creative Commons. *Design 2029* did post Creative Commons code on their wiki to encourage non-commercial attribution of work posted on the site. While a number of participants in the three case studies were familiar with the Creative Commons it was not seen as essential to either the Sloodle or WikiTree projects. It was the intention of the *Design 2029* team to integrate the Creative Commons machine, designed by Zero Linden, into the game. There were architectural complexities involved in this integration and this was scheduled for a later date but did not happen due to lack of time and resources. When participants use the WikiTree they must ensure that all textures and prims are copy and transfer enabled because they must be able to share their creations with other participants in the design team. Under the terms of the Open Architecture Network Challenge, all entrants must agree to license their entry under one of eight Creative Commons Attribution licenses, however participants in the Studio Wikitecture project were not necessarily aware of the terms of their participation. Any participant in the project could visit the Open Architecture Network website to read the conditions of entry but it is unclear how many took the time to do that. It could be expected that as they were taking part in an open architecture project, some participants may have been aware of this permissible approach to copyright. During the Safe Trestles project one participant expressed a concern that their IP could be taken by other cyborgs, because they were in effect giving their textures and virtual objects to the group who were working on the project with no regulation of their future use. Participants in a Studio Wikitecture project in SL have not necessarily agreed to terms applied by third parties outside of SL and this could possibly inhibit participation by those unclear about the copyright implications of their participation. It appeared that despite a lack of explicit mention of copyright in SL there was no apparent inhibition slowing the pace of the indosymbiotic life cycle on the Safe Trestles project due to concerns about the law. It was unclear whether any initial designers dropped out of the project due to copyright concerns.

This area requires further research as the explicit outcome of the participants in the Safe Trestles project does not reveal whether they were holding back on designs or ideas for fear of others copying their designs and loss of ownership. This difficulty occurs with any analysis of innovation as members of a design team may still be active in a project and share ideas, but the research might not reveal if they have submitted their very best ideas or if they have withheld knowledge from the team. In a discussion with one of the members of the Safe Trestles team, there was some discomfort about sharing, which might suggest they could have held back their most prized ideas:

> [07:56] Zonn Ellison: so what is the most annoying aspect of using the wikitree
>
> [07:57] Melchizedek Blauvelt: hahaha you mean after submitting things full perm to it?
>
> [07:57] Zonn Ellison: yeah anything - tell me about that
>
> [07:58] Melchizedek Blauvelt: well the openness certainly is annoying, in the sense that anyone can come in, grab the design and submit it to the Trestles contest
>
> [07:58] Melchizedek Blauvelt: Or sell parts of it on Xstreet

This would suggest that trust plays a large part in the degree to which a design team will share knowledge. In the official guidebook to SL it is suggested that the best way to collaborate with another resident is to grant modify rights to your objects. To do that, a cyborg must be on their friends list, however the guide warns, ‘Once you grant someone modify right they’ll be able to edit, anything you own anywhere in the world. If you don’t trust them with everything of yours, consider collaborating with them using an alternate account' (Rymaszewski et al., 2007, p. 150). Trust does not just have to be between people or cyborgs but could be between cyborgs and machines. In other words, cyborgs in SL trust the DRM permissions system, and the US Digital Millennium Copyright Act 1998 (DMCA) to a large degree, as a large number of cyborgs have spent a very large amount of time and resources building virtual objects to sell in SL. The Creative Commons was intended to give designers more certainty around their creations and inform others of who owns the copyright, and what rights others had to use their creation, without necessitating having to ask the creator each time they wanted to reuse it (Lessig, 2008). The Safe Trestles project and indosymbiosis could have been slowed down due to the uncertainty surrounding the legal status of the project. If Safe Trestles had implemented an explicit Creative Commons Attribution Deed, and built it into the design, that could have reassured collaborators and enabled more design innovation.

5.2.3.2. Copyright and *Design 2029*

In a conversation with the senior research technician for *Design 2029*, it was apparent that for them copyright law was no longer simply an enabler of design innovation; it now entailed a complex decision about how to license their designs.

> [2010/09/26 16:26] Lux Bluxome: I've been working in software for a long time, and I need to think abuot licensing and sharing
>
> [2010/09/26 16:26] Zonn Ellison: So what do you think of SL being ruled by Californian law
>
> [2010/09/26 16:27] Zonn Ellison: and US law such as the Digital Copyright Millenium Act?
>
> [2010/09/26 16:27] Lux Bluxome: yeah that's a bit of a disaster
>
> [2010/09/26 16:27] Lux Bluxome: it makes sharing very risky, because you never know what company with deep pockets will go after you
>
> [2010/09/26 16:28] Zonn Ellison: for patent infringement do you mean?
>
> [2010/09/26 16:28] Lux Bluxome: yeah
>
> [2010/09/26 16:28] Lux Bluxome: no
>
> [2010/09/26 16:28] Zonn Ellison: copyright
>
> [2010/09/26 16:28] Lux Bluxome: copyright infringement

The developers of *Design 2029* had reviewed and examined Lessig's theory on how copyright law could inhibit design innovation and had acquired a copy of the Creative Commons Machine from the creator, Zero Linden, under a GPL open source license. Prior to joining Linden Lab, Zero Linden designed and wrote the code for a Creative Commons Machine. Knowledge of this machine prompted the researcher to approach Zero Linden to open source the code. Without much fanfare this was done and this copyright licensing machine was made available on MediaZone Island in Exhibition Hall A, where there were a collection of tools that could be freely adapted by entrants to the *Design 2029* game. The Creative Commons Machine was modified to look more organic and biological and all scripts were free to be copied. The intention was to integrate the copyright licensing machine into the *Design 2029* game and the WikiTree build.

One of the complexities faced by the *Design 2029* developers was the interoperability of the copyright licenses. The Open WikiTree was licensed under a liberal BSD (Berkeley license, and the Sloodle software was open sourced with a GNU GPL. The two license variants were verified to be free software licenses by the Free Software Foundation and have been vetted by the Open Source Initiative. It was unclear, however, exactly how the licenses would work together if the WikiTree became a module of Sloodle and the WikiTree incorporated the Sloodle Award System. In addition to this problem it was unclear how a Creative Commons Machine could also be made to be compatible with the other two licenses. These issues required professional legal advice and could be seen to be a drag on the speed of design innovation. The complexities of copyright law suggested that *Design 2029* required further resources to simplify and streamline the various licenses so that game participants clearly understood the copyright agreement that they signed up to. The Creative Commons organisation spent a long time and a lot of money creating a system that could be easily understood and implemented. The concept was to remove constraints on design innovation and collaboration due to uncertainty around copyright. *Design 2029* would have required legal expertise and incurred large expenses in resolving this issue.

The *Design 2029* integration of the WikiTree and Sloodle projects required the removal of social, technical and legal/market constraints to have been successful. The R&D of *Design 2029* illustrated the necessity in any design project of a thorough scope. A good analysis of what the users wanted and an extensive examination of the code and documentation of each project were required. However, these requirements were outside the scope of an academic research project and required more resources than were available.

5.2.3.3. Copyright and Sloodle

The Sloodle project is somewhat different from the WikiTree and *Design 2029* in that the regular users of Sloodle are intended to be students who are not necessarily part of a design team. There is also no formal copyright notice on the official Sloodle website except for a reference to Sloodle being an open source project. The Sloodle Wiki includes a sample of LSL that allows a Sloodle scripter in SL to be able to use the Sloodle API to access Moodle features. This text is included in the Sloodle scripts within SL:

```
/********************************************
* Copyright (c) 2009 yourname
* Released under the GNU GPL 3.0
* This script can be used in your scripts, but you must include this copyright header as per the GPL
Licence
* For more information about GPL 3.0 - see: http://www.gnu.org/copyleft/gpl.html
* This script is part of the SLOODLE Project see http://sloodle.org
* example_plugin.lsl
* Copyright:
* yourname
* youremail
```

When students use Sloodle they are not informed of copyright issues and there is no explicit information with regard to copyright integrated into the Sloodle toolkit. This is not particularly unusual, although in design curricula, and indeed any learning environment that deals with IP, this would seem to be a glaring omission. University and school IP policies tend to override the copyright concerns of academic design teams and the Victoria University of Wellington policy governed *Design 2029*. In simple terms, the university's IP policy states that IP ownership will be split into thirds between the university, the School of Design, and the student. Students concerned with losing a share of their IP may regard giving away 66.6 percent of their IP as too high and not share their most innovative ideas within the university research ecology. The IP policy does not discuss open source, Creative Commons or release into the public domain. The market modality works closely with the law in determining whether a cyborg will share and collaborate in the creation of an inogism, and so enable or limit the indosymbiotic life cycle in SL.

5.2.4. Introduction to market regulators

The case studies were all affected by the market regulation of the wider SL ecology. This was despite the facts that they were all open source projects and the tools were all licensed under open source licenses. When a design team sets out to form a strong knowledge vision that can support a virtual design innovation ecology, there is often competion for the survival of an idea or inogism, just as in nature.

5.2.4.1. Studio Wikitecture and the market modality

The Studio Wikitecture project had experimented with various ways to assess the quality of designs and to engage the wisdom of the crowd and the collective intelligence of the community. The experiments played with the interdependence of three of Lessig's four modes regulating the design of a technical architecture, legal considerations of copyright and open source, and the normative values of participants. The market modality was not fully considered, as the open source philosophy negated a commercial approach.

According to the official history of Studio Wikitecture,

> The design that resulted after the 2nd experiment was by far more coherent (than the first). Here we introduced a few technical measures to facilitate some measure of consensus in the group. Unlike the

> first, we incorporated a crude archiving system that allowed members to ether mix and match submissions of other contributors or, if the group so choose, [sic] simply revert back to a previous design iteration. In addition, to facilitate asynchronous, off-line communication, we utilized a Flickr account where members could unload screenshots with descriptions of their ideas, while others could comment and vote. (Studio Wikitecture, 2011, n.p.)

In the next iteration of the Studio Wikitecture project, the WikiTree integrated a voting system with a website. The limitation of this voting system has already been discussed with regard the normative modality. A number of commentators on peer production have identified the ability of knowledge markets to assist in quality assessment of ideas, that helped to overcome the limitations of a voting system without cost (Bryan & Joyce, 2007; Hamel, 2007; Reeves & Read, 2009; Sunstein, 2006). The Studio Wikitecture WikiTree, unlike a scoring system, with a limited number of points that could be added and subtracted, has the limitation that every voter could simply add another point or subtract it without proper consideration, and without benefit or cost. The market modality and attention to economics were two considerations that *Design 2029* attempted to improve.

5.2.4.2. Open source and the hidden markets of the WikiTree

The Free Software Foundation holds that free software is a matter of liberty, not price. To understand the concept, you should think of 'free' as in 'free speech', not as in 'free beer' (Free Software Foundation, 2011). Open source and the various copyright licenses do not necessarily imply that a software product or virtual design object in SL cannot be sold or be commercial (Free Software Foundation, 2011). 'Free software is a matter of the users' freedom to run, copy, distribute, study, change, and improve the software' (Free Software Foundation, 2011). The Open WikiTree project explicitly mentions that it is a liberal BSD license that permits commercial exploitation of design improvements to the WikiTree. However, the requirements of the WikiTree and how its architecture works mean that all objects and textures included in a collaborative design using the WikiTree must have copy and transfer enabled using the SL DRM. It is possible to design and build a virtual object that is for sale, but it can also be copied, transferred and modified by anyone. It is highly unlikely that anyone would pay Linden dollars to buy such a design when they can copy it for free, although this could happen inadvertently. There were no reported cases of copy enabled objects being sold in any of the Studio Wikitecture projects.

If there is no obvious commercial activity within the Studio Wikitecture project, how does the market modality regulate the creative collaboration and knowledge creation? Within the wider context of the SL design innovation ecology it was apparent that all participants were aware of the predominance of commercial activity surrounding the Studio Wikitecture project. One participant in the Safe Trestles project had expressed concern that an open design process also enabled others to copy the entire design, including the virtual objects, code and textures without compensation or attribution. There were no explicit Creative Commons deeds or notices that could have allayed fears of copyright infringement. The market modality regulated the activity of the Studio Wikitecture projects in a less direct way through a non-price-based knowledge market and a non-commercial talent market. The knowledge market can be seen as an example of the gift economy commonly referred to in the open source community (Ghosh, 2005a, 2005b). Collaborators contribute to the benefit of the whole project without expectation of direct personal reward, but with the acknowledgement that a design team can create something that is greater than the sum of its parts (Ghosh, 2005a). Attribution, acknowledgement and reputation were significant motivators for cyborgs on the Safe Trestles project. The cash reward of US$5,000 for the winners of the Open Architecture Network Challenge was not mentioned by the cyborgs in SL, but there was mention of past achievements such as a previous first prize for the Studio Wikitecture's entry in a global competition to design a Nepalese medical centre and a Linden Lab Founders Award for Innovation.

A knowledge market that is not based on price requires a system to recognise contributions and reward effort through advancement in reputations. Reciprocity of compliments and contributions to the overall design helped build a core team of around five designers in the final

Safe Trestles design team. Knowledge itself can be regarded as the valuable commodity that was being traded during the Studio Wikitecture projects. Cyborgs were trading knowledge with other team members by participating in the Safe Trestles project. The founders of Studio Wikitecture were professional architects who were developing an open architecture practice, and each project contributed to the development of that practice and the evolution of their commercial aims. This is not to imply a cynical approach to open architecture, merely to recognise that commercial praxis and wikinomics are not necessarily incompatible (Tapscott & Williams, 2006). This non-priced-based knowledge market can also foster trade in ideas that are altruistic and philanthropic. One member of the design team was an environmental ecologist who deeply believed in maintaining the health of the ecology of the Safe Trestles sand dunes and the wildlife surrounding it. The intellectual challenge of such an exercise can make these projects fun and the very fact that they are not commercial can attract professionals who find the challenge more like a game than a regular business contract (Reeves & Read, 2009). One of the cyborgs on the Safe Trestles project was also a professional software programmer who was simultaneously leading the Open WikiTree project that included one other developer from the *Design 2029* project. This cyborg was not getting paid but was enthusiastic about solving software issues for the Safe Trestles project and looking for ways to improve the WikiTree.

5.2.4.3. Treet TV and the WikiTree

Working on a previous Studio Wikitecture project known as Treet TV, the lead developer for the Open WikiTree had posted comments on the challenge of writing code that would allow multiple WikiTrees on one virtual estate. This cyborg appeared to be the only developer working on this problem and was unpaid. There is a challenge for any open source project to find team members prepared to devote enough time and their own resources to achieve a design innovation outcome (Goldman & Gabriel, 2005). With only two weeks to go it was decided by some of the Studio Wikitecture leaders that there was not enough time to carry out the voting and selection process for the project. It was therefore decided to carry out a marathon build in order to complete the entire model together. Treet TV was a machinima TV channel in SL and produced quiz shows and other productions that were shown on the web and in-world. Treet TV was a commercial operation that was looking to attract other production companies to their island. Although, Treet TV did not pay Studio Wikitecture, the two organisations entered into a non-commercial agreement to use the Studio Wikitecture group to design the Treet TV island. This is an example of how a non-commercial open design project can still be part of the knowledge market.

5.2.4.4. Market motivation and the WikiTree

Describing the motivation of any designer is problematic, and the motivation of a cyborg designer adds an additional layer of complexity as it is more difficult to triangulate their actual activities with their virtual behaviour. One of the recognised motivators for open source coders to contribute to a project is their participation in a talent market (Goldman & Gabriel, 2005). In the Safe Trestles project there were members of the design team who looked upon the project as an opportunity to explore new career opportunities. One of the cyborg members of the design team was a philosophy graduate who had been caring for their handicapped cousin, and was looking for opportunities in SL to explore new opportunities to work from home. Thus, the Studio Wikitecture projects attracted other non-professional designers who could see the opportunities of an informal talent market that gave them a platform to promote themselves, and an important creative outlet for their new skills. The rise of the prosumer is a two fold challenge and opportunity for design praxis as projects such as Studio Wikitecture confront academic and professional designers through these open knowledge and talent markets (Leadbeater, 2000, 2008; Tapscott & Williams, 2006). The market modality both enabled and inhibited design innovation within the Studio Wikitecture projects. This was happening without explicit mention of this cybernetic regulator except with reference to an open source philosophy.

5.2.4.5. Sloodle and the open source markets

Sloodle is another project that is not obviously regulated by the market modality, but despite an educational, non-commercial, open source philosophy, it is apparent that both knowledge and talent markets are discreetly affecting cyborg behaviour and regulating design innovation. Within SL there is a significant number of cyborgs who are employed as graphic designers. There are also non-professional designers from almost every conceivable occupation, as well as the unemployed, physically handicapped, and other disabilities (Guest, 2007). The Sloodle project is a learning management tool that has attracted a community of mostly educators. The occupations and income of the cyborgs have an impact on the ecology and indosymbiosis of an inogism's life cycle through this talent market. From a practical point of view, if a cyborg is employed in a full-time occupation that discourages social media and online activity not sanctioned by the management then they can only participate in a design project during their leisure time. Some companies employ firewalls (an architectural regulator) to prevent work time access to social networks such as SL. In the Sloodle project the principle developers are mostly IT academics at universities in the United Kingdom. Funding for the project has come from Eduserve and early work was supported by a small research grant from the Carnegie Trust for the Universities of Scotland. Sloodle is hosted by the San Jose State University School of Library and Information Science. Therefore, most of the developers and community leaders were not dependent on incomes directly attributable to the project. Open source and a non-priced-based knowledge markets have a comfortable fit with educational organisations and this is the origin of the hacker's ethic and the free software movement (Levy, 1994). The Sloodle organisation was able to develop the project through educational funding and academics that were given leave to work on the project part time. However, Sloodle.org realised that hiring a freelance developer to work on the features of the project, and to develop an API environment to enable easier development of the Moodle/Sloodle project, could advance the project faster and more efficiently.

The Sloodle organisation had approached this freelance developer after reviewing their Facebook application. Sloodle is an open source GPL licensed project and the modules, including the scripts, can be copied and transferred under the terms of that license. The freelance cyborg developed a number of modules that attempted to make learning fun and more game-like. This included a large game show that educators could establish on their land in SL, a treasure hunt, and a Sloodle Awards System. The cyborg was eager to promote these modules and was eager to display how it worked and demonstrate it to anyone who was interested. Early prototypes of these modules were offered to *Design 2029* for free. The Sloodle cyborg developer also ran regular workshops and advertised these through the Sloodlers group chat, offering to teleport cyborgs to the classroom where he would demonstrate Sloodle. One possible interpretation of this behaviour is that the cyborg developer would advance their reputation and future employment prospects if the Sloodle modules he developed were popular. Knowledge markets and talent markets overlap when cyborgs advertise their knowledge and skills in order to find employment opportunities. The Sloodle cyborg developer used YouTube to post freely available machinima of how their modules worked and these were also embedded in webpages. The Sloodle cyborg developer was on a short-term contract and was eager to find other contracts following the one with the Sloodle organisation. This was made explicit when at workshops and demonstrations the cyborg developer would mention that their services were available for custom development work. *Design 2029* was impressed by the work that the cyborg developer had carried out and wanted to use the Sloodle Award System with the Studio Wikitecture WikiTree. Initial negotiations took place about a paid contract, however the Victoria University research grant had prevented the hiring of outside experts.The researcher attempted to get the university to change the terms of the research grant but was unsuccessful and so the cyborg developer could not be hired to complete the integration of Sloodle and the WikiTree. At the conclusion of their contract with the Sloodle organisation the developer was asked by *Design 2029* if they could provide a simple transport system, similar to what they had developed for the Sloodle quiz game. This was something outside the Sloodle project and the cyborg developer negotiated a price for their development. The relevant extract the SL chat transcript appears below. (The avatar's name has been changed to Cyborg Developer.)

[2010/02/10 18:19] Cyborg Developer: k, price if you like it is 3000

[2010/02/10 18:19] Cyborg Developer: took me 30 minutes, to program

[2010/02/10 18:19] Cyborg Developer: my time is 40/hour - right now - for you

[2010/02/10 18:19] Cyborg Developer: is that fair?

[2010/02/10 18:20] Cyborg Developer: thats 15 dollars I think

[2010/02/10 18:20] Cyborg Developer: actually

[2010/02/10 18:20] Cyborg Developer: just flip me 2000 , that was the orig

[2010/02/10 18:20] Zonn Ellison: oh ok it is really just a piece of fun but yeah that is fine

This illustrated that the cyborg freelance developer applied their hourly rate as a developer in such situations and that they were approaching the design innovation ecology in SL as a knowledge and talent market.

5.2.4.6. The *Design 2029* market modality

All three of the case studies were open source projects that were not obviously regulated by the market modality. However, it was observed that even when there were non-price markets or non-commercial arrangements a wider design innovation ecology existed that regulated the case studies in SL. The necessity for most designers to have some form of income meant that cyborgs involved in the Studio Wikitecture project, the Sloodle project, or *Design 2029* required an alternative form of income that indirectly supported these non-commercial projects. In *Competitive Innovation Management*, Christiansen (2000) identified the importance of a strategic vision accompanied by the allocation of resources to support innovation. The allocation of funds will have a direct impact on the pace and quality of the R&D phase prior to the commercialisation of an innovative design (Christiansen, 2000). This is also the case with not-for-profit academic research and design innovation, as illustrated by the three case studies under investigation.

The *Design 2029* project required resources to support the development of software used to track and trace contributions to individual design projects, to score the game, and to integrate the Studio Wikitecture WikiTree and Sloodle Award System. All three projects required resources to sustain and advance their indosymbiotic life cycle. An illustration of how resources and the market modality had a direct impact due to lack of resources was apparent when one lot of funding for the Sloodle project concluded. An extract from a Discussion Forum on the Sloodle.org website appears below.

> Re: What are you doing with SLOODLE?
>
> by Mike McKay / Professor Merryman - Monday, 21 February 2011, 09:26 PM
>
> Hi Nick. Great to hear from you. I don't think the Awards System is going to continue, starting with version 1.2. Support for OpenSim and Moodle 2.0 is still being talked about. One of the biggest problems is that the project doesn't have funding. This is something we need to discuss.
>
> Fantastic to hear you are using Chris's Devil Island Mystery. It's a great way to get students conversing in the language.
>
> Thanks for the great reply.
>
> Show parent | Reply
>
> Re: What are you doing with SLOODLE?
>
> by Daniel Livingstone - Wednesday, 23 February 2011, 07:34 AM
>
> Yup, awards is not in 1.2 - though the tracker will be, which does keep track of completed activities (but does not award points)
>
> Awards is still in development for SLOODLE 2.0... but the schedule for release is much vaguer.
>
> Agree, sounds like great work Nick! If its OK, I'll post some of this on the blog...

An educational funding process within the wider context of an education market modality supported *Design 2029*. The ability to successfully allocate resources of time, money and personnel is dependent on the various modalities that regulate knowledge creation and creative collaboration within an academic ecology. Research design policy in academia can also be enabled or inhibited due to Lessig’s modalities and can either encourage or discourage experimentation and innovative research design. A more conservative approach to research can result in incremental innovation. The inability to change the conditions of the *Design 2029* research grant and funding allocations had a direct impact on another important innovation resource: time. The three case studies have illustrated how Lessig's four modalities can regulate the indosymbiotic life cycle of an inogism in SL and the design innovation ecology in SL. In the wider context of the design innovation ecology of SL there are cybernetic regulators also actively enabling and inhibiting the flow of design knowledge creation and collaboration.

5.3. Analysis of SL as a design innovation ecology

NASA's design model describes how a designer must first identify the problem; then identify the criteria and constraints; and only then can they indulge their creativity and imagination in brainstorming the ideas (McCloud, 2010). The criteria and constraints in SL in a future scenario such as *Design 2029* are less cumbersome than the restrictions faced by NASA, however cybernetic regulators still constrain design innovation in SL these and can be identified. The research question of this thesis considers how to design a virtual innovation ecology using the SL platform. This thesis has presented three cyber-ethnographic case studies that closely address this question – and the supporting sub-questions of how to enable tacit knowledge creation and design collaboration within the simulated virtual ecosystem – using a qualitative cybernetic systems approach in SL. Beyond the case studies a bricolage of other evidence was collected to help to triangulate the data collection of the case studies. This is now examined through the lens of the thesis's theoretical framework in order to analyse how the SL design innovation ecology has been regulated.

Before an individual enters SL they become aware of the cybernetic regulators that determine what they can say, do or think in-world. Lessig (2006) describes these regulators as four interrelated modes: norms; law; architecture; and market. Von Krogh et al.'s (2000) theoretical framework suggests how to enable knowledge creation during design innovation in SL and what enables creative collaboration amongst designers in SL. The spectrum of fidelity model assists with understanding how a virtual design innovation ecology can regulate the behaviour of a cyborg designer. Finally, an overview of a design's innovation cybernetic system is provided by the indosymbiotic model that describes the stages of innovative development of an inogism in a complex adaptive system, known as the virtual design innovation ecology within SL. A first-time cyborg in SL must have the ability to use sophisticated computer technology; access to the Internet via a broadband account; a fast graphics computer that can handle 3D objects, sound and video; and the time and money to explore SL. They must first make their way onto the Internet to the URL www.secondlife.com and navigate the website in a language they understand, then hit the join button. They then must make various decisions about what to call their avatar, what they will look like, whether to download the large SL client, and finally whether they can be bothered reading the Terms of Service. Therefore, before they even enter their username and password to login, prior to the complications of joining a group, such as one of the three case study groups in SL investigated in this thesis, they have already experienced the intersection of all four of Lessig's regulatory modes.

It is difficult to determine which of the four modalities is most important when it comes to the user's decision to join and then enter SL. The first motivation or enabler may be *norms*, and these could take many forms, from peer group interest in virtual worlds, to fascination with media hype, or an interest in VR and IP. The primacy of norms over the *law* was illustrated in the legal scholar M.F. Schultz's (2006) example of 'Jambands' and the sharing of Grateful Dead music tapes. He pointed out that while fans were encouraged to record live concerts of the Grateful Dead and share them for free with the other fans, those who transgressed this norm and sold the tapes became subject to community opprobrium and quickly found they must conform or leave the community (M.F. Schultz, 2006). This normative pressure, Schultz has argued, can be more powerful than legal regulation. Malaby (2009) agrees that in SL the strongest protection against IP violation was not the

DCMA but community opinion: 'Far more stringent is the community of content creators who watch over each other and report on instances of theft or more vaguely defined "copying"' (p. 138).

When an individual decides to join up they are very quickly made aware of the most explicit regulator, the *law.* The Terms of Service is the first legal document that is encountered when signing up to SL. It is also underpinned by a semi-legal Code of Conduct or Community Standards document but this is not readily available when they sign up and they have to go searching to find it. The law is the last gate they must pass through before they can enter SL and if they do not click the button that says 'I Agree' to the Terms of Service they can go no further, and will never get to experience this virtual world. Lessig has also described the code as law, by which he means that software code will either enable or limit entry and behaviour in SL. The first obvious example of that is the user name and password that authenticates and either enables entry or prevents access to SL. If the password is forgotten and cannot be retrieved via an email process, an individual may face a long period of time on the phone to Linden Lab trying to prove they own that account.

Closely related to the code is *architecture*, which Mitch Kapor also described as the law (Lessig, 2006). The architecture regulates your access to SL by means of Internet protocols and access speeds; it also includes server and client connections which in turn are negotiated via software and hardware. Another important mode that regulates entry into SL is the *market*. Without this mechanism and 'creative capitalism' it is unlikely that SL would have been the big success it has. All four of these modes intersect and provide a cybernetic feedback mechanism that regulates the usage of SL and therefore regulated the design activities of the members in the three case studies. The four modes of cybernetic regulation provide a means to understand how the cyborg designers of SL are encouraged or discouraged by the ecology of SL when it comes to design innovation with respect to the case studies. The inogism's or cybernetic design innovation organism's life cycle provides a model to help extract meaning from activities that are regulated by the intersection of the four modes. These four modes and how they interconnect with the indosymbiotic life cycle of design innovation are now explained in further detail.

5.3.1. Important norms in the SL design innovation ecology

Guimaraes (2005) argues that all communities can be regarded as virtual as they are based more on shared ideas and purpose than geographical location. A shared knowledge vision is a necessary prerequisite for community-building and creative collaboration (Von Krogh et al., 2000). Hunter (2008) describes 'vision' as the first of seven pillars of innovation:

> Vision is the ability to see in your mind's eye a view of how things might really be – to imagine what is only yet in the realm of the hoped for or the achievable. Vision is not daydreaming. Dreams are fanciful – vision is seeing the possible. (p. 67)

Kevin Roberts wrote about the passion of leaders who share a vision, or 'inspirational dream', and who go beyond the 'everyday'. Such leaders are credited with the ability to coach teams to achieve 'peak performance' (Gilson, Pratt, Roberts, & Weymes, 2000). A shared knowledge vision must grow out of a community and cannot be simply mandated (Von Krogh et al., 2000). *Design 2029* began by describing a vision of the future that had been documented by various writers such as Lessig (2004), Kurzweil (2005), Drexler (1986) and Garreau (2005). The *Design 2029* vision was shared through building a future world on MediaZone Island; discussions in SL; notecards given to cyborgs in-world; a wiki website; and a YouTube video introducing the game through machinima (http://www.youtube.com/watch?v=9EbCqzi86HU). It takes time and resource to promote a vision, and *Design 2029* intended to build a shared vision amongst the player community after the game was launched. Normative or 'normal' behaviour is an important aspect of building design innovation communities in SL. Because SL is a virtual world it is inherently social, therefore communication and groups are two well-developed features of the SL architecture.

The normative aspects of group formation and community in SL underpin the cybernetic regulation of knowledge creation and design innovation through the regulation of culture. Groups are the formal organisation of communities in SL and allow like-minded people to come together and meet to interact. Since the advent of the Internet there has been much debate amongst ethnographers about the distinction between online and offline communities and yet it can be argued all communities are virtual (Guimaraes, 2005). One of the difficulties in maintaining virtual relationships is that the limited sensory bandwidth of the communications, or spectrum of fidelity, limits the amount of emotional content, and therefore tacit knowledge creation, necessary for design innovation in SL (Rive et al., 2008). It was generally observed that numbers of cyborgs in SL could feel intense and emotional relationships with cyborgs they had never physically met, however those relationships could also be dramatically short-lived and so suggest that the emotional connection was somewhat weaker in a simulated environment.

Community-building is an important and time-consuming aspect of design innovation in almost any ecology, and yet it is one of the least understood aspects of peer production (Bartle, 2004; Benkler, 2005, 2006; Bryan & Joyce, 2007; Lessig, 2008; Raymond, 1999; Tapscott & Williams, 2006; T.L. Taylor, 2006). The difficulty of drawing together self-organising teams of geographically dispersed designers under a unifying knowledge vision has been highlighted in all three of the case studies: *Design 2029*; Studio Wikitecture; and Sloodlers. The most successful community, Sloodlers, emphasised that 'community-building' was the most important challenge that they faced. A powerful knowledge vision that is shared can unite a community and give it purpose and goal objectives that can enable knowledge creation and design innovation (Von Krogh et al., 2000). Malaby (2009) noted that various attempts by Linden Lab at social engineering such as avatar ratings had failed, but that normative behaviour had encouraged other community-building behaviour to emerge.

In commercial design praxis, which seeks to use design innovation for competitive advantage, the culture of the organisation is equally important. In the early exploratory research carried out for this thesis it was observed that the student design teams remained unified by the common objective of academic assessment, and that would often gloss-over team differences missing from a shared knowledge vision.

In virtual design praxis a knowledge vision may hold less community bond for a design team than the clear goal of completing the design objective of the design team, however a knowledge vision is an important support to a more pragmatic approach. The relative weakness of emotional engagement between members of a virtual design team due to low fidelity suggests that greater attention needs to be focused on a shared knowledge vision and getting to know each other in a virtual design innovation ecology, thereby building trust and agreed purpose. As it has been emphasised in the Von Krogh et al. (2000) and Hussi (2003) models, it first requires a knowledge vision to unite the design team in a common purpose to carry the project forward.

Four important norms work together to provide cybernetic feedback to the cyborg designer in SL. Trust is often built on reputation and reciprocity, and a cyborg's reputation is contingent on whether they comply with the normative value system expected of their community. Value systems can deviate from community to community and from group to group. One group of cyborgs in SL considered it fun to appear as a 'flash mob' on a named 'sim' in order to crash the server. This behaviour they valued as positive and conformist even though it was banned under the Terms of Service by Linden Lab and was referred to by most cyborgs with the pejorative phrase 'griefing'.

5.3.1.1. Trust in the SL design innovation ecology

Trust is an essential norm of knowledge sharing and the exchange of intangible assets in SL (Bowers et al., 2008; Lencioni, 2002; Lin, 2001; Malaby, 2009; Reeves & Read, 2009; Von Krogh et al., 2000). Trust helps to build social capital as a foundation for the free flow of ideas and knowledge within and between self-organising, distributed teams who are seeking design innovations (Lin, 2001; Malaby, 2009; Von Krogh et al., 2000). Even within the same company a lack of trust can be a significant roadblock to sharing information, knowledge, and developing innovative solutions (Christiansen, 2000; Lencioni, 2002). Working together as a design team encourages the members to strengthen their social capital and to project a reputation that depends on trust (Lencioni, 2002; Malaby, 2009). According to Malaby (2009), current research into online games and virtual worlds has shown how ‘collaborative action in urgent conditions is highly generative of trust and belonging’ (p. 24). According to management consultants, this attribute of gaming could be a valuable training device for companies seeking to build strong teams that trust one another (Reeves & Read, 2009). Research has shown that without trust many will not participate in SL co-design with companies owning a brand they dislike (Bughin et al., 2008). It was observed when corporate activity began to increase in 2006 that there was considerable debate amongst cyborg designers about the virtues of large corporate participation in SL and their apparent ignorance of the norms of the SL community. Some commentators have opined that companies who lack an ethical vision may have more difficulty encouraging their employees, customers and suppliers to contribute to knowledge sharing and creative collaboration (Bughin et al., 2008; Csikszentmihalyi, 2004; Hamel, 2007).

The complexity of the SL permissions system often encouraged cyborgs to grant other cyborgs they trust with almost unfettered control over their virtual property. In some cases this went as far as giving access to their avatar by sharing their user name and password. This implies the ultimate trust of one designer cyborg in another in order to overcome some of the architectural limitations of the DRM permissions system. While it is possible to create a group that controls permissions of the members, such as the ability to modify, sell or copy a virtual object, there were a number of instances where a cyborg was given an object and told not to sell it or give it away even though the permission control was not implemented. In contravention of the Terms of Service, some cyborgs have given trusted cyborgs their passwords to their Linden Lab account. In SL this is the ultimate trust as this exposes the cyborg to the potential of identity theft and monetary loss. During field research it was observed that some designers who established very close, and trusted partnerships with other cyborgs in SL have ignored the Terms of Service and warnings to enable them to more easily collaborate with one another even though they have never physically met. Linden Lab has recognised this level of trust without mention of it in the Terms of Service by providing a means for cyborgs to partner with other cyborgs. This formal act is indicated on their profile, and is often treated as a precursor to marriage and a formal wedding ceremony in SL. Like a marriage, a cyborg partnership can be annulled and permissions reversed, however if a cyborg has given access to their passwords the only means of reversing this level of trust is to change passwords.

In the Studio Wikitecture projects trust is required as designers are not only sharing virtual objects with one another, they are also sharing their reputation and final prize, if they are successful in a competition. The WikiTree can generate permission-free virtual objects that all members of the Wikitecture group can copy and use and so there is the potential for cyborgs to copy and sell objects and textures that have been openly shared. This was a concern explicitly mentioned by one of the Safe Trestles team. *Design 2029* also required that permissions were open, however there were cyborgs who were nervous and reluctant to open their designs to copying as it required trust and meant they lost control and ownership of the design. In order for a cyborg to participate in the *Design 2029* project they had to first agree to the principles of openness and sharing of virtual objects. *Design 2029* illustrated how knowledge visions and norms can compete as some cyborgs who began participating in the project also benefited from the 'hybrid' economy of SL, selling virtual objects for micro-payments. In SL it was not uncommon for cyborgs to acquire 'freebies' and then package them up and sell them to unwary buyers. This was considered to be very poor behaviour and was subject to scorn and anger by cyborgs who found out about this practice. In the Sloodlers case study the norm of sharing virtual objects and designs was a popular and almost subconscious norm amongst the members. It was observed that the free flow of ideas is a common principle in education and that many of the Sloodle members joined SL led by an educator with a knowledge vision of knowledge creation within a classroom. Many teachers who were not particularly interested in the market economy of SL treated SL and Sloodle as subordinate tools to the curriculum. One indicator of the possible level of engagement and immersion in SL was the appearance of a cyborg's avatar. Teachers and students who occasionally used Sloodle as an extension of their curriculum and were not fully engaged with the SL community at large presented relatively simple avatars that were either from the Linden Lab inventory or freely given away. Sloodle developers on the whole exhibited greater sophistication with their avatars, however it is important to note that avatar appearance was not a reliable indicator of normative bias as an experienced SL cyborg could make their own avatar without engaging in the very large market economy of buying and selling avatars in SL. Generally, the SL birth date (when a cyborg first enters SL) is a good indicator of SL sophistication and avatar appearance. The longer a cyborg has been in SL generally the more sophisticated the appearance, however what is probably more reliable would be how many hours they have clocked in-world.

The knowledge vision and norms of all three case studies required a sophisticated appreciation of complex SL issues and so a majority of their members presented relatively sophisticated avatars. All of the three case studies were open source and provided tools and virtual objects for free to share amongst the three groups. If any member of those groups had been caught selling an open source object they would have most likely been reprimanded and asked to leave the group. The norm of trust was an important social contract necessary for design innovation and was more powerful than the legal regulation that prohibited behaviour according to copyright law and the open source licenses such as the GPL 3.0 governing Sloodle and the BSD that regulated the WikiTree. Trust was built up over time in SL design teams and was often founded on reputation. However, it is worth noting that many cyborgs have commented how quickly and intensely relationships of trust can occur in SL – and that it can just as rapidly disappear.

During field research it was observed that the more time that a cyborg has spent in SL, and the more they have invested in their reputation there, the more likely it was that other cyborgs were going to trust them. It is all too easy for a cyborg to do something wrong in SL and then disappear by shifting their assets to an alternative avatar and then closing that account. How far a cyborg may go with their trust will also depend on the perceived value of the virtual objects and IP involved. Commentary from blogs showed that many corporations that have been interested in using SL for distributed teams have been concerned that they do not trust the security of the SL clients and servers and believe IP could be lost or stolen. None of the three case studies involved IP that was considered commercially valuable, however innovative designs can be worth considerable amounts of money and so this could present a challenge to design praxis that has commercial goals. Many designers are conscious of their reputation and want to be reassured by all the regulators, including their group norms, the architecture of the DRM in SL, and the law pertaining to copyrights, trademarks and patents.

5.3.1.2. Reputation in the SL design innovation ecology

Reputation is another important normative component that has a significant influence on knowledge sharing and attitudes to creative collaboration (Schroeder, 2002; M.F. Schultz, 2006). The reputation of a digital identity has been recognised by online community designers as an important digital currency (Loke, 2009; Raymond, 2001; Smith & Kollock, 1999; T.L. Taylor, 2006). It has been stated by many writers that reputation is one of the biggest motivators of the open source movement, and the fear of loss of reputation can be a very strong reason not to commit offences against the public good, but rather to contribute to the commons (Abramson, 2005; Goldman & Gabriel, 2005; Hippel, 2005; Lessig, 2004; Raymond, 2001; M.F. Schultz, 2006). The original founders of SL, Rosedale and Ondrejka, had closely looked at other rating and reputation systems such as the one used by eBay and were keen to implement it in SL (Au, 2008; Ondrejka, 2008). In earlier versions of SL there were reputation points awarded to individuals for how they behaved towards others and their skill level in building. There was a cost to the individual who rated the other individual of $25 Linden dollars (approximately US10c) per rating, however ‘rating parties’ became common. At the rating parties individual avatars which might not even know each other would rate each other positively. The reputation point system has since been dropped because it could be 'gamed' or manipulated and lost its meaning. It was also a drag on the Linden servers (Boellstorff, 2008). New third-party innovations created by residents have been designed to replace the official Linden Lab reputation system with new techniques to prevent manipulation.

Open source software developers have recognised reputation as a significant motivator for those who contribute to projects without financial rewards, and have supplied sufficient incentive to enable self-organising and emergent complexity in millions of lines of code (Goldman & Gabriel, 2005). The reputation and trust of a cyborg is influenced by the degree to which that cyborg also divulged their identity outside of SL (Schroeder, 2002). The user interface in SL provides a cyborg with the ability to reveal their name and occupation in the 'real world' and an actual photograph of their appearance. There were a number of academic and professional groups in SL that insisted that members reveal their 'real world' name and occupation as a condition of membership to avoid cyborgs who might not conform with norms of trust and honesty. Their 'real world' reputation provided another layer of assurance to cyborg participants. It was observed that a majority of the organisers in each of the case study groups freely divulged their actual identity and often their contact information and legal name outside of SL. The reasons for this could have been based on the assumption that by freely giving that information the members would trust them more. They were also less likely to experiment with their avatar appearance, although this was common among members of their group, with some cyborgs choosing appropriate avatars for different context, much as you might change your clothes for a business meeting in a physical context.

5.3.1.3. Reciprocity in the SL design innovation ecology

The rating parties showed that reciprocity in reputation ratings in SL acted as an unspoken normative rule, encouraging everyone to partake, even though an individual could hang back and accept positive ratings without reciprocating (Au, 2008). This sort of behaviour was unusual as an individual who did not reciprocate could risk being ostracised. This behaviour is common amongst other communities and is the strong social glue that maintains relationships and a common sense of belonging and purpose (Malaby, 2009; M.F. Schultz, 2006). In SL fashion designers who work together to advance their designs would often share textures and techniques with other friendly designers, however when a particular designer failed to reciprocate, the amount of sharing that happened dropped off dramatically. Reciprocity and the normative expectations of the social group can be powerful stimulants and inhibitors of knowledge creation and sharing (Lessig, 2004; Lin, 2001; Malaby, 2009; M.F. Schultz, 2006; Von Krogh et al., 2000). These norms are especially active and necessary amongst the residents of SL who may never meet each other face to face and can only rely on reputations, friends and experience to decide whether to trust others in a relationship. The norms of SL can vary just as much as in a physical environment as the context of the virtual environment will suggest the normative expectations of the participants. Copying someone else's virtual object may be encouraged, frowned on, or even result in legal recourse depending on the circumstances, the possible circumvention of DRM, or reciprocal relationship between the parties (Rive et al., 2008). The normative regulators of gifting and reciprocity are tied to the market modality and Linden Lab could have dramatically increased the price of rating in SL which would have likely caused a sudden decline in rating parties. This would have also caused a great imbalance of reputations between older avatars who had amassed high ratings and those 'noobs' who could not afford to casually hand them out. The ratings points had been used as a reciprocal reward by one cyborg who appreciated a favour from another, and was also used legitimately to show approval for another's design. Gifting and reciprocity have long been recognised as a powerful means of increasing social capital in a virtual world and amongst geographically dispersed collaborators (Raymond, 1999; Rheingold, 1993).

5.3.1.4. Value systems in the SL design innovation ecology

According to Christiansen (2000), incentives are a major management tool for companies who are looking to encourage knowledge sharing and design innovation. These incentives are closely related to an individual's value system; their motivation; and the allocation of resources such as bonuses and R&D budgets. In order to address the normative enablers of knowledge creation and design innovation in SL it is important to explore the value systems that motivate the cyborg participants in the SL ecology and case studies. According to James Gee (2009), in his discussion of learning and MMO game design,

> In good games, players feel that their actions and decisions – and not just the designers' actions and decisions – co-create the world they are in and shape the experiences they are having. Their choices matter. What they do matters. I would argue that all deep learning involves learners feeling a strong sense of ownership and agency, as well as the ability to produce and not just passively consume. (p. 35)

This accords with Boellstorff's (2008) theory of 'creationist capitalism' in SL and what commentators Lessig (2008), Au (2008), Maraby (2009) and Ondrejka (2008) claim as a significant contribution to SL's success. The fulfilment of creativity has been observed as one of the most significant motivators of cyborg design activity in SL. This is readily apparent from the interviews with cyborgs involved in many different areas of design in SL. One fashion designer in SL, who is employed as a senior manager for a biotechnology company, reported that they found the experience of designing and selling clothes in SL deeply rewarding. Despite earning well above the average wage in the US as a scientific manager, this designer was motivated by both the creativity and micro-payments they earned from selling their virtual clothes for Linden dollars. Like many serious fashion designers in-world they spent in excess of 30 hours a week using Adobe Photoshop and the SL client to design and create their fashions.

5.3.1.5. The Linden dollar value system and design innovation

It has been observed by T.L. Taylor (2006) that in the virtual game world of *Everquest* market forces and economics can dramatically impact the gifting of services and virtual goods; as the number of players in-world increased and spells became more rare and expensive, the gifting of those spells declined rapidly. Prior to the increasing cost of these spells, experienced players would dole out spells as favours to younger players in order to help them, and also to increase their own reputation. The Sloodle Awards System and game show were two attempts to build a value system that provide cybernetic feedback and used reputation and reward to motivate knowledge creation and learning in SL. Educational tools such as the Sloodle Awards System and interactive virtual quiz chairs provide teachers with valuable tools for monitoring student response and engagement. The Sloodle tools could be extended into design practice in order to reward and engage designers (Reeves & Read, 2009). Virtual currency and point systems can help to evaluate and motivate innovative design solutions (Reeves & Read, 2009).

Although Linden Lab denies that SL is a game, some commentators have explained that the virtual world has game-like qualities such as the performance aspect of real-time communication that introduces the possibility of public success or failure (Malaby, 2009). Reeves and Read (2009) have also discussed how SL's virtual currency (although it is locked to a floating exchange rate against the US dollar) gives transactions a game-like quality. As the average transactions and values of most virtual objects in SL are little more than micro-payments it is interesting that the Linden dollars can regulate normative behaviour with respect to design innovation. Considering the prerequisite high cost of entering SL – when you account for a fast graphics computer, a broadband account, and accessories – it is surprising that residents should be motivated by micro-transactions in-world. Even when it is possible to enter SL for free, it is of significance that one of the first questions a noob will ask a more experienced resident is, 'How do you earn money in SL?' It is likely that if a cyborg can afford the computer and broadband connection to enter SL then they could easily afford to buy Linden dollars from Linden Lab. The exchange rate between the Linden dollar and the US dollar is around $L270 to US$1 and as long as you have a PayPal account, credit card or debit card you can simply click on a button at the top of the screen and purchase more Linden dollars. However, as there is no challenge to this activity, it cannot be regarded as a fun or game-like motivational means of supporting the value systems of SL (Malaby, 2009; Reeves & Read, 2009; T.L. Taylor, 2006).

SL is full of competing and conflicting value systems that help to determine the regulation of norms and the ‘hybrid’ economy is just one of these. There are many scripters in SL, however the ‘hybrid’ economy is still emerging as some scripters were paid well below standard market rates outside of SL while others worked as consultants for large corporations that paid them in accord with regular software development rates in the US. Thus the norms of open source coding were still closely connected with the markets. The need for seed development is a common requirement for most open source design projects that require a core initial team to design and develop a concept or prototype that is sufficiently compelling, accessible and advanced for co-designers to want to participate in (Goldman & Gabriel, 2005; Tapscott & Williams, 2006). In order for *Design 2029* to be a compelling game and a potentially rewarding project, it needed a means of providing feedback to the game participants and a scoring system to make it fun and engaging (Reeves & Read, 2009). The scoreboard was devised as a cybernetic feedback system that would give participants positive feedback on knowledge sharing and collaboration. The scoreboard was designed to visualise a value system based on the shared knowledge vision and was seen as an improved option for the Studio Wikitecture and *Design 2029*. The inability of *Design 2029* to execute this design phase severely inhibited the regulation of knowledge sharing and creative collaboration in that project.

5.3.2. Architecture as a regulator

According to Lessig (2001), ‘The code of cyberspace—its architecture and the software and hardware that implement that architecture—regulates life in cyberspace generally. Its code is its law' (p. 35). The former Chairman of Linden Lab, Mitch Kapor (2006), also once said that 'architecture is politics and politics is architecture'. The architecture of the Internet is often used to illustrate how open source code and standards, with a simple end-to-end network, can stimulate innovation and prevent monopolies from stifling creativity and change (Hamel, 2007; Hippel, 2005; Lessig, 2001, 2004, 2006). The SL architecture is a complex combination of both a client-server, and peer-to-peer network that supports open and closed access simultaneously. The architecture of SL regulates design innovation by enabling a flexible permissions system built on an open source philosophy, however a tension exists between this philosophy and the 'Californian ideology' of 'creationist capitalism' and 'technoliberalism' that enables a knowledge marketplace but can restrict the free flow of ideas that are sold as virtual goods (Boellstorff, 2008; Lessig, 2006, 2008; Malaby, 2009; Turner, 2006). All four of Lessig's modalities interact to produce the unique ecology of design innovation in SL. The architecture of SL has evolved as part of a complex adaptive system that is itself a result of the indosymbiotic design innovation at Linden Lab and the process of normative cybernetic feedback of its cyborgs (Malaby, 2009).

> One of the best features of SL is the way it allows you to collaborate with other residents. Together, you can work on bigger and more complex projects, build on each other's strengths, and make things that you might not be able to on your own. However, collaborating with other residents can be difficult, and not just when it comes to playing well with others. (Rymaszewski et al., 2007, p. 150)

The regulation of SL through architecture can be examined from the outside in as the various architectural layers of code and hardware are shown to regulate the design innovation ecology of SL, and how knowledge creation and collaboration are controlled and enabled. Each layer adds another point of regulation, beginning with the Internet and concluding with the fine grain control of the SL DRM system. A number of commentators have credited the open protocols and standards of the Internet with the explosion of innovation around digital content (Abramson, 2005; Ghosh, 2005b; Lessig, 2001, 2004, 2008). With respect to knowledge flow it is important to briefly mention that SL relies heavily on the architecture of the Internet backbone and broadband network to achieve real-time social presence, or the perception of virtual co-location. During the course of this research SL has been disrupted as a result of network interruptions and SL performance difficulties on servers. Access to SL is largely regulated by bandwidth and software preferences that can modify the detail of the imagery downloaded, and whether the user chooses to communicate with text and/or voice and video streaming. The Internet backbone is an essential component of whether a cyborg will experience a spectrum of fidelity more closely related to an actual face-to-face presence and high emotional bandwidth. In the SL design innovation ecology fast broadband capacity and efficient graphics processing must support creative collaboration and knowledge creation. The Linden Lab minimum requirement for SL access is specified as a broadband cable or DSL. Knowledge flow between cyborgs has been limited by poor bandwidth and has caused various performance issues that can be as basic as the inability of a cyborg to move their avatar to higher order issues that affect the spectrum of fidelity such as streaming with water reflections, shadows, streaming music, video, and 3D object creation. When SL experiences network difficulties, design innovation is severely inhibited. This can be due to a number of factors, such as: poor performing servers; traffic overload due to an influx of new residents; or local difficulties with New Zealand's distance from the San Francisco servers. When a cyborg experiences this extreme poor performance the avatar cannot create 3D virtual objects and can only text message, and will experience 'rubber banding', or a latency lag, whereby the avatar will appear not to be moving and then suddenly leap backwards and forwards as the server attempts to negotiate their expected position in SL.

The original Internet was not designed to support real-time streams of data but subsequent engineering and open protocols have resulted in innovative solutions. Thus, the architecture that supports real-time computing and the underlying Internet cannot be taken for granted in supporting design innovation in SL. Real-time text or speech within a large group of people in SL enables ideas and knowledge creation to flow as individuals communicate with each other and co-create new ideas. Latency and lag were already known to be an inhibitor of creative collaboration and knowledge flow in the early MUDs such as LambdaMOO (Dibbell, 1998).

5.3.2.1. The hardware architecture of SL

The Linden Lab servers are based in San Francisco and run on the open source operating system GNU/Linux with additional open source support from Apache, Squid and MySQL, and while there is a variation of their source code in the public domain, known as OpenSim, the main server code is currently not open source. According to Ryan (2009), 'As a boundary object between the real world and the virtual world, SL's infrastructural code provides certain constraints and affordances that affect the experience of residents within its world and beyond' (p. 23). The number of cyborgs that can share co-presence on a 'sim' is determined by the performance of the Linden Lab servers. The earlier server generations limited the number of cyborgs that could be co-located to around 40 and this was later increased to around 70, depending on local bandwidth. The architectural software and hardware of SL combine to enable a simulation of actual face-to-face meetings that can be measured on the spectrum of fidelity, becoming more or less like a face-to-face meeting. SL software also makes high demands on the client hardware of the individual cyborgs. The SL website specifies minimum hardware requirements that continue to evolve with each generation of the client viewer software. For the second generation SL client software, version 2.4.0.216989, the minimum requirement for a Mac operating system was Mac OS X 10.4.11 or better; computer processor 1.5Ghz Intel-based Mac; computer memory 512mb; screen resolution of 1024 x 768 pixels or higher; graphics processor ATI Radeon 9200, or NVIDIA GeForce 2. These specifications were the minimum requirements and Mac and the other operating systems such as Windows and Linux also recommended more expensive and higher performance specifications. These technical specifications and the requirements for high performance computing have a long association with VR and the search for a high measure of verisimilitude according to the spectrum of fidelity (Davies, 2003). The performance of an individual computer has historically had an engineering focus on the personal perception of presence and immersion as opposed to an emphasis on social presence.

5.3.2.2. The software architecture of SL

The Linden Lab CEO, Philip Rosedale (2007), announced that the client viewer source code would be released to the public and that that was the most significant decision that they had made in seven years. They formed an Architecture Working Group to assist in making it possible to move between other virtual worlds and SL. Linden Lab signed an interoperability agreement with IBM and successfully 'teleported' between the SL 'mainland' and the OpenSimulator running the Open Grid Protocol. According to the official Architecture Working Group website,

> If virtual worlds are to become as ubiquitous as e-mail and the Web (and we believe they will), then like the Internet itself, virtual worlds must be built upon open protocols. Linden Lab is pioneering the development of open, well-specified standards through the design and implementation of its SL Grid technologies ('Architecture Working Group,' 2008).

Open source software has evolved from what has been described, in normative terms, as the 'hacker's ethic' (Lessig, 2001; Levy, 1994). This was epitomised by Stewart Brand's (1998) maxim, 'Information wants to be free.' The normative attitude of open source developers in SL towards software development provides cybernetic feedback to the architecture modality and informs the features and capability of the software. It is the ability of developers to read the source of code of the SL viewer and the open source code of Sloodle and Studio Wikitecture that impacts on the knowledge creation and flow of the design innovation ecology. *Design 2029* was also conceived as an open source project to assist the free flow of knowledge and to accelerate the speed of innovation. It must also be noted that open source does not necessarily mean that all designers in SL will have the knowledge or inclination to review and modify the source code, however in the case of both the Sloodle project, and the Open WikiTree project there were coders who were motivated to be involved in innovations that could improve the operation of both projects. Design innovation often requires esoteric knowledge of particular areas and the tools to perform design outcomes are also often specialist. In order for the residents of SL to participate in a design team they may require not only skills in 3D design and Photoshop, but knowledge of specialist 3D programs such as 3D Studio Max and Maya. In addition to these skills a design innovation project could require knowledge of networks, servers, wikis, version control software, HTML and LSL. Open source software architecture enables knowledge creation and collaboration by providing tools and freely available information about the software, and that in turn enables software developers and their supporters to share, promote and discuss design innovations. All three case studies explicitly supported this open source approach in order to encourage further innovative designs within those projects.

The normative and market regulation of land in SL was maintained by the architecture of SL and the projects and this in turn regulated the design innovation ecology. Linden Lab provided a number of ‘sandbox’ areas in SL that allowed anyone to build almost anything within the constraint of the server’s capacity and the architectural regulation of the number of objects. The sandboxes could be seen as a way to loosen the regulation of design innovation due to land property prices and the SL economy. The architecture of SL provides landowners with the ability to regulate sandboxes on their land and to automatically return objects to the creators after a specified period of time. The architecture of software and hardware in SL allows landowners to regulate cyborg movement on their land. They can restrict access only to those members of a particular group or ban individual cyborgs from their land. Force fields can be erected around certain portions of land and whole regions and islands can become restricted. A cyborg that has been prevented from accessing land in SL will face communication restrictions as text and voice chat are limited to certain distances in SL. A cyborg who is busy can adjust their status so no one can see that they are online in SL, or signal they are busy by using a pull-down menu that prevents other cyborgs from communicating with them. This is often used by designers as they work on a project. If a cyborg is being harassed in SL they can ‘mute’ an individual or object so that the cyborg or virtual object cannot communicate or interact with them. This gross form of architectural regulation of an inogism can be refined through software programming that can accept only specified communications and/or security passwords. The inability of a cyborg to travel freely from island to island in SL is an attempt to regulate both privacy and knowledge flow based on the physical metaphor of actual land, but can also inadvertently inhibit an inogism. Just as this architecture can regulate knowledge creation within SL it can also regulate the flow of inogisms between other virtual worlds, the physical world, and SL.

5.3.2.3. Interoperability between other virtual worlds and SL

Many have argued that it is the open standards and the network neutrality of the Internet that has continued to feed creativity and innovation between applications and thus prevented 'garden-walled' communities that restrict knowledge flow (Benkler, 2005, 2006; Lessig, 2001, 2006, 2008). One commentator has drawn the analogy that the current state of virtual worlds is much like the isolation of early Bulletin Board Systems (BBS) (Morgado, 2009). Morgado explains that with these BBS, if you wanted to find information not held on your current system but held on another, you would have to hang up and redial your modem to connect to another system. He further illustrates that if the web worked more like virtual worlds then to link between pages would require you to quit one browser and open another to be able to read the next page, because currently virtual worlds such as SL do not share common protocols or client software. Morgado (2009) outlines three requirements for interoperable virtual worlds:

- An avatar must be able to cross from one virtual world to another retaining the same name and appearance.
- The virtual world should be independent of the client software. Morgado admits that SL does this to a certain extent with the Open Simulator virtual worlds but there is still no virtual world open protocol shared by all.

- Possibly the most important feature would be virtual servers that could talk to other virtual servers so that virtual objects and metadata could move freely between worlds. (p. 6)
- Other commentators have also mentioned virtual currency exchange.

One of the powerful aspects of SL is the architecture's ability to create virtual conferences and seminars in which cyborg attendees can hear and discuss ideas from around the world in a virtual co-location. The shared philosophy of open protocols and the interoperability of virtual worlds, which means a cyborg's ability to freely move from one virtual world to another, has been embraced by a commercial software company, Green Phosphor. In a regular series known as 'Smarter Technology' the cyborg Ben Lindquist, CEO of Green Phosphor and co-founder of bubblecloud.org, shared his ideas with an SL audience about their recently developed open protocol Mud eXtension Protocol (MXP) that will allow movement of avatars and virtual objects between virtual worlds. In the seminar he said that what made SL so ground breaking was that the content is dynamic. The MXP open protocol will enable unprecedented sharing of data from massive databases and virtual objects by cyborgs in real time. This could lead to easy interactive access to supercomputers and their data from within SL and other virtual worlds. This would enable very complex protein-folding visualisation, for example, or massive design complexity such as a plane or car design.

Currently, SL is limited by the real-time architecture that regulates the complexity of the 3D models, restricting the number of linked prims in one object to 256, and to 15,000 prims on a private island. There are a number of export plugins that allow designers to use more sophisticated 3D applications such as Maya or Blender to create models for SL. However, these models must still be simplified. It will be necessary for SL to achieve greater architectural interoperability in the future to support sophisticated design innovation and to move further to the right-hand side of the spectrum of fidelity. The greater interoperability between design innovation ecologies the greater the opportunity to sustain an inogism's life cycle through indosymbiosis, where ideas are shared and knowledge creation enabled. Open protocols and interoperable architecture would connect SL with other virtual worlds and grow diversity, and the design innovation ecology, beyond just the community of SL.

5.3.2.4. Group architecture in SL

One important distinction between virtual worlds and VR designed for single-person experiences is that virtual worlds are predominantly social virtual environments (Bartle, 2004). Technically, this distinction has meant that technologists and scientists in VR historically focused on individual presence and trying to increase the verisimilitude along the spectrum of fidelity (Davies, 2003; Farshchian, 2003). Virtual world designers have tended to focus on 'social presence' and a simulation of co-location in order to enhance the sense of being in the same place, at the same time, at the expense of photo-realistic graphical displays (Farshchian, 2003; Ijsselsteijn, 2003; Lombard & Ditton, 1997). Technologists in the past have had to decide whether they were going to design a virtual environment intended for one person or one that is useful to groups, and this compromise is determined by cost and architecture. According to Farschian (2003), the cost of the architecture can also impact the degree of informality and opportunities for serendipitous meetings in a MMO virtual environment: 'Informal collaboration is facilitated through high quality communication channels, low cost of initiating communication, and high frequency of opportunities for communication' (p. 211).

SL is not the most sophisticated 3D modelling application available. During a mixed-reality workshop that included senior digital design students and digital design lecturers, there was a consensus amongst the participants that the SL building tools were more difficult to use and slower than the professional design applications such as Maya. It has been observed by a number of commentators, including Linden Lab themselves (Boellstorff, 2009; conversation with Mitch Olson at Digital Media Summit, Auckland, 2009), that the SL tools are not easy to use. However, they are relatively inexpensive and do support sophisticated group communications not included in many other applications. In a face-to-face focus group following an SL workshop, one participant made the comment that they could achieve a lot more, and a lot faster, using Maya than they could with the SL client. The focus group did concede that Maya did not have the ability for users to collaborate on a shared design in real time, and that it lacked communication features to assist in this. Maya provides workflow and pipeline tools, however it is more intended to be worked on by one designer at a time, and not many designers simultaneously.

In the late 1990s Silicon Graphics responded to customer suggestions that they modify their million-dollar ‘Reality Center’ that ran on their proprietary VR supercomputer. Car designers at Toyota, Mercedes, and the tractor manufacturer John Deere all used Silicon Graphics supercomputers in a virtual environment to create vehicle designs. Dispersed design teams encouraged Silicon Graphics to use an expensive and technically difficult technique to allow co-design in a Multiuser Virtual Environment (MUVE) using point-to-point, dedicated data channels and ISDN links of 256kbs. The complexity and expense of synchronising data-intensive 3D over relatively slow communications channels meant that this design environment was only used by the very high-end designers with large R&D budgets. More importantly, the 3D models were not created in real time but were often rendered first in Maya 3D on expensive workstations; they then required customised coding to create the virtual environment prior to the MUVE design discussions. With some difficulty, the 3D files could be moved and examined in two geographically dispersed labs, however, apart from live voice chat using phone or ISDN data channels, there was no ability to modify the 3D object in real time. Complicating the co-design process was that the Reality Centre was like a small theatre with a curved screen in which the designers all wore active 3D glasses. Each designer would only observe the MUVE from their own perspective, which meant that another observer in the same physical space would perceive their actions to be misaligned with the 3D model. Some Reality Centers could seat up to 50 viewers, however active participants were more limited to around five at the most at either end. This was determined by the architecture of the hardware and software of the Reality Center.

By 2003 SL had radically democratised and improved the possibilities with a cheap, real-time MUVE that originally only used text chat. Prior to the introduction of voice in 2007 experienced gamers were used to augmenting their communications with either Ventrilo or Skype software to have group conversations. Rosedale (2012) remarked that group text chat was one of the most technically demanding requirements of the SL architecture. The social nature of the virtual world and the Linden Lab desire to foster creative collaboration meant that overcoming this technical obstacle was considered to be very worthwhile. Group architecture places a heavy burden on the Linden Lab servers and so the number of groups an individual could belong to were initially limited to 15. At the time of this research, it had been increased slightly to 25. Expanding the number of groups is a popular request and it has since been further extended to 42. Setting up a group in SL requires a cyborg to have had some experience of the SL client and customs of SL. The cyborg must pay Linden Lab 100 Linden dollars to set up a group, an expense and market device intended to regulate the number of groups that individual sets up. A group must also have a minimum of two people, and if a group fails to attract that minimum within a limited time, it is deregistered. The architecture of the groups allows for complex customisation including inviting others to be group officers, setting their roles and abilities, and inviting the main members. Flexibility in design comes at a cost of complexity, however this creates a tool that can accommodate the greatest amount of diversity, which encourages design innovation. How a group is formed, whether it is closed or open, whether it is free or there is a joining fee is further supplemented with the founder’s ability to write a covenant to allow for rule making and community culture. Virtual worlds are implicitly social and this was recognised by the designers of SL well before the take-off of social networks on the web. At a superficial level this is most readily apparent to the SL cyborg through the ability to join groups enabled by the SL architecture.

5.3.2.5. Real-time architecture

According to James Gleick (1999) in *Faster*, the neologism 'real time' was invented in the 1953 and was a form of instantaneous cybernetic feedback.

> With the advent of large-scale high-speed digital computers, there arises the question of their possible use in the solution of problems in 'real time', i.e., in conjunction with instruments receiving and responding to stimuli from the external environment. (p. 66)

The extraordinary ability of thousands of servers, using high-speed networks, to deliver real-time data has gone beyond mathematics and text; they can now stream 3D in a virtual environment that only ten years ago seemed improbable. It is likely that Rosedale's experience in streaming media at Real Networks informed some of the technology of SL, and it is one of the biggest benefits for design innovation. Real-time, persistent 3D object creation has an intuitive flow that allows designers to create virtual objects that other cyborgs can see and interact with in real time. As soon as a cyborg points at the ground and clicks the button 'build', someone on the other side of the planet can see the same object appear. If they have been given permission, that cyborg can begin to manipulate the virtual object, add an interactive script, and change the texture of its surface as if they were in the same room playing with intelligent silly putty. SL, like many 3D applications, uses various technological ploys to assist flow such as a local cache of textures and objects that have not moved since the last visit in-world.

Creativity often depends on flow to sustain a stream of thought and ideas necessary for originality and design innovation (Csikszentmihalyi, 2004). In order to support this creative flow SL must maintain an uninterrupted stream of 3D images, text chat, 3D spatial audio, and voice conferencing with multiple cyborgs. This presents a significant technological challenge that must be achieved by the architecture of the SL servers and clients. The focus and attention of a design team working on a 3D design in real time must flow and this architectural requirement rests heavily on the design of SL as well as the ability of the Internet and local users to access broadband without interruption.

5.3.2.6. The architecture of DRM in SL

Digital rights management (DRM) has become a loaded phrase that requires some definition here. One of the reasons that many find the phrase contentious is because of a divide: those for and those against DRM line up according to their assessment of copyright, file sharing, music piracy, open source, and the Creative Commons. DRM is defined here as the process of controlling access and usage of digital objects according to rights and management rules. Lessig (2008) maintained that open protocols and the ability to remix digital content were responsible for a boom in innovation and he used SL as an example of a vibrant hybrid economy that maintains both public domain software and virtual objects that are protected and sold.

Lessig argues that the ‘code is law’ and that closed architectures using DRM regulate and constrain design innovation. However, he acknowledged the paradox that SL uses a form of DRM to control permissions to virtual objects which he had argued encourages co-design and innovation (conversation with Lessig, Auckland, 2008). Without some means of a flexible DRM architecture there would be no way to regulate the complex permissions system that has enabled cyborgs to design and sell virtual objects inside SL and on the SL Exchange web marketplace. DRM can be used to prevent copying, but it can also be used to protect metadata such as the data that informs who is the original creator and owner as well as the time of creation, amongst other details.

5.3.2.7. The CopyBot scandal

How seriously cyborgs regarded the DRM permissions system in SL was revealed in November 2006 when www.libsecondlife.com, a wiki-based group that was focused on the goal of reverse engineering the SL client, released source code known as the CopyBot. The CopyBot software was designed in part to allow content creators to back up and archive their creations outside SL. This has been considered a concern by designers who have no easy means of archiving versions of their designs. There were applications developed to do this with the OpenSim platform. Almost as soon as the CopyBot code was released cyborgs in SL used the software to remove permissions and the DRM of prims and textures in-world in order to copy them and then resell them as their own. There was widespread panic amongst store owners and cyborgs who made Linden dollars selling virtual objects in SL as this effectively meant that anyone with the CopyBot could strip the permissions of a virtual object, with the exception of protected scripts. Overnight a large number of stores in SL closed and used virtual force fields to keep out anyone but the owners for fear that they may have their IP stolen. There was even speculation at the time that the entire SL economy would freeze. There were many angry and frightened reactions on the Official Linden Blog, and it became clear that most businesses in SL relied on the DRM permissions system to protect their copyright and enable their business. The architecture of the DRM protection appeared to be a central enabler for knowledge creation and creative collaboration amongst general designers in SL.

Linden Lab moved quickly to reassure the residents and tell them that anyone caught using the CopyBot would be held to be in breach of the Terms of Service and would be banned from SL. The CopyBot was also said to be illegal under the DCMA as it removed copy protection from virtual objects. When the panic died down it was pointed out by a number of bloggers and Linden Lab employees that it is almost impossible to completely protect digital assets from copying and duplication. If it can be seen on the screen, or heard, it can be copied and texture rippers which can grab images from the screen are easily found. The ability of the CopyBot to do so much damage and distress to businesses and cyborgs in SL caused concern amongst the developers of the CopyBot and so it was removed from the libsecondlife developer’s repository. The CopyBot scandal illustrated how the DRM architecture encouraged design innovation through the protection of the metadata and that it was a key component of the SL economy.

5.3.2.8. DRM and cybernetic control

Lessig, just as Wiener and Brand before him, feared that the architecture of cybernetics and the regulation of the flow of ideas also provided the tools of control. Lessig saw that the architecture of DRM could be used to extend control beyond the law to achieve ‘perfect control’ in the esoteric realm of architectural software design. This design, which is understood by only the knowledgeable few, becomes ‘the invisible hand of cyberspace’.

> This invisible hand, pushed by government and by commerce, is constructing an architecture that will perfect control and make highly efficient regulation possible. . . . While once it seemed obvious and easy to declare the rise of a “network society” in which individuals would realign themselves, empower themselves, and undermine traditional methods of social and cultural control, it seems clear that networked digital communication need not serve such liberating ends. (Lessig, 2006, p. 5)

DRM can embed the assumptions and normative values of those who design and write the code and this can remain hidden from the users, just as the permissions system in SL is unquestioned by many cyborgs. The cybernetic control of DRM can be used to enable the flow of ideas, but it can also be used to limit and regulate that flow. In SL the creator of digital content has at their disposal a DRM permissions system with which they can determine who will have access to what they build. This is a complex process whereby the ‘Creator’ has the ability to detail the metadata that describes the object. When a cyborg first starts to build a component of a virtual object, each prim has fields that the creator can fill out. This includes the name, the object, and description. The metadata of the Creator’s name and Owner are automatically added and there is also the ability to change the Group and to Share the object with that Group. There is also the ability to sell an object and determine whether to sell a copy, the contents, or the original for a price determined by the Creator. This virtual object can also be listed in the SL search. Finally, the creator can determine if anyone can move, copy or transfer ownership and when that object is sold what the next owner can do with it, for example modify, copy or transfer it. It is apparent from this process that the protection and recording of who the creator is and who the owner is are a focus of the permissions system based on the SL market economy.

The variables and complexity of the DRM permissions system arise from the Linden Lab assumptions that determine the market economy in SL. The ideologies of ‘Californian capitalism’ and ‘technoliberalism’ are hidden in the architecture of the DRM in SL. It would appear from the design of the GUI that Linden Lab assumed that the majority of cyborgs would want to create virtual objects to be sold. Or perhaps another interpretation is that the GUI was designed to protect ownership of virtual objects as a default in order to prevent surprises when an object was inadvertently made available to everyone. When an object is first created the default permissions for that object are set to prevent anyone but the owner from modifying, copying or taking that object. The owner must deliberately change these parameters in order for someone else to make those changes. Even when an object has had the permissions edited to allow anyone to do anything with it, if that object is then taken back into the owner’s inventory then the permissions are automatically reset to the default non-sharing setting. Moreover, if just one object was contained in another which did not have full permissions, it would override all other permissions. The DRM architecture was regarded by most of the participants in the three case studies as a barrier to collaboration and working together, as the life cycle of an inogism was slowed by a complex permissions system which tended more towards control than an open innovation process. However, DRM also enables knowledge flow by assuring content creators that their metadata and copyright will be protected. Therefore, a specific architecture can both inhibit and enable knowledge creation and an inogism depending on the context and the cyborg’s perception.

5.3.2.9. Architecture of version control

In order for a design team to work effectively and efficiently together it is necessary to have some form of version control. In the field of software design there are a number of tools that assist teams working together to ensure that a developer is working on the latest version and not a previous or out-of-date copy. While proponents of SL talk about the ease with which cyborgs from all around the planet can work together, there is no easy method of version control within SL. Many scripting and other higher-level software coding projects, such as the open source SL client viewer, use version control tools like Subversion outside of SL and are supported by wikis and software repositories that allow coders to check out modules and work on them before checking their own version back into the repository with notes to be reviewed by their peers. SL lacks an easy-to-use version control system to assist design innovation, however there are freely available public domain update scripts that will inform users that there is a newer version of a design available and deliver it to their inventory. Beyond this, the SL architecture lacks the level of sophistication around version control found in software tools that allow designers to inspect and modify components of a design and provide collaborators with clear time-stamped documentation and a reversible decision tree that tracks and traces all iterations of the design.

5.3.3. Legal regulators in SL

To what extent have the existing copyright law and SL code that regulates access been successful in encouraging innovation in SL? On the surface it would appear that neither of these regulators have seriously inhibited innovation and creativity.

> The residents of SL have created a massive two hundred and seventy terabytes of user created content, and well over 90 percent of all the content 'in-world'. In October 2006 cyborgs spent 240,000 user hours per day in-world, and 25 percent of their time creating, the equivalent of 30 user-years per day. (Ondrejka, 2008)

There is no clear distinction or boundary between the virtual and actual world as ideas float freely in and out, and yet this flow is not totally frictionless – a cyborg in SL can experience the regulation of the law and the code. Lessig (1999, 2001, 2004, 2006, 2008) argues that copyright law is an explicit regulator that can either enable or inhibit creativity and innovation. Furthermore, while the original intent of copyright and patent law may have been to encourage innovation, today existing legislation and the execution of the law are conversely acting as limiters on creativity due to high transactional costs and uncertainty (Lessig, 1999, 2001, 2004, 2006, 2008). 'The main function of copyright law is to protect the commercial life of creativity. Though there are exceptions, in the vast majority of cases, that commercial life is over after a very short time' (Lessig, 2008, p. 262).

Lessig (2001, 2004) argued that copyright regulation, now with the added power of increasingly effective technological control, threatens not only innovation but also political and sociological freedoms of thought. 'Copyright law regulates culture in America. Copyright law must be changed. *Changed* not abolished' (Lessig, 2008, p. 253). Lessig (2008) wrote that the dual control of US copyright legislation and a flexible permission-based content control software built into SL regulates a vibrant and creative hybrid economy in-world. 'Hybrid economy' is defined as a mix of commercial transactions, and the file-sharing economy typified by open source and public domain software.

According to the website *IP Value*,

> Successful product creation and distribution are fundamental to any business strategy. And neither process is possible without intellectual property rights. Now, more than ever, the ability to generate and safeguard intellectual property value is a crucial differentiator for organisations worldwide. Intellectual property is firmly established as a boardroom issue, involving significant strategic legal, tax and corporate finance issues. ('IP Value', 2008, n.p.)

The former Chief Technology Officer of Linden Lab Cory Ondrejka also warned that digital artefacts are IP, rather than property. Ondrejka (2008) shared the concern of Lessig that while IP governs the digital domain,

> IP helps to steer innovation by creating excess value through temporary monopolies, it is the cost of learning that drives the rate of innovation. Strong copyright, like the approach currently being applied in the United States, hampers innovation due to the increased learning costs. It also legislates areas of innovation rather than allowing less structured exploration, compounding the damage. (p. 238)

The foundation of IP law in the US is the concept that knowledge is a public good and that innovation would arise from the publication of knowledge by individuals who were motivated to share through a limited legal monopoly (Abramson, 2005; Lessig, 2001, 2004, 2006). The Statute of Anne or Copyright Act of 1709 had the long title of ‘An Act for the Encouragement of Learning, by vesting the Copies of Printed Books in the Authors or purchasers of such Copies, during the Times therein mentioned’. Thus the law was originally intended to promote innovation and knowledge rather than to simply award monopoly to powerful publishers. A number of writers have argued that IP law is no longer delivering the innovation stimulus that was intended by the policy makers and is actually inhibiting innovation (Abramson, 2005; Chesbrough, 2003; Lessig, 2001). The US IP law governs SL and, beyond the Terms of Service and Community Standards, ultimately determines the rights of cyborgs in SL. In the design innovation ecology of SL copyrights, trademarks and patents are very much to the fore and as the popularity of SL has grown more legal regulation of SL was enforced.

There is a semi-permeable barrier between the jurisdiction of the US and SL that requires some attention as IP law can have a direct impact on design innovation in the SL ecology. While there are no known prosecutions of patent violations due to activity in SL, corporations have been concerned to ensure that employees are aware of the dangers of publication or industrial espionage, and have insisted that there are no discussions or exchanges in SL that may threaten patents due to insecure servers. In the wider context, IP law has been accused of slowing the pace of design innovation. For example, it is being used by corporate strategists to create patent ‘thickets’ that encircle technology, making it very difficult for a competitor to innovate or take new products or services to market (Chesbrough, 2003). The traditional approach to copyright that implies ‘all rights reserved’ but gives no indication of the copyright owner is also seen as an inhibitor to innovation and is the motivation behind the alternative approach of the Creative Commons (Lessig, 2001). The democratisation of innovation is readily apparent in SL and yet the legal status of IP within the world is determined by the Terms of Service and End User License Agreement that each SL cyborg must agree to (Balkin & Noveck, 2006; Castronova, 2004, 2005, 2007; Dibbell, 2006a; Koster, 2006; Lessig, 2006; Ondrejka, 2006; Rive et al., 2008; Rymaszewski et al., 2007; Zarsky, 2006). Despite the representation of people from over 25 countries with a presence in SL, the jurisdiction of SL is determined more by the origin of the Linden Lab than the physical location of the user (Zarsky, 2006). However, some authors believe this could be challenged in the future as the rights of avatars become recognised and the rights of intangible assets are claimed by individuals from other jurisdictions (Balkin & Noveck, 2006; Castronova, 2003; Dibbell, 2006a; Koster, 2006; Zarsky, 2006).

Once again it must be noted that Lessig (2006) observed that the modality of the law was interdependent with the other modalities and was dynamic according to changes in the other three modes. Lessig (2006) points out that the difficulty for governmental regulators, who might use the law to encourage or constrain behaviour, is another indirect effect that can cause other structures of constraint with unexpected consequence. Within a year of launching, Linden Lab was seriously concerned about the viability of SL. They were experiencing a very slow take-up in numbers and asked for Lessig’s advice. Lessig suggested that the company assign all ownership and copyright of virtual objects created in-world to the creators. This decision has been credited with the outstanding success of SL and the reason so many have been attracted to the virtual world, and content creation (Ondrejka, 2006). The ownership of virtual contents in SL is seen by many residents as not just a moral legal right, but also as a means of income through micro-payments. The legal regulation of cyborg behaviour in SL is determined by two complementary documents enforced by Linden Lab: the Community Standards and the Terms of Service. The Terms of Service is an attempt by Linden Lab to write their own bylaws under the auspices of Californian, and US Federal, law. This in effect brings the international community in SL under the control of US copyright law and jurisdiction, which some international residents find disagreeable. SL until relatively recently was largely dominated by US citizens but now 60 percent or residents live in jurisdictions outside of America. This supra-jurisdictional control through a Terms of Service or End User License Agreement is a common means of regulation by 'game' developers (Balkin & Noveck, 2006; Boellstorff, 2008).

5.3.3.1. SL Terms of Service

The SL Terms of Service of SL states:

> Linden Lab acknowledges and agrees that, subject to the terms and conditions of this Agreement, you will retain any and all applicable copyright and other intellectual property rights with respect to any Content you create using the Service, to the extent you have such rights under applicable law. (Linden Lab, 2009)

However, just as copyright law does not grant an unlimited monopoly to the copyright holder, Linden Lab reserves the right to use any content created by a content creator in-world with a 'royalty-free, worldwide, fully paid-up, perpetual, irrevocable, non-exclusive right and license' (Linden Lab, 2009).

There was considerable irritation when there was a suggestion that Linden Lab might offer images of one avatar to a third-party magazine. The cyborg regarded their avatar as their property and they had spent a considerable amount of time and money using Photoshop and SL tools to create the skins (including genitalia), shapes and clothes that adorned their avatar. The cyborg strongly believed that Linden Lab should have no right to take the image of their avatar without permission and had in fact discussed contracts with third-party publishers to print their image for payment. In this case the cyborg designer expressed some concern over the ability of Linden Lab to take their creative output without permission or compensation. However, this same designer continued to spend considerable resources on their avatar and so we can conclude they were not unduly inhibited by this condition of the Terms of Service. However, the cyborg's feedback could have been more negative and their creativity inhibited if Linden Lab had indeed gone ahead and published their images without permission. There is currently no law protecting the rights of avatars beyond copyright and the Terms of Service in SL. The Community Standards is the closest thing to protection for an avatar and includes provisions that can result in Linden Lab suspending an account or permanently expelling a resident from SL. They are known as the 'big six' and advise on the following areas:

- Intolerance of other avatars and actions that 'marginalize, belittle, or defame individuals or groups'
- Harassment of others
- Assault in safe areas that permit no shooting, pushing or shoving
- Disclosure – right to privacy in-world and out of world – no remote monitoring of conversations or sharing conversation logs
- Adult Regions, Groups, and Listings – SL is an adult community that restricts membership to over 17s – adult content is permitted on land zoned 'Mature' and not the 'mainland'
- Disturbing the Peace – 'Every Resident has a right to live their SL'
- Disrupting scheduled events, repeated transmission of undesired advertising content, the use of repetitive sounds, following or self-spawning items, or other objects that intentionally slow server performance or inhibit another Resident's ability to enjoy SL are examples of Disturbing the Peace. (Linden Lab, 2009)

All residents have the ability to file an Abuse Report for any violations of the Community Standards or Terms of Service. Linden Lab has a policy of not publicising the outcomes of these reports, although they did publish a police blotter of the worst repeat offenders**.** Linden Lab has maintained that it is impossible for them to control all content and behaviour in SL, however in January 2006 Nimrod Yaffle found himself the first avatar to be transported to the 'Cornfield' for hacking the SL code in order to steal from a virtual store. Every time Yaffle logged into SL he would arrive in a cornfield where there was nothing else except a TV playing a 1940s cautionary film about the disastrous results of a teenage life of crime (Guest, 2007). Linden Lab assumes a loose and what many would consider a benevolent rule over SL, although they are still regarded as the 'Game Gods' and many seasoned residents treat the Linden Lab employees or 'Lindens' as they are known in-world with either awe, love or loathing. It is possible to become a 'friend' with another avatar in-world by right clicking on them and selecting 'Add as Friend'. Like mythological gods the Lindens incite the residents to spread rumours and myths that contribute to these reputations of mythical powers. To know a Linden, or be friends with them gives lowly residents bragging rights, and digital reputations are awarded to those who command Linden attention such as the virtual property magnate avatar Ansche Chung. A cyborg who was friends with one of Chung's senior managers in SL regularly got advice on their properties and clearly advanced their status and wealth in-world through their clever use of property management. While Ansche Chung employs as many as 200 cyborgs in her SL business, the ultimate power resides with Linden Lab and this is sometimes viewed with jealousy and fear by some residents (Guest, 2007).

The game designer Ralph Koster (2006) wrote the Rights of Avatars based on the historic 'Rights of Man', and while many of the rules of SL acknowledge the spirit of those so-called rights, because Linden Lab controls the entire world and the currency some feel uncomfortable. The early MUD and virtual world developer Bartle (2004) believes that the god-like powers of the game developers should be sacrosanct, however as more wealth, status and power is associated within virtual worlds such as SL this is being tested more and more by the vocal opinions of the residents and the reach of policy makers and legislators.

In one well publicised case the prominent cyborg Stroker Serpentine had been accused of invoking the DMCA to pressure another cyborg, Candace Sullivan, from re-selling his product, a big four-poster bed called 'SexGenBurl' that includes sex pose balls. Excerpts from the text chat conversation in SL were published by another cyborg, Prokofy Neva, who described the action as 'thuggish'.

[21:35] Stroker Serpentine: And..btw...Im not alone

[21:35] Candace Sullivan: ohhh scared

[21:35] Candace Sullivan: another...transfer itme i can't sell?

[21:35] Candace Sullivan: lol

[21:36] Stroker Serpentine: you have nothing to be afraid of when your account is audited from a DMCA claim then..right?

[21:36] Stroker Serpentine: Every sale..every item of inventory will be there

[21:36] Candace Sullivan: whatever u say there....they can do whatever u say...all beds are mine..no matter where i buy them or from whom and u made them …

(Neva, 2006)

This was then followed by a notecard delivered to Candace Sullivan in SL.

'Dear Candace Sullivan,

It has been evidenced and documented that you are selling, distributing or in general profiting from the sale of a copyrighted item.

Consider this your only warning to remove and delete all copies, originals and facsimilies of:

SexGen Burl v0.9a

This original work was created by Stroker Serpentine (aka Kevin Alderman) and is protected by United States copyright, which is considered de facto criteria for processing a Digital Milineum Copyright Act herein after refered to as "DMCA"

SexGen and its source code has been properly prepared and presented to the United States Patent Office. (Neva, 2006)

Stroker Serpentine went on to threaten litigation under the DMCA and a claim for compensation for lost revenue. Neva (2006) is a 'Californian creative capitalist' who goes on to point out that a virtual good in SL is more like a physical good than software and so it should not be open to software licensing. In 2007 it came as a surprise to a number of cyborgs in SL that, despite their naïve protestations, the long arm of US Federal law could extend into their virtual world.

The Linden Lab Terms of Service states:

> 7.1 Governing Law. This Agreement and the relationship between you and Linden Lab shall be governed in all respects by the laws of the State of California without regard to conflict of law principles or the United Nations Convention on the International Sale of Goods.

The first example of this was the closure of gambling casinos by the FBI deemed to be illegal under US Federal law as the Linden Lab servers were based in San Francisco. Following that, Linden Lab outlawed any bank that did not meet the regulatory registration requirements of a legally defined bank after a Ponzi scheme in SL defrauded cyborgs of $US160,000. The ability of a cyborg to design an innovative gambling service or introduce a new banking operation is inhibited by the regulation of US Federal law and the Linden Lab Terms of Service. After the ban on gambling in SL there was a significant dropoff of resident numbers. Even when Californian and US Federal law are not explicitly mentioned in the Linden Lab Terms of Service, there is the implicit ability of these jurisdictions to regulate design innovation in SL, as happened in the case of the FBI investigation of casinos in SL.

5.3.3.2. Copyright regulation in SL

Copyright law can regulate many different phases of the design innovation ecology of SL. Beyond the three specific case studies of this research an examination of how that regulation works illustrates the wider context of design innovation in the larger SL ecology and how that regulation is brought to bare on the groups *Design 2029*; Sloodlers; and Studio Wikitecture. The DCMA is the only explicitly quoted legislation in the SL Terms of Service and this signifies the importance that Linden Lab has accorded to copyright in SL. In 2006, as the numbers in SL began to rise and big corporations such as IBM, American Apparel and Pontiac entered the virtual world, Linden Lab began to receive complaints from companies who claimed their copyright was being infringed. Linden Lab implemented a takedown policy following a documented compliance process under the DMCA. This policy affected numerous products and services in-world ranging from Nike shoes to Guinness beer. These are gross examples of how the law has regulated design in SL. The Terms of

Service clearly instructs all cyborgs to comply with the DMCA whether they physically live within the US or not:

> 4.3 You will comply with the processes of the Digital Millennium Copyright Act regarding copyright infringement claims covered under such Act (Linden Lab, 2009).
>
> Linden Lab goes on to state that the company will remove copyright infringing material from SL. (Linden Lab, 2009)

The DMCA is regarded by many technologists to seriously inhibit innovative design (Abramson, 2005; EFF, 2008, 2010). The Act has been successfully used to prevent trivial circumvention of printer cartridges and automatic door openers that would not have passed patent tests for novelty but prevented third parties from accessing their copyright computer code. The DMCA has been used to stifle competition, creating ‘an artificial barrier to entry by placing a technological roadblock in front of a copyrighted product. The technology doesn’t have to be good . . .That’s a boon for producers looking to monopolize a particular niche, because it lets them create trivial artificial barriers to competitive entry’ (Abramson, 2005, p. 238). Linden Lab states it will notify the residents of SL about the DMCA and instruct them on the process for notification of an alleged copyright infringement (Linden Lab, 2010a).

The Electronic Freedom Foundation initiated a joint project on the DMCA called the ‘Chilling Effects of the DMCA’ with Harvard, Stanford, Berkeley, University of San Francisco, University of Maine, George Washington School of Law, and Santa Clara University School of Law clinics. One serious criticism of the DMCA is that the ‘Safe Harbour’ subsection of the legislation will encourage Internet Service Providers such as Linden Lab to quickly remove alleged copyright infringements without court process (EFF, 2008, 2010). However, Linden Lab does warn those who misuse the DMCA that they could be prosecuted, and that one case, not involving SL, had resulted in a fine of US$100,000 (Linden Lab, 2008). Linden Lab sent out a ‘God’ warning to all the residents in SL that it would simply remove all DMCA infringing material from residents’ inventories.

5.3.3.3. New Zealand and the DMCA

In 2009 the New Zealand Government attempted to implement legislation that would have seen an amendment to the Copyright Act known as section 92A. In response, Google made a submission to the Telecommunications Carriers Forum in which they heavily criticised the DMCA-like draft law. ‘In its submission, Google notes that more than half (57%) of the takedown notices it has received under the US Digital Millennium Copyright Act 1998, were sent by business targeting competitors and over one third (37%) of notices were not valid copyright claims’ (Gibbons, 2009). Google went on to say that this type of takedown law, like the DMCA, regulated against innovation. While inadequate copyright protection can reduce incentives to create, excessive copyright protection can stifle creativity, choke innovation, impoverish culture and block free and fair competition. As both an intermediary and an innovator in online technologies, Google supports a flexible and adaptable legal framework that provides those who create and invest in new technologies the freedom to innovate without fear that their efforts will be hindered by an overly restrictive approach to copyright. Copyright must have sufficient flexibility so that new, legitimate and socially desirable uses enabled by new technologies can flourish (Gibbons, 2009). The discussion of the wider context of copyright law and the DMCA has influenced the regulation of the design innovation ecology of SL and in particular the three case studies in this research.

5.3.3.4. DRM and the Creative Commons

In 2006, as SL began to take off, Lessig, as the CEO of the Creative Commons, conducted a seminar to promote his book *Free Culture* in SL (Lessig, 2004). Other employees of Creative Commons also started groups around the organisation in SL and discussed the concepts behind this flexible copyright system. Lessig had previously advised Linden Lab on a permissions system and copyright law which gave the creators of content in SL ownership rights. In 2006 and 2007 there were regular discussions about the possibility of incorporating Creative Commons licensing within the DRM architecture of SL.

Linden Lab was kept busy with other architecture issues such as traffic loading and the overall stability of the platform, however, and the Creative Commons project remained only a discussion point. Many of the cyborgs of SL were largely ignorant of the philosophical debate surrounding open source and the Electronic Freedom Foundation. There were small pockets of groups in SL who were familiar with Creative Commons, however the predominant culture in SL was the market economy of SL that bought and sold virtual goods and virtual land.

5.3.4. Market regulators in SL

The Nobel Prize-winning economist Friedrich Hayek once referred to market pricing as a ‘marvel’ of information aggregation (Hayek, 1945; Howe, 2008; Sunstein, 2006; Surowiecki, 2004). A single price can represent not just a buyer’s or seller’s attitude to the product or service being sold but an aggregation of dispersed information that can range from the effects of a hurricane off the coast of Florida; a war in the Middle East; or a movie being shot in Auckland. Entwined in the price are details about an object’s physical or virtual life cycle: its indosymbiosis. The false analogy of physical property with virtual or informational property has come to a head in the entertainment industries that have depended on a market that guarantees a limited monopoly in IP rights through copyright, trade marks and patents (Lessig, 2004). We now face a very real constraint to innovation in the knowledge economy where the effect of the marketplace sits in a pivotal position at the crossroads of massive technological change. The relative ease of making digital copies, which in no way diminishes the quality or abundance of the original, has begun to challenge the assumptions of those who argue that physical property and IP are analogous (Lessig, 2001, 2004, 2006, 2008). The business model of the very large entertainment industries is under threat as consumers bypass controlled market distribution to share digital files with friends, family and people who they barely acknowledge on file sharing services such as Limewire or, in some cases, SL. DRM has become a political rally cry for both sides as owners of IP attempt to control the market price of their content and a large number of consumers attempt to circumvent it or simply ignore copyright laws and share music and movies without cost. The old market is broken, and record companies and Hollywood studios cry foul while trying to extend the period of copyright protection that they have traditionally enjoyed (Lessig, 2001, 2004, 2006, 2008). Markets mechanisms can be seen to inhibit and enable innovation while helping to direct resources, while some argue for the ‘invisible hand of the market’ and others demand the intervention and inevitability of government policy and laws.

The market modality in SL can be seen to be affecting the life cycle of the inogism in all three case studies even though all of them are open source and there are no explicit commercial transactions integrated into the projects. Tapscott and Williams (2006) recognised the market modality in SL as a new form of economics which they have called ‘wikinomics’. They have examined the impact of Web 2.0 on the exchange, motivation, and regulation of knowledge sharing. The pricing and economics of knowledge has suggested that markets can play a significant role in the transfer of knowledge as Hamel (2007) and Bryan and Joyce (2007) have discussed with regard to ‘Knowledge Markets’ and ‘Talent Markets’. Sunstein (2006) has also identified how these markets, along with ‘Prediction Markets’, can assist decision making and avoid political pressures and cascading failures in teams. Benkler (2006) writes that what we are seeing now is a shift to a non-priced-based, decentralised networked information economy.

The wisdom of the crowd and the ability of the ‘collective intelligence’ to correctly determine the answer or shape the direction of an innovation are all considered by a number of writers to be part and parcel of the application of Web 2.0, the ReadWriteWeb, social media and virtual worlds such as SL (Bryan & Joyce, 2007; Hamel, 2007; Howe, 2008; Lessig, 2004, 2008; Sunstein, 2006; Surowiecki, 2004; Tapscott & Williams, 2006). Due to the semi-permeable membrane that barely separates SL from the physical and intellectual world, jurisdictions and markets have a direct impact on the other modalities of an inogism and its indosymbiotic life cycle within SL. The design innovation ecology of SL is a complex adaptive system that is dynamically evolving due to the interplay of Lessig's modalities. The market modality is now examined in the context of the three case studies and the overall ecology of SL.

The ability of markets and prices to abstract and aggregate knowledge sits on top of more fundamental human norms such as reciprocity, trust and social capital. These markets provide a visible layer of interconnectivity that is underwritten by systems theory, information theory and complexity theory and is explained by second-order cybernetics. Cyberculture has been developed and promoted by evangelists who embraced the counterculture of collective mysticism and cybernetic scientists who have identified the inherent laws of nature that influence innovation and the evolution of complexity (Boellstorff, 2008; Turner, 2006). The three case studies – Studio Wikitecture, Sloodlers, and *Design 2029* – must be considered both within the broader design innovation ecology of SL and beyond it, in the context of a global economy. Lessig's four modalities are all interdependent and the market modality of the SL economy must be understood in order to see these case studies in context. The ability of SL to provide a flexible permission system or DRM resulted from Lessig's advice to Linden Lab in November 2003. He suggested giving the residents the right to retain ownership of their IP and copyright. This was unusual because professional designers employed by the development companies mostly created virtual worlds, and their End User License Agreements explicitly stated that any IP that was created in the virtual world was also owned by the development company (Au, 2008; Balkin & Noveck, 2006; Bartle, 2004; Dibbell, 2006a, 2006b; Lessig, 2008; Ondrejka, 2006). According to Au (2008), 'By giving their world's users a legally meaningful sense of ownership of what they create in SL, Rosedale and his board had unleashed a ferocious level of content creation and investment that would have been unthinkable otherwise' (p. 136). By the end of 2006 this change of policy had resulted in user-generated content estimated to be the equivalent of that produced by a professional development staff of 7,700 people, with an annual cost of $US800 million (p. 136). According to the Chief Technology Officer of Linden Lab at the time,

> Property rights are a key enabler of innovation and therefore per capita economic growth. Without ownership, property is not fungible and retards economic growth. This was one of the key ideas behind SL's decision to grant residents ownership of their creations. (Ondrejka, 2008, p. 237)

The business model for SL was all based on user-generated content, which was a fundamental shift for virtual worlds. Before SL there had been very few virtual worlds, and they were small, such as TinyMUD which was a simple text-based world (Bartle, 2004). The venture capitalists that Rosedale had visited with this model to seek investment for SL were skeptical; they regarded art and design as dark arts and the private privilege of a few talents, with names such as Spielberg and Lucas (Au, 2008). The industry veteran Richard Bartle (2004) went further:

> The bad news is that players know nothing about virtual world design: Nothing whatsoever…This is because actually playing a virtual world adds a subjective element to all discussion. Designers have to be objective. If you can play a virtual world for fun, it's very hard to be a designer; every decision you make is related to your own experiences as a player. Designers can't play virtual worlds for fun. When I enter a virtual world, all I see is the machinery, the forces at work, the interactions – it's intellectually interesting and can be artistically exciting, but it isn't fun. Other designers are the same: The price you pay for being able to deconstruct a virtual world is that of being unable not to deconstruct it. Magic isn't magic when you know how the trick is done. That's why most players aren't good at design. They still sense the magic. (pp. 122–123)

Bartle had not perceived the changes happening all around the Internet, with the rise of social media, peer production, wikinomics, and easy 'prosumer' tools that flooded the marketplace with inexpensive creative content (Benkler, 2006; Bruns, 2008; Howe, 2008; Tapscott & Williams, 2006). The creation of a marketplace in SL unleashed a torrent of content that no professional virtual world designers could match. It is here that the *market* modality intersects with the other three modes of regulation: the *law* of copyright and contract gave the residents of SL ownership over their creations and an incentive to create; the software code which according to Lessig is equivalent to the law as it enforces copy permissions; the *architecture* of SL and the code made the design tools easy to use; and the *norms* of 'creationist capitalism' and open source values lived side by side in the hybrid SL economy and marketplace (Lessig, 2008). In SL most virtual objects have some sort of embedded scripting and mostly sell for between US$1–$10; apart from large land sales, the SL market is primarily based on micro-transactions. There are a small number of residents who can support themselves through full-time work in SL, however the financial side of SL is currently unlikely to be the biggest motivator for design innovation. The relative abundance of virtual goods in-world keeps prices low, while the scarcity factor has been known to push up illegal sales of virtual goods from other virtual worlds (Dibbell, 2006a, 2006b). Micro-transactions can still amount to considerable amounts of money; in 2009 it was reported that they contributed 86 percent of all revenue in virtual worlds and account for $US1 billion worth of sales. This was predicted to grow to $US17.3 billion by 2015 and ultimately outstrip the movie industry (‘Virtual Worlds News,’ 2009, n.p.).

CHAPTER 6
6. THEORETICAL FRAMEWORK REVISED

6.1. Overview of revised theoretical framework

After a literature review and an examination of existing models that could be used to describe design in a virtual innovation ecology, gaps were identified in the existing research. The theoretical frameworks of Von Krogh et al. (2000) and Lessig (2004) were modified and two new models devised to explain the regulation of design innovation in SL and to address the research question (How to design a virtual innovation ecosystem?) and the two sub-questions (What enables knowledge creation during design innovation in SL? and What enables creative collaboration amongst designers in SL?). The theoretical framework of this research used three models to describe the cybernetic design innovation process in SL: Lessig's cybernetic modality; the spectrum of fidelity; and indosymbiosis. Following the research data collection, the original theoretical framework was revised to integrate Lessig's model with the indosymbiotic model. In each of the three case studies cybernetic regulators were examined to understand how the participant cyborgs responded to the positive or negative effects of their regulation and feedback. To be able to give a comprehensive description of regulation of design innovation in SL it is important to first understand the communal context, or ecology, of design innovation in SL and the process by which norms are transmitted between cyborgs. In the revised model, which integrates Lessig's theory with the indosymbiotic model (see Figure 13), this is explained through the indosymbiotic life cycle, and most importantly the initial normative infection of an inogism, or innovative design idea, within the wider SL ecology. As this is a life cycle there is a phase prior to infection, or Phase 1 of the indosymbiotic life cycle, that is there is the population or context of the entire SL ecosystem known as Phase 10 (see Figure 3). However, it is important to remember that the evolution of an idea, and an inogism, is not linear but can be stochastic and can intersect the indosymbiotic life cycle at any point. It is the ecology of this population, and the population of the entire human species, that regulates the context of the initial infection. Ideas and inogisms must first exist within the ecology or community of groups and sub-groups within SL before they can infect the individual. The effectiveness of that inogism depends largely on the tacit knowledge creation that takes place between cyborgs who may collaborate on a design. A higher degree of fidelity will assist in the communication of emotional content necessary for design innovation.

6.2. Life cycle of an inogism

The indosymbiotic life cycle of an inogism is mapped out in order below. This is followed by some suggestions for how to improve the current rate of design innovation, with application to SL and other virtual worlds. The infection of a cyborg host by a design inogism can take place anywhere, either in SL or outside the virtual world, prior to the creation of their avatar. The idea that begins the indosymbiotic cycle may either be well developed or barely formed prior to the cyborg's infection. The ability of the inogism to infect the host will be regulated by the same architecture that shapes the Internet, as this is the backbone to the SL network. Lessig's (2004) cybernetic regulators are effective throughout the indosymbiotic life cycle of an inogism. The host will be provided with constant cybernetic feedback as the inogism gathers more resources or is inhibited in its growth according to Lessig's four regulators. All three case studies struggled to successfully incorporate or develop the means to respond to cybernetic feedback despite a common belief in the benefits of this process. The indosymbiotic life cycle of design innovation can be applied to all three case studies. Following the establishment of the wider SL community or population and the ecological context of design innovation, both outside and within SL, there is the initial infection, or Phase 1 of the indosymbiotic life cycle of an inogism. The process of infection in SL begins with Orientation Island when enthusiastic volunteers help newly arrived cyborgs navigate the complexities of the SL user interface, and in the process pass on the norms of life in SL (Malaby, 2009). The infection phase is an attempt to account for the 'fuzzy' front end of design innovation and creativity; the autopoietic metabolism of an idea; a cybernetic systems approach to an individual's creativity and ideation.

The network neutrality of SL will determine to what extent a cyborg can have access to new inogisms and the permissions that have been embedded in the inogisms by the code of the DRM, and who is deemed to own the inogism according to copyright law and the Terms of Service (Lessig, 2004, 2006, 2008). Open access to locations in SL will create more flow of ideas but can be regulated by code that enables the cyborg to restrict access according to access lists based on group membership and friendships (Lessig, 2001, 2004, 2006). Another important aspect of access is the architectural regulator and the speed of Internet connections for the individual as the degree of interactivity and communications is determined by bandwidth. Indosymbiosis describes the non-linear life cycle of a design innovation. There is never really any clear beginning or end of an idea or inogism; before the infection of the individual host there is a population of inogisms floating in a culture or population that penetrates the semi-permeable membrane of SL. The availability and ease of exchange is partially dependent on the legal status and understanding of the cyborg or designer. In order to maintain flow and enable knowledge creation and creative collaboration in this design innovation ecology the designers rely on real-time architecture to simulate face-to-face meetings and to sustain the inogism's life cycle. The three case studies, and other design projects in SL, suffered from a less than optimum spectrum of fidelity that reduced tacit knowledge creation. A strong group such as the Sloodlers augmented their virtual meetings with actual face-to-face gatherings. A break in the indosymbiotic life cycle of design innovation will interrupt the flow of creativity and collaboration between designers. The indosymbiotic life cycle of a design innovation should not imply that the process is always linear or predictable; the stochastic nature of evolution is an important contributor to novelty and innovation.

6.2.1. The life cycle of the *Design 2029* inogism

The Sloodlers and Studio Wikitecture were two groups that had already been established before the researcher began to investigate them as case studies. Therefore, it was only *Design 2029* that presented the opportunity to consider the infection or first phase of indosymbiosis. The researcher originally entered SL after reading about Lessig's work with Linden Lab and reading a number of his books. The infection created an inogism based on Creative Commons and Lessig's theories on the future of ideas (Lessig, 2001, 2004). Von Krogh et al. (2000) stressed the importance of a knowledge vision and so the researcher and senior research technician set about creating an inogism that would sustain the *Design 2029* community. At that stage of the *Design 2029* inogim's life cycle it recombined with other inogisms and borrowed freely from outside of SL in the areas of open innovation and Kurzweil's (2005) theory that all value will eventually reside in IP, embodied in design. A comparison with the experience of both the Sloodlers and Studio Wikitecture groups showed that simulated face-to-face meetings with in-depth and sustained conversations were an effective means of progressing a design. The researcher did initiate a number of preliminary conversations around the construction and design of *Design 2029*'s toolset, however while the spectrum of fidelity seemed adequate in some instances, it also led to some frustration as communication was inhibited by the inferior fidelity of the SL ecology.

Prior to the formulation of the *Design 2029* knowledge vision the researcher had become infected by an inogism that eventually developed into *Design 2029*. The deliberate formulation of the *Design 2029* knowledge vision was an attempt to infect others with that knowledge vision. Tacit knowledge creation, that is necessary for design innovation, requires a high degree of fidelity in order to simulate face-to-face meetings, and requires sustained and in-depth conversations. *Design 2029* stalled before these sustained conversations occurred as the game toolset had not been built at that stage of the project. The previously mentioned Studio Wikitecture example, when three screens were used in conjunction with a simulated face-to-face meeting, also highlighted the requirement for better real-time explicit tools to assist in the communication of ideas. The researcher recognised this and experimented with real-time screen-sharing and meeting tools such as dimdim and Sloodle's Presenter and Chat logger, and social network software such as Elgg, Twitter and Facebook. Linden Lab recognised that cyborgs wanted to be able to share information in real time and developed 'web on a prim' that allowed web information to be viewed and interacted with by multiple cyborgs together. The limited ability to interface with external applications and SL's shortcomings as a data storage and retrieval environment suggested experimentation with screen-sharing web applications, web on a prim, and wikis within the *Design 2029* office. However, this not only required further learning of complex applications but also a willingness on behalf of a team to use explicit knowledge tools within a predominantly graphical design ecosystem (Panteli, 2009).

For a design to be regarded as an innovation it must be widely accepted and have active users, described as Phase 4 or the hive phase in the indosymbiotic innovation life cycle. The lack of success of the Sprinkle Server was largely due to a lack of promotion or use by the design and development communities. In the hive phase the host finds and rewards others to feed the inogism in a micro-community or a hive of five to seven parents – a micro-community is an effective way to develop an innovative idea as different parents take on different well-defined but fluid roles. Without this micro-community, a design innovation or inogism is unlikely to develop further and be adopted by lead users (Hippel, 2005; Von Krogh et al., 2000). The value of the design innovation must be recognised by a hive, even if it is free and open source. The utility of the innovation must be understood and recognised and this requires promotion and knowledge activism (Goldman & Gabriel, 2005; Hippel, 2005; Lessig, 2008; Von Krogh et al., 2000). The Sprinkle Server failed to attract a micro-community which would use it to benefit further innovations and development of the WikiTree.

Design 2029 employed a vision of a future scenario in order to attempt to build a community, however the ability of a designer to create and their receptivity to new ideas is very much dependent on the designer's existing skills, levels of knowledge, and team leadership (Johansson, 2004; Von Krogh et al., 2000). In the early phases of the *Design 2029* inogism there was good momentum and it managed to prepare a lot of groundwork before it began to slow down and the project eventually went into hibernation. During the incubation of the *Design 2029* inogism resources and nutrients were sought to assist its growth. This phase revealed a valuable lesson, because despite resources appearing to be available, the conditions of their use regulated and inhibited their necessary deployment. The *Design 2029* inogism went into hibernation due to the regulation of time and money which halted the inogism's progress at Phase 4 (see Figure 3) and inhibited the creation of a hive or micro-community of five to seven designers regulated by norms and the market modality. Important stakeholders who controlled the necessary resources had not been infected by the inogism and did not buy into the *Design 2029* knowledge vision. The flow of resources had stopped and so the indosymbiotic life cycle of the *Design 2029* inogism was therefore interrupted and could not mature beyond its early incubation phase.

6.2.2. The life cycle of the Studio Wikitecture inogism

Given that the life cycle of an inogim could take many years, the research for this thesis could not hope to observe a complete life cycle even if all the regulators enabled the necessary knowledge creation for an inogism to mature. The researcher did not participate in the early infection phase of the Studio Wikitecture group. The active research was confined to the initial phase of the Treet TV project and another project called Safe Trestles. Studio Wikitecture had matured beyond the early incubation and hive phases, and had on occasions reached Phase 5 (migration) when the founders of Studio Wikitecture had invited others to contribute their own inogisms to further evolve the project. The success of Studio Wikitecture projects such as the Nepalese medical centre design and the Founders Award had managed to get the inogism to Phase 5. However, Studio Wikitecture highlighted the difficulties of attempting to achieve the critical mass for an inogism to achieve colonisation. Two dominant cybernetic regulators inhibited the inogism's life cycle: the normative modality and the software architecture of the WikiTree. Studio Wikitecture cyborgs gathered together to consider how they could increase designer engagement in projects and discuss the norms that would enable knowledge creation and design innovation. The low spectrum of fidelity in SL inhibited the prerequisite tacit knowledge exchange and the necessary emotional bandwidth for an inogism to mature, and without a critical mass of passionate lead users the inogism failed to attract enough software developers who could provide the software architecture to support an evolved design innovation ecology. While some of the founders and lead users attempted to manage sustained conversations with WikiTree users, the low level of fidelity probably required much more time and effort than might have been needed if the fidelity had increased the tacit knowledge flow to those users. During the Safe Trestles project the researcher only attended a couple of simulated face-to-face meetings when the inogism was discussed and no clear knowledge vision emerged to assist in the future evolution of the Studio Wikitecture architecture. It became apparent that this was a considerable task and would take time and focused effort. It did not appear that the Open Source WikiTree project was evolving and the *Design 2029* mashup was stalled when the project ran out of time and resources for the inogism to evolve. Studio Wikitecture was more advanced than *Design 2029* in its indosymbiotic life cycle but also only exhibited a narrow phase during the research.

6.2.3. The life cycle of the Sloodlers inogism

The most evolved and advanced inogism of the three case studies was the Sloodlers group. It had managed to attract a significant membership and at the time of writing was about to progress to the second generation of Sloodle tools. Of the three case studies, the strongest normative bonds were exhibited by the Sloodlers group who met regularly in a virtual meeting space in the sky in SL. The Sloodle developers were comprised mostly of educational developers who passionately believed in the ‘constructivist’ ability of SL to enable knowledge creation among students. Developers who had successfully gained funding from a UK government education fund and were looking to provide educators and education developers with the tools to progress Sloodle led the members of the group.

This group shared a vision for education and Sloodle in SL, and had evolved over time into a community that shared tacit norms of behaviour and attitude. Some members of the Sloodlers group had also met face to face which has found to help strengthen relationships and increase trust (Rheingold, 1993). A freelance developer who had contributed many new tools and code to the Sloodle project had been 'infected' by the vision of the Sloodlers group and had accepted the group's open source philosophy, as well as its educational purpose. It must also be noted that as the freelance developer was a 'gun for hire' they were also motivated to accept the knowledge vision of the Sloodlers group. Financial incentives can help to align team members with the strategic vision of a group, however this is often not the only, and often not the most important, incentive to accept community norms (Ghosh, 2005a; Reeves & Read, 2009). *Design 2029* illustrated the importance of an early infection of a host by an inogism. The Sloodlers case study provided further evidence that without sufficient time and resources early infection is unable to fully incubate and mature. The norms of the group were well understood and there appeared to be a strong knowledge vision directing the lead users, developers, and education cyborgs amongst the Sloodlers. This group had reached Phase 6 (colonisation) stage and was populating other hives with its inogism. Design innovation amongst the Sloodlers was continuing to evolve, although the future is uncertain as the popularity of SL will inevitably decline to be replaced by another virtual world making it harder to spread their inogisms. The critical mass of Sloodlers provided a bigger pool of cyborg lead users and designers who could contribute to the evolution of the inogism.

The Sloodlers case study also helped to identify that an inogism did not necessarily have to progress through each phase in order to complete the indosymbiotic life cycle. This also occurred in the Studio Wikitecture group when it was apparent that individual projects had evolved the inogism and could exhibit features of the colonisation phase when new members came in to contribute design innovations to those individual projects such as a new feature of a construction but without design collaboration on the WikiTree toolset. The Sloodlers also managed to evolve from Phase 6 (colonisation) to Phase 9 (mitosis) when the software developers evolved the Sloodle software to 2.0. This was achived without going through Phase 7 (globalisation) and Phase 8 (universalisation) which would have presented the Sloodle toolset to a much larger community, and possibly even a breakthrough design inogism. Indosymbiosis was not only non-linear but the research suggested that one phase did not necessarily need to lead to the next. The virtual design innovation ecology was non-deterministic even when certain regulators were enabling knowledge creation in design. The less than optimum fidelity of SL regulated a certain level and speed of design innovation, however a much higher fidelity could have led to an inogism that exhibited breakthrough features due to enhanced tacit knowledge creation in a virtual design ecology beyond the capability of an actual face-to-face environment. This biological model is non-deterministic and acknowledges the contribution of stochastic chance due to the complex intersections of communities in the life cycle of a design innovation (Capra, 1983b; Johansson, 2004; Margulis, 1970; Margulis & Sagan, 1997; Wolfram, 2002). Technological evolution is part and parcel of greater cybernetic laws that relate to evolutionary complexity theory and how human biology and society contribute to complex adaptive systems. Human design innovation can thus be explained within this universal innovation epistemology (Kurzweil, 2005; Laszlo, 1987, 2007; Margulis & Sagan, 1991, 1997; Skoyles & Sagan, 2002). However, individual creativity is not seen here as unitary and isolated from the community of ideas but is what Bateson and Donaldson (1991) called the ‘ecology of mind’. In SL, and the three case studies researched here, the communities are sub-sets of the greater ecology and are not neat units of analysis but ‘messy’ liminal boundaries that are like semi-permeable membranes, constantly passing new ideas backwards and forwards with other communities, both inside and outside of SL.

The normative ecology of SL provided the initial context for the infection of the researcher and others who participated in the *Design 2029* inogism. It is not practical to describe all of these inogisms, although some have been mentioned in the Literature Review. *Design 2029* incubated after the researcher's initial infection and proceeded through the first few phases of the indosymbiotic life cycle. The cybernetic flow of knowledge is regulated, in part, by the norms of those communities and enabled through a context, or cyber ba, communicated through simulated face-to-face meetings and prolonged conversations (Hussi, 2003; Leonard & Swap, 2004; Rive et al., 2008; Von Krogh et al., 2000). The ability of SL and the cyborgs to simulate face-to-face meetings could be seen to have a regulatory impact on *Design 2029*, and depended heavily on the spectrum of fidelity and how closely the cyber ba of SL managed to simulate the subtle nuance of an actual meeting (Botella et al., 2003; Riva et al., 2007). According to Bailenson et al. (2004), cyborgs in a virtual environment that simulate mutual gaze, mimic or communicate facial expressions and gestures, and simulate naturalistic body language can be more persuasive than in an actual face-to-face meeting (see also Beall et al., 2004; Davide & Walker, 2003; Deng et al., 2006; Yee et al., 2007). However, *Design 2029* and the other case studies appeared to suffer from a low spectrum of fidelity with regard to normative face-to-face infection and the ability of one cyborg to convert another through knowledge activism. It should also be noted that other researchers have found that social presence can overcome the limitations of a low spectrum of fidelity that does not closely simulate a physical presence (Botella et al., 2003; Mantovani, Agliati, Mortillaro, Vescovo, & Zurloni, 2006; Yee et al., 2007). Social presence is heavily dependent on the ability to form strong communities and once again *Design 2029* suffered because normative infection is most effective when it most closely simulates a physical face-to-face meeting. The willingness to suspend disbelief was observed to correlate with the amount of time and energy a cyborg invested in SL, with an obvious persistence of social norms from their actual experience as opposed to SL (Boellstorff, 2008; Schroeder, 2002; Yee et al., 2007). Cyborgs continually blurred social norms that were part of their physical daily experience with those of the virtual world. These norms could be as simple as interpersonal distance between avatars or more complex behaviour such as relationship building.

In the four years of research numerous examples were observed of cyborgs new to SL who struggled with the computer interface and who were either put off and failed to return or found new friends in SL who helped them to use the tools and find their way around the world (Rive et al., 2008). There appeared to be a threshold of engagement in SL that depended on a cyborg's knowledge of the interface, normative commitment to community standards, and the friends they made in SL. The normative challenge for all three case studies was in community-building and regular communication between the cyborgs. The architecture of SL provided tools for the groups to meet and communicate together in virtual face-to-face meetings, however as the avatars lacked the ability to communicate the real-time facial expressions and gestures of their cyborg controllers, the tacit knowledge creation was regulated by a lack of strong normative bonds within the groups (Rive et al., 2008). Normative infection requires high emotional bandwidth that is conveyed via high sensory bandwidth. The emotional bandwidth of SL was further regulated by the architecture and the technical limitations of the interface. As SL suffered from a low spectrum of fidelity with regard to emotional bandwidth, the capacity to develop strong normative bonds and trust within *Design 2029* and the other case studies also suffered.

Design innovation requires designers to have deep tacit knowledge of their subject and often involves design tools that are esoteric (Bartle, 2004; Dixon, 2000; Leonard & Swap, 2004; Mau et al., 2004; Shavinina, 2003). In late 2006, 15 percent of residents in SL were experimenting with scripting every week (Ondrejka, 2008). While this percentage is considerably higher than the number of people who have attempted to build their own website, it still limits the pool of designers capable of manipulating the SL architecture. The life cycle of an inogism is therefore closely bound to the requisite knowledge of the designer and the design team. The three case studies all required designers who could write and understand LSL. In addition to that, each of the projects required the setting up and maintenance of website support in the form of HTML and a wiki. There were further requirements for the Sloodle project to establish a Moodle site and server hosting. The establishment of version control software and knowledge of how to use client software were necessary for those who were contributing code to the repository. In any design team there are designers with different skills and knowledge. It is not, therefore, necessary that every designer have knowledge of software development and software development tools. However, in all three case studies the more software development knowledge the designers had, the faster the indosymbiotic life cycle progressed. With limited resources and limited knowledge of software development the creative collaboration on the projects was constrained due to the architectural requirements of the design innovation ecology.

As hardware becomes software and software becomes hardware the toolkit required for design innovation will rapidly expand, putting greater pressure on education and professional organisations to keep up with software development tools in design innovation (Highsmith, 2004; Mau et al., 2004). Close attention needs to be paid to the architecture of the hardware and software as it has a significant impact on the regulation of design innovation. That architecture is underpinned by the other modes of regulation and is influenced and influences the enablers of knowledge creation and creative collaboration. Architecture and the law are two modes that closely interact to determine the indosymbiotic life cycle of design innovation. For example, in order for the WikiTree to work with co-designers all the objects in the build had to be fully shared with everyone in the group. In this case the DRM slowed the flow of the inogism and the life cycle of indosymbiosis due to the complexity and the control of copyright ownership. In the first few phases of the inogism's life cycle in SL the law and the code can be seen to regulate the behaviour of participants in the design innovation process.

The model of indosymbiosis describes the ecology of design innovation in SL. In Phase 1 an individual designer is infected with an idea through imitation, similar to Dawkins' theory of memes (Blackmore, 1999; Dawkins, 1976). The legal status of that idea will influence what happens to that idea next. If the infected recipient is aware of the legal status of a inogism this can give them a clear choice about what to do with it next. Ambiguity and uncertainty with regard to the law and IP can slow or even halt the indosymbiotic life cycle (Lessig, 2004, 2008). Trade secrets, copyrights, trademarks and patents can all prevent or enable knowledge exchange and is part of a complex adaptive life cycle that includes Lessig's other three modalities of norms, architecture, and the market.

The incompletion of *Design 2029* provided valuable research data and suggested some possible areas for improvement and further research into the design innovation ecology in SL. The indosymbiotic life cycle of design innovation is a complex adaptive system that depends on feedback from the participants in the design ecology. The norms of those communities are in turn regulated by the market, architecture, and law governing the context of a virtual design ecology. These cannot depend on actual face-to-face meetings but rather the spectrum of fidelity and a simulation of those meetings to ensure the maximum emotional bandwidth to the participants in the design teams in order to provide the best possible context for design innovation. The software, and hardware architecture of SL both reflect and reinforce the norms that are held by the cyborgs in SL.

Following the review of the research data there was an attempt to integrate Lessig's model of cybernetic regulators with indosymbiosis showing the different stages of the inogism's life cycle and how Lessig's cybernetic regulators can enable or inhibit the metabolic pathway of the design process. This revised theoretical framework has suggested future areas of research for design innovation in a virtual symbiotic ecology and what would enable knowledge creation and collaboration amongst self-organising design teams in virtual worlds such as SL. Figure 13 is a revision of the sketch in Figure 4 and incorporates the original model of indosymbiosis with the integration of Lessig's four cybernetic modes of regulation. This describes how during each phase of an inogism's evolution through its life cycle it can be inhibited or enabled before it might progress to the next stage of maturation or stop, only to progress when the prerequisite conditions are right. The research findings contributed to this revised model and suggest further areas for exploration.

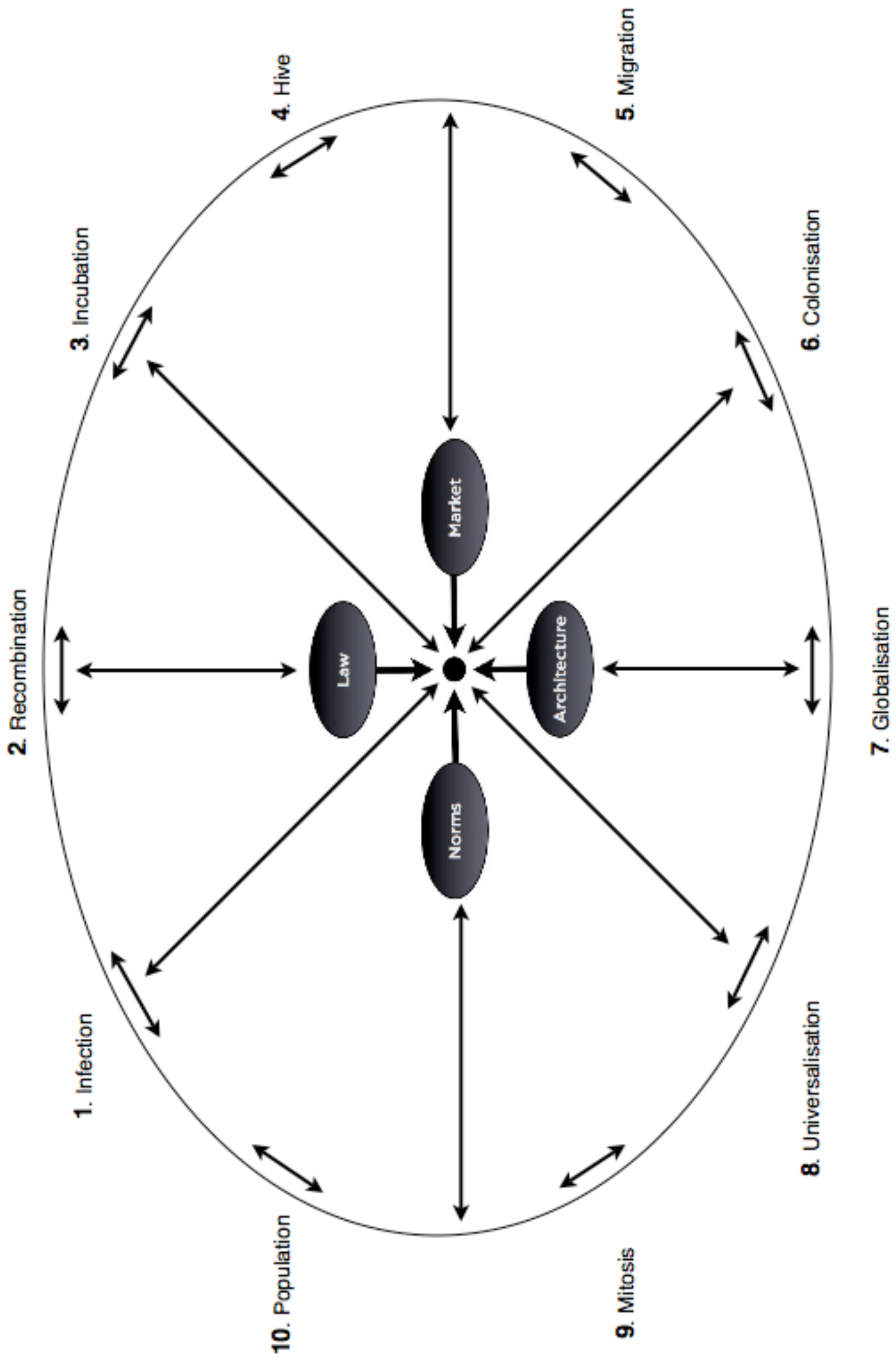

Figure 13. Revised indosymbiosis life cycle with regulators

7. CHAPTER 7
FUTURE RESEARCH

7.1. Overview of future research

This research applied a cybernetic systems approach to design innovation in a virtual ecology. The following proposition was put forward:

> *In order to design a virtual design innovation ecology, cybernetic regulators must provide feedback and will either enable or inhibit design collaboration and knowledge creation in SL.*

To understand and explain how design innovation and knowledge creation is regulated the indosymbiosis model was created to explain the knowledge life cycle of an inogism, or a cybernetic design innovation organism, a self-replicating innovative idea with a life cycle determined by a knowledge vision and a final maturation described by a successful user ecosystem. The revised indosymbiotic model provided a useful way of understanding the cybernetic regulation of design innovation and identifying future opportunities for research. The obvious limitation of this research was that the amount of time dedicated to the three case studies was insufficient to consider an entire indosymbiotic life cycle. The fragmentary nature of this cyber-ethnographic research also illustrated the difficulty of applying a systems approach to knowledge creation. Only the *Design 2029* case study could examine an inogism from Phase 1 (infection) of the life cycle. The Sloodlers and Studio Wikitecture groups were both well evolved when the data was collected, and the inability of *Design 2029* to engage those case studies prevented an opportunity to research any acceleration in indosymbiosis.

7.1.1. Further market research for *Design 2029*

Design 2029 was devised to have a definitive end point with a winning team decided by the Sloodle points system. However, the prize money was only intended to provide the cyborg participants with an incentive to engage in the first round of the game. It was the intention of the developers of *Design 2029* to provide a self-replicating and self-improving design innovation organism that would continue after the game was concluded. The indosymbiotic life cycle of the cybernetic inogism could continue indefinitely, and could even break out of SL to infect other virtual worlds and knowledge spaces beyond the current ecology. Further market research of the *Design 2029* inogism could be afforded by this breakout and self-replication within SL. Qualitative and quantitative data would be continually collected and could provide further opportunities for analysis and interpretation of data. This chapter will pull together an analysis of the component parts that are necessary to design a virtual innovation ecology. It will consider the central research question as a holistic cybernetic system that draws from the ethnographic case studies and Lessig's four regulators; Von Krogh's knowledge creation enablers (2000); and a synthesis of these in the revised indosymbiotic life cycle. Lessig's four cybernetic regulators operate as four interrelated modes in a cybernetic approach to knowledge creation and creative collaboration in design. This in-depth analysis of how norms, the market, architecture, and law regulate knowledge flow and creativity with reference to ethnographic case studies within SL was intended to elucidate perceived gaps in the Von Krogh et al. (2000) theory of what enables knowledge creation and tacit knowledge in the Nonaka and Takeuchi (1995) SECI model of innovation. The indosymbiotic life cycle is a synthesis of the earlier models in order to interpret the data of the ethnographic case studies and answer the primary research question – How to design a virtual innovation ecology? – by applying second-order cybernetics to knowledge creation and creative collaboration.

7.1.2. Enabling norms in *Design 2029*

Von Krogh et al. (2000) have emphasised the importance of tacit knowledge in knowledge creation and innovation present three premises of knowledge creation:

- Knowledge is justified true beliefs, individual and social, tacit and explicit.
- Knowledge depends on your perspective.
- Knowledge creation is a craft, not a science. (2000)

The social aspect of knowledge is vitally important in establishing a design innovation project and this requires Von Krogh et al.'s (2000) first knowledge enabler, a knowledge vision.

This complements Lessig's normative modality and requires solutions that consider how to enable this regulator in order to increase the flow and speed of design innovation in SL. *Design 2029* must first address the normative function of a knowledge vision in order to enable tacit knowledge creation and design innovation in SL. Trust, reputation and reciprocity are all normative features that can help to build a community that will share a common knowledge vision and build good relationships amongst the design teams which will encourage tacit knowledge sharing. In the words of Von Krogh et al. (2000), 'the ways in which people interact – cooperative sharing versus competitive hording, "join us" versus "not at my table" – strongly affect the distribution of tacit knowledge' (p. 45).

Design 2029 requires a manifesto that will outline the knowledge vision and justify the belief that public knowledge sharing can be a more effective means of knowledge creation and design innovation than competitive knowledge hording. That manifesto would communicate the vision to key stakeholders and potential sponsors of the project who would be presented with a business case to support their commitment of resources including knowledge, cyborgs, time and money. This manifesto should represent a 'rousing and comprehensible goal' that informs the game participants of the context of the game and conveys a future scenario that engages the imagination of the players and is supported by a narrative and game devices, including positive cybernetic feedback for those that share knowledge and innovative designs that are rewarded (Hunter, 2008; Hussi, 2003). The manifesto and game rules of *Design 2029* will also inform the players of their game strategy and how they can win by sharing knowledge and gaining positive feedback for their design innovation. Von Krogh et al. (2000) outline five steps to achieving knowledge creation in an organisation and these steps could be detailed in the manifesto as a suggested game strategy for the informal, self-organising design teams in SL:

- sharing tacit knowledge
- creating concepts
- justifying concepts
- building a prototype
- cross-leveling knowledge (Von Krogh et al., 2000)

A successful inogism will become a self-replicating innovation that publicises the increases in intellectual, social and human capital in support of the Hussi (2003) model. In the *Design 2029* game this will be made explicit to the players through the Sloodle Awards System and their scores will reflect their increase of intellectual, social and human capital. The reputation of the most active knowledge creators and design innovators will be publicised in the Hall of Fame with a dynamic script that will place the profile pictures of the leading cyborgs in the picture frames in the hall, and these will be connected to the Sloodle Awards System. This was devised to provide positive feedback to those that are successful in executing the game strategy outlined in the manifesto. The *Design 2029* knowledge vision requires further enablers such as active knowledge activists who could illicit support and attract sufficient resources for the project. In order to create a sustainable inogism the knowledge vision must be shared and maintained by the stakeholders and knowledge activists. Once the inogism has infected the host knowledge activists, they will be responsible for the ongoing promotion of *Design 2029* and the knowledge vision expressed in the game manifesto. In order to encourage self-replication and eventual hive migration of one inogism to another the game must be fun and rewarding for the designers and players.

7.1.3. Further normative research for *Design 2029*

Design 2029 was designed to be a self-regulating design innovation game, or inogism. The game strategy for *Design 2029* could be regularly reviewed and revised based on the lessons learned from early gameplay and feedback from the design teams. In the case studies there was some ambiguity surrounding the motivation of individual group members. While the design goals appeared to be identical, hidden agendas could mask the true motivation of individual designers and the extent that that motivation aligned with the knowledge vision could have impacted on the success of a design innovation. It is possible that an individual design team member is more concerned with achieving a good grade or pay bonus than a sincere belief in a shared design vision, and this requires further research (Lencioni, 2002; Reeves & Read, 2009). Also required is research into how to align the cyborg's motivation with the knowledge vision, and whether that is important to the outcome of a design innovation. The first requirement would be to integrate the Sloodle Awards System to provide metrics of game engagement and the desired objectives of increased social, intellectual and human capital. The awards system and the Hall of Fame would provide tangible cybernetic feedback to the game developers and participants as to whether the inogism is alive and thriving or dying and failing. Regular interviews with informant players and developers would provide data that would inform researchers of the efficacy of *Design 2029* and the inogisms that are released. Focus groups and surveys could also provide research data about the degree of engagement and perceptions of the knowledge vision. Further improvements to SL, new virtual worlds, and the latest trends in computing could further support an improvement of the spectrum of fidelity and the ability to simulate face-to-face meetings, with a possible increase in tacit knowledge exchange and emotional bandwidth through enhanced emotional communications. This would provide an important opportunity to research the correlation of the improvement of the spectrum of fidelity and greater tacit knowledge exchange.

7.2. Enabling architecture in *Design 2029*

The normative enablers of *Design 2029* must be supported by the architecture of the game design within the cyber ba, or virtual knowledge space in SL. Lessig (2006) recommended that the SL architecture support open protocols. The case studies also suggested that DRM can perform a useful task in supporting normative attitudes to knowledge sharing, ownership, and content management.

The *Design 2029* architecture should provide the players with an assurance that their copyright will be protected, and that the metadata embedded in the inogism will be recorded and remain intact. Ownership of knowledge and the means of externalising tacit knowledge amongst design teams is not mutually exclusive to knowledge sharing and the knowledge vision of *Design 2029*. The architecture of the game should track and trace ownership, contributions, and the metrics of ideation (velocity and volume) in order to support the cybernetic feedback of the inogism. This architecture would be integrated with the WikiTree and replace the binary voting system currently in place. The WikiTree could become a part of the Sloodle learning management system and the Sloodle Awards System could become a module of the WikiTree. This would require development resources prior to the launch of the game in order to support the game rules and provide feedback to players and developers. The integration of the Sloodle Awards System and the Studio Wikitecture WikiTree would provide valuable research data about design innovation and the ecology of SL. The collection of quantitative and qualitative data from player and designer engagement could inform further research and prototype development of future *Design 2029* architectural improvements. Thus the operation of the game could provide a self-improving feature and help to sustain the *Design 2029* inogism. The game would provide further research prospects for researchers who could modify and add to the original architecture in order to extract new data and metadata in support of unexpected research questions arising from *Design 2029*. The architectural integration of *Design 2029* would provide a useful tool for design education and praxis that would stimulate further research questions. A more ambitious area for architectural research could be the redesign of the SL permissions system that could include an easy-to-use and understandable Creative Commons licensing device. This would provide research data to inform research questions into the effect of copyright perceptions and design innovation.

7.3. Enabling the laws and codes of *Design 2029*

The inclusion of an easy copyright licensing device such as Creative Commons would provide *Design 2029* players and developers with some certainty around the ownership of their creations and their contributions. This would be supported by the knowledge vision and architecture built into the *Design 2029* game. The mashup of the Creative Commons licensing and SL permissions system could enable more remixing and knowledge sharing amongst design innovators in SL (Lessig, 2008). The software codes and scripts of *Design 2029* should provide further support to the legal and normative aspects of the game's inogism. The recognition of multi-jurisdictional players presents a complexity that could possibly be overcome by each cyborg deciding what Creative Commons license and jurisdiction to apply to their creation.

7.3.1. Further legal research for *Design 2029*

The legal status of virtual worlds and cyberspace is uncertain and dynamic. The default legal position of many games and virtual worlds such as SL are the Terms of Service and End User License Agreements. In the case of *Design 2029* and SL the legal regulation of this knowledge space is further determined by US federal and Californian laws, including the DMCA. Legal experts could further research the possibility of replacing US laws with localised Creative Commons licenses and dispensing with the DMCA which is regarded by many to be an inhibitor of design innovation.

7.4. Enabling markets in *Design 2029*

In SL the market modality is heavily influenced by the normative mode of the community and the extended innovation ecology, including the customers, the management, designers, and other stakeholders. The manifesto of *Design 2029* could outline the normative enablers of the game, reinforced and supported by the game's architecture, code and law, and a shared knowledge vision of the game's knowledge economy. The knowledge and talent markets of *Design 2029* would be derived from the original knowledge vision outlined in the manifesto and detailed in the game's strategy. The manifesto could state that the *Design 2029* game was a non-priced-based knowledge exchange that tracked and traced the velocity and volume of knowledge sharing and creation amongst the players and design innovators. These market enablers would encourage knowledge creation by acknowledging the principle that intellectual capital and property are distinct from physical property and can be increased in value by sharing. *Design 2029* could provide a prototype for self-organising talent and knowledge markets in design praxis and education.

7.5. Future scenarios

Future scenarios are important in the design innovation process and provide designers with knowledge visions and conceptual futures as a context for new and improved designs (Von Krogh et al., 2000). While these can appear speculative, and even fanciful, they release the imagination and powerful creativity that are necessary for design innovation. The Agile design innovation approach advocates open innovation; the virtualisation of physical objects; simulations; and the abstraction of the physical through digitisation and software (Highsmith, 2004). Technologists such as Kurzweil (2005) have used trend analysis, and projections to predict the innovative future evolution of computing and biotechnology. Kurzweil has predicted a convergence of computing, nanotechnology and biotechnology that will see a transition from the current state of virtual worlds to verisimilitude before the end of the current decade, and from there to invisible neural implants that will provide synthetic sensory stimulus to the synaptic nerves, thus completing the promise of VR and the nanotechnology of Drexler's (1986) *Engines of Creation* (Kurzweil, 2005). According to this perspective, it will be possible to create a virtual world which includes all the sensory inputs with the veridical illusion of the actual world to the far right of the spectrum of fidelity. There are already brain-control interfaces that allow interaction between thought and virtual and physical interactivity (Knops & Bühler, 1999). NASA designer Storrs-Hall has created blue-prints for flying nanobots that can represent and physically emulate actual objects or visual 3D simulations through a 'utility fog', operating as a continuous bridge between the physical and the virtual worlds. Storrs-Hall has concluded this design is already theoretically possible (Crandall, 1996; Kurzweil, 2005). The utopian potential of these visions is counterbalanced by the dystopian warnings of Bill Joy, who fears the potential loss of privacy and the danger of self-replicating nanobots that could consume the Earth's resources (Garreau, 2005).

As controversies over privacy concerns in social networks such as Facebook have shown, there is great potential for abuse, and this will become even more poignant in virtual worlds. The great promise that immersive virtual worlds offer has to be considered against the backdrop for the potential for abuse; researchers have shown the ability of avatars to be persuasive through subtle body mimicry and the mixing of facial features to match the person that they are talking to (Bailenson, Beall, Loomis, Blascovich, & Turk, 2004; Yee, Bailenson, Urbanek, Chang, & Merget, 2007). Bailenson et al. (2004) warn us about the potential misuse of this technology by unscrupulous marketers and politicians. Merging this technology with general AI could result in cyborgs who are more effective, and persuasive with their communications and design innovation in these virtual worlds (Goertzel, 2007; Moon, 2008). The more virtual worlds interact with the actual world and provide seamless and intuitive knowledge creation with full sensory participation using ultra-high-fidelity models, the more design innovation will progress beyond the current limitations of purely physical design. Converging with virtual worlds are mirror worlds that are simulations of actual animals, objects or events using remote sensing. When this convergence is also mixed with the growing trend of 'life-logging', or recording an individual's activities using cameras, implants, and other sensing devices, then there exists huge opportunities for design innovation, as well as unethical abuse (Cascio & Paffendorf, 2007). Radio-frequency identification (RFID) technology and Internet Protocol version 6 (IPv6) will enable the tagging and tracking of almost everyone on the planet, as well as synthetic and natural objects that can be simulated in virtual worlds and even interact through remote sensing. Projects such as Virtual Australia involve the systematic tracking of all non-trivial objects and their contextual environment 'from blue sky to bedrock', thus making it possible to remotely sense, simulate, and ultimately interact with the physical world from the virtual (Onsrud, 2007).

All of this future technology will make it important that we learn further lessons in international communications and design innovation from early virtual worlds such as SL. It is argued here that SL provides useful tools and lessons for design teams and international collaborators to work together on innovative projects and that design education can play a major role in introducing virtual worlds to design practice. More research is required into the strengths and limitations of this rapidly developing technology.

APPENDIX

The Evolutionary and Biological Model of Design Innovation

It is useful to describe the evolutionary theory that challenges the Darwinian assumption that underpins some models of design innovation. Second-order cybernetics, emergence, bio-feedback, systems and complexity theory have reformulated evolutionary theory to suggest that natural selection does not simply arise from chance (Laszlo, 1987, 2007). The evolutionary biologist Lynn Margulis has criticised neo-Darwinists such as Dawkins, who wrote *The Blind Watchmaker* (1986), for their mechanical reliance on mathematics, chemistry, and physics to explain evolution. Margulis, who originally struggled to have her theory of endosymbiosis accepted by mainstream science, eventually had large parts of her evolutionary theory of symbiotic microorganisms validated by scientists, including Dawkins (Margulis & Sagan, 1997). Margulis argued that microbes have been essential to evolution and are the invisible network that binds all life here on Earth:

> Without microbes, life's essential processes would quickly grind to a halt, and Earth would be as barren as Venus and Mars. Far from leaving microorganisms behind on an evolutionary ladder, we are both surrounded by them and composed of them. The new knowledge of biology, moreover, alters our view of evolution and chronic, bloody competition among individuals and species. Life did not take over the globe by combat, but by networking. Life forms multiplied and grew more complex by co-opting others, not just by killing them. (Margulis & Sagan, 1997, p. 78)

The evolutionary biologists Matruana and Varela (1992) support this view; they argue that knowledge comes from activity and social interaction, and not from hyper-individualist competition. A number of other second-order cybernetic theorists have applied these biological evolutionary models to technological evolution and design innovation (Kelly, 1994; Kurzweil, 2005). The need for an evolutionary approach to innovation arose from the failure of neo-classical economics to explain dynamic qualitative changes that are the internal features of technological innovation (Marinova & Phillimore, 2003). Hodgson has argued that the weakness of a mechanical model is that economics applies to biological, not mechanical, creatures, i.e. humans (Hodgson, cited in Marinova & Phillimore, 2003). The mechanistic view of the universe handed down to us from the 16th century and the clock metaphor has left us still in its debt 400 years later (Capra, 1983b; Rifkin, 1991).

Sixty years of cybernetic theory has seen many variants of what amounts to an exceedingly complex interdisciplinary field in which not all followers agree on all matters (Turner, 2006). This is especially true of evolutionary biology and the application of information theory to genetics and vice versa, (Margulis, 1970; Margulis & Sagan, 1991, 1997). The simplistic mechanical analogy of the human brain to information circuitry that was suggested by Wiener (1954) and his colleague Dr Ray Ashby and the emphasis on the role of mutational variance by the likes of Dawkins has perpetuated this approach (Dawkins, 1976, 1986). However, as computing moved away from an obvious mechanical substrate, some cybernetic theorists, such as Stewart Brand and Kevin Kelly, picked up on the work of humanists like anthropologist Gregory Bateson (Turner, 2006). This more complex biological approach to communication theory and social networks was blended with techno-mysticism that envisioned humanity as a ‘hive mind’ and the Internet as a ‘global brain’, a technological mirror of fundamental quantum truths (Turner, 2006). The charge was led by writers such as Brand, and later Kelly, and John Perry Barlow, who merged cybernetics with evolutionary theory that described the Internet as a self-organising, complex adaptive organism (Turner, 2006).

The mechanical model was more deeply critiqued by physicist and Buddhist Frijof Capra, who blended quantum theory with Eastern philosophy that showed the interconnectedness of the universe and the deep organisational energies that produce a universal ‘mind’ and a human brain in its own image (Capra, 1983a, 1983b). Capra’s book was followed in 1994 by the immensely popular *Out of Control*, written by WELL intimate and *Wired* editor Kevin Kelly, who wrote, ‘The apparent veil between the organic and the manufactured has crumpled to reveal that the two really are, and have always been, of one being' (Turner, 2006, p. 200).

Some biologists and evolutionary theorists still tend to suffer from a reductionist, mechanical perspective, and this in turn has coloured innovation theory and knowledge management practices. Holistic system theorists such as James Lovelock, Margulis and Capra have criticised this mechanistic approach that has shaped the neo-Darwinist school of Dawkins et al. (Capra, 1983b; Dawkins, 1976; Lovelock, 1979; Margulis & Sagan, 1997). Margulis has also criticised the Dawkins concept of the 'selfish gene' saying it ignores endosymbiosis, or symbiotic evolution, and implies that rampant individualism and competition are the natural drivers of human evolution and therefore design innovation (Dawkins, 1976; Margulis & Sagan, 1997). Dawkins (1976), and later Susan Blackmore (1999), in the *Meme Machine* established the concept of the meme, which used the metaphor of a gene to explain the survival and propagation of an idea and culture.

Gary Hamel and others have applied the evolutionary model to corporate management structures, idea generation, and creating an enabling context for breakthrough innovations according to a theory of complex adaptive systems (Hamel, 2007; Marinova & Phillimore, 2003). As members of the new cybernetics, Margulis, Lovelock, and Maturana and Varela moved away from the mechanically deterministic model towards a living biological view of evolution, which is more symbiotic than aggressively individualistic.

Clippinger and Bollier (2005) argue that 'A growing body of evidence suggests that social trust and cooperation has been the enduring theme of human evolution' (p. 266). They describe three general lines of evidence:

- 'Social exchange is an 'evolutionarily stable strategy' (ESS) and thus the critical platform for cognitive development in humans' (p. 266). They explain that scientific studies have shown that the notion of 'reciprocal altruism' is showing strong evidence that it is an ESS. This has been shown to be a trait not limited to humans but common to other species such as bats, wolves, ravens, baboons and chimpanzees. Cooperative strategies in other species, they argue, are a compelling argument that it could be an ESS of humans.

- ‘Reciprocal social exchange is a highly specialised brain function critical to the rise of identity, community and culture’ (p. 267). They argue that social exchange is an instinctual response genetically encoded that enables humans to function as communities and results in behaviour such as reciprocity, social guilt, and trust. They quote the evolutionary biologist David Sloan Wilson, who wrote, ‘social groups become so functionally integrated that they become higher-level organisms in their own right’ (p. 267). Cognitive science has shown that we are hard-wired to empathise with others through the discovery of ‘mirror neurons’ (Clippinger & Bollier, 2005; ScienceDaily, 2007). The neurologist Damasio (2003) argues that social emotions have an identifiable physiology, and that the biological reality of self-preservation leads to virtuous behaviour because we would perish outside of social groups. Clippinger and Bollier (2005) argue that reciprocity and trust are therefore hard-wired and are an ESS.
- ‘The rational “free choices” that FMD (free market doctrine) considers a primary justification are in many instances reflexive social “flocking”’ (Clippinger & Bollier, 2005, p. 270). Cognitive science is revealing evidence that humans are not rational actors but behave according to cultural habits and generic predilections, especially influenced by an individual’s social environment (Blackmore, 1999; Clippinger & Bollier, 2005; Maturana & Varela, 1992; Riva & Waterworth, 2003).

The analogy between evolutionary design and innovation has been extended by writers such as MIT’s Henry Chesbrough, who argues that innovation is undergoing a Kuhnian ‘paradigm shift’, from competitive ‘closed innovation’ to shared ‘open innovation’, and that open innovation can assist in dramatically increasing the ‘metabolic rate’ of the innovation process (Chesbrough, 2003; Kuhn, 1970).

Second-order cybernetics provided a theoretical framework for understanding evolutionary epistemology and how a symbiotic interpretation of microbiology can also be applied to human and technological evolution. Heinz von Foerster, in a lecture on ‘Ethics and Second-Order Cybernetics’, quoted Wiener on cybernetic systems: ‘The behavior of such systems may be interpreted as directed to the attainment of a goal’ (Foerster, 1995b). The anthropologist Gregory Bateson wrote that ‘Cybernetics is a branch of mathematics dealing with problems of control, recursiveness and information’ (Foerster, 1995b). For Foerster (1995b) one central theme of second-order cybernetics is that of circularity. This recursiveness was also acknowledged by ethnographers such as Margaret Mead and Bateson and resulted in the ‘participant observation’ methodology. The second-order cyberneticists such as Foerster pointed out that it is impossible to remove the observer from the scene, and that thinking about thinking was ultimately recursive and required that the observer acknowledge their own presence. As Foerster (1995b) wrote, ‘it needs a brain to write a theory of the brain’. ‘Translated onto the domain of cybernetics: the cybernetician, by entering his own domain, has to account for his own activity; cybernetics becomes cybernetics of cybernetics, or second-order cybernetics.’ Thus the actual world is actually virtual.

BIBLIOGRAPHY

Abramson, B. (2005). *Digital phoenix: Why the information economy collapsed and how it will rise again*. Cambridge, MA: MIT Press.

Ackerman, D. (1990). *A natural history of the senses* (1st ed.). New York: Random House.

Anderson, C. (2006). *The long tail: How endless choice is creating unlimited demand*. London: Random House Business.

Architecture Working Group. (2008). Retrieved from http://secondlifegrid.net/programs/open_source/awg

Au, W. J. (2008). *The making of Second Life: Notes from the new world* (1st ed.). New York: Collins.

Bailenson, J. N., Beall, A. C., Loomis, J., Blascovich, J., & Turk, M. (2004). Transformed social interaction: Decoupling representation from behavior and form in collaborative virtual environments. *Presence: Teleoperators & Virtual Environments, 13*(4), 428-441.

Bailenson, J. N., Blascovich, J., Beall, A. C., & Loomis, J. M. (2003). Interpersonal distance in immersive virtual environments. *Pers Soc Psychol Bull, 29*(7), 819-833.

Bainbridge, W. S. (2007). The scientific research potential of virtual worlds. *Science, 317*(5837), 472-476.

Balkin, J. M., & Noveck, B. S. (2006). *The state of play:Llaw, games, and virtual worlds*. New York: NYU Press.

Ball, P. (2004). *Critical mass: How one thing leads to another.* New York: Farrar, Straus and Giroux.

Barras, C. (2008). Matrix-style virtual worlds "a few years away." *New Scientist*. Retrieved from http://technology.newscientist.com/article/dn13585-matrixstyle-virtual-worlds-a-few-years-away.html

Bartle, R. A. (2004). *Designing virtual worlds*. Indianapolis, IN: New Riders.

Bateson, G., & Donaldson, R. E. (1991). *A sacred unity: Further steps to an ecology of mind* (1st ed.). New York: Cornelia & Michael Bessie Book.

Beall, A. C., Bailenson, J. N., Loomis, J., Blascovich, J., & Rex, C. S. (2004). *Non-zero-sum gaze in immersive virtual environments.* Retrieved from vhil.stanford.edu/pubs/2003/beall-non-zero.pdf

Beckett, B. (2007). *Falling for science: Asking the big questions*. Dunedin, NZ: Longacre Press.

Bell, L., & Trueman, R. B. (2008). *Virtual worlds, real libraries: Librarians and educators in Second Life and other multi-user virtual environments*. Medford, NJ: Information Today, Inc.

Benkler, Y. (2005). Coase's penguin, or, Linux and the nature of the firm. In R. A. Ghosh (Ed.), *CODE: collaborative ownership and the digital economy* (pp. 169-206). Cambridge, MA ; London: MIT.

Benkler, Y. (2006). *The wealth of networks: How social production transforms markets and freedom*. New Haven, CT: Yale University Press.

Bennett, J., & Beith, M. (2007, July 30). Alternate universe. *Newsweek, 5*, 36-43.

Bertalanffy, L. v. (1979). *General system theory: Foundations, development, applications* (rev. ed.). New York: G. Braziller.

Bester, A. (1957). *The stars my destination*. New York: New American Library.

Biocca, F. (2003). Being there: Preface. In Biocca, *Being there: Concepts, effects and measurements of user presence in synthetic environments*. Retrieved from http://www.emergingcommunication.com/volume5.html

Blackmore, S. J. (1999). *The meme machine*. Oxford: Oxford University Press.

Boellstorff, T. (2008). *Coming of age in Second Life: An anthropologist explores the virtually human*. Princeton, NJ: Princeton University Press.

Boellstorff, T. (2009). Method and the virtual: anecdote, analogy, culture. *Journal of Virtual Worlds, 1*(3). Retrieved from http://journals.tdl.org/jvwr/index.php/jvwr/issue/view/70

Book, B. (2004). *Moving beyond the game: Social virtual worlds*.

Botella, C., Baños, R. M., & Alcañiz, M. (2003). *A psychological approach to presence*. Paper presented at the PRESENCE 2003, 6th Annual International Workshop on Presence. Retrieved from http://www.presence-research.org/papers/Botella.html

Bowers, C., Smith, P. A., Cannon-Bowers, J., & Nicholson, D. (2008). Using virtual worlds to assist distributed teams. In P. Zemliansky & K. St. Amant (Eds.), *Handbook of research on virtual workplaces and the new nature of business practices* (pp. 408-423). Hershey, PA: Information Science Reference.

Boyd, B. (2009). *On the origin of stories: Evolution, cognition, and fiction*. Cambridge, MA: Belknap Press of Harvard University Press.

Brand, S. (1974). *II cybernetic frontiers*: NY: Random House.

Brand, S. (1988). *The Media Lab: Inventing the future at MIT*. New York: Penguin Books.

Broderick, D. (1997). *The spike*. Port Melbourne: Reed Books.

Bruns, A. (2008). *Blogs, Wikipedia, Second Life, and beyond: From production to produsage*. New York: Peter Lang.

Bryan, L. L., & Joyce, C. I. (2007). *Mobilizing minds: Creating wealth from talent in the 21st-century organization*. New York: McGraw-Hill.

Bughin, J. R., Chui, M., & Johnson, B. (2008). The next step in open innovation. *McKinsey Quarterly, 4*, 112-122.

Campbell, J. (1971). *The hero with a thousand faces* (2nd ed.). Princeton, NJ: Princeton University Press.

Capra, F. (1983a). *The Tao of physics: An exploration of the parallels between modern physics and Eastern mysticism* (2nd ed.). Boulder, NY: Shambhala.

Capra, F. (1983b). *The turning point: Science, society, and the rising culture*. Toronto: Bantam Books.

Cascio, J., & Paffendorf, J. (2007). *Metaverse roadmap overview*. Retrieved from http://www.metaverseroadmap.org/overview/

Castells, M. (2000). *The rise of the network society* (2nd ed.). Malden, MA: Blackwell Publishers.

Castronova, E. (2003). *Theory of the Avatar*: Retrieved from http://www.cesifo-group.de/pls/guestci/download/CESifo%20Working%20Papers%202003/CESifo%20Working%20Papers%20February%202003%20/cesifo_wp863.pdf.

Castronova, E. (2004). Right to play. *New York Law School Law Review, 49*(1), 185-210

Castronova, E. (2005). *Synthetic worlds: the business and culture of online games*. Chicago: University of Chicago Press.

Castronova, E. (2007). *Exodus to the virtual world: How online fun is changing reality*. New York: Palgrave Macmillan.

Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Boston, MA: Harvard Business School Press.

Chown, M. (2007). *The never-ending days of being dead: Dispatches from the frontline of science*. London: Faber and Faber.

Christiansen, J. A. (2000). *Competitive innovation management: Techniques to improve innovation performance*. New York: St. Martin's Press.

Christiansen, J. K., & Varnes, C. J. (2007). Making decisions on innovation: Meetings or networks? *Creativity & Innovation Management, 16*(3), 282-298.

Clippinger, J., & Bollier, D. (2005). A renaissance in the commons: How the new sciences and the Internet are framing a new global identity and order. In R. A. Ghosh (Ed.), *CODE: Collaborative ownership and the digital economy* (pp. 259 -286). Cambridge, MA: MIT Press.

Coates, J. F. (2003). Future innovations in science and technology. In L. V. Shavinina (Ed.), *The international handbook on innovation* (pp. 1073-1093). Amsterdam: Elsevier.

Coghlan, D., & Brannick, T. (2005). *Doing action research in your own organization* (2nd ed.). London: Sage Publications.

The Compact Edition of the Oxford English Dictionary: Complete text reproduced micrographically (1971). Oxford: Clarendon Press.

Cooper, R. G. (2003). Profitable product innovation: The critical success factors. In L. V. Shavinina (Ed.), *The international handbook on innovation* (pp. 139-157). Amsterdam: Elsevier.

Cottone, P., & Montavani, G. (2003). Grounding “subjective views”: Situation awareness and co-reference in distance learning. In G. Riva, F. Davide & W. A. Ijsselsteijn (Eds.), *Being there: Concepts, effects and measurements of user presence in synthetic environments* (pp. 249-260). Amsterdam: IOS Press/Ohmsha.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Thousand Oaks: Sage Publications.

Csikszentmihalyi, M. (2004). *Creativity, fulfillment and flow* [Video file]. Retrieved from http://www.youtube.com/watch?v=fXIeFJCqsPs&feature=channel

Cutler, T. Venturous Australia: Building strength in innovation. Retrieved from http://www.business.nsw.gov.au/__data/assets/pdf_file/0016/5407/NIS_review_Web3.pdf

Damasio, A. R. (1999). *The feeling of what happens: Body and emotion in the making of consciousness* (1st ed.). New York: Harcourt Brace.

Damasio, A. R. (2003). *Looking for Spinoza: Joy, sorrow and the feeling brain*. London: Heinemann.

Davenport, T. H., Prusak, L., & Wilson, H. J. (2003). *What's the big idea? Creating and capitalizing on the best management thinking*. Boston, MA: Harvard Business School Press.

Davide, F., & Walker, R. (2003). Engineering presence: An experimental strategy. In G. Riva, F. Davide, & W. A. Ijsselsteijn (Eds.), *Being there: Concepts, effects and measurements of user presence in synthetic environments* Retrieved from http://www.neurovr.org/emerging/book4/4_03WALKER.PDF.

Davies, R. (2003). *Virtual reality hardware and software: complex usable devices?* Retrieved from http://www.emergingcommunication.com/volume5.html

Dawkins, R. (1976). *The selfish gene*. Oxford: Oxford University Press.

Dawkins, R. (1986). *The blind watchmaker*. Harlow: Longman Scientific & Technical.

Dawkins, R. (2006). *The selfish gene* (3rd ed.). Oxford: Oxford University Press.

de Nood, D., & Attema, J. (2006). *The second life of virtual reality*. 2007. Retrieved from http://www.epn.net

Dell. (2007, February 14, 2007). *Dell IdeaStorm Terms of Service and Guiding Principles*. Retrieved from http://www.dell.com/content/topics/global.aspx/policy/en/ideastorm?c=us&l=en&s=corp

Deng, Z., Bailenson, J. N., Lewis, J. P., & Neumann, U. (2006). *Perceiving visual emotions with speech*. Retrieved from vhil.stanford.edu/pubs/2006/deng-emotion-perception.pdf

Denzin, N. K. (1997). *Interpretive ethnography: Ethnographic practices for the 21st century*. Thousand Oaks, CA: Sage Publications.

Denzin, N. K., & Lincoln, Y. S. (2005). *The SAGE handbook of qualitative research.* Thousand Oaks, CA: Sage.

Dibbell, J. (1998). *My tiny life:Crime and passion in a virtual world* (1st ed.). New York: Holt.

Dibbell, J. (2006a). Owned!: Intellectual property in the age of eBayers, gold farmers, and other enemies of the virtual state. In J. M. Balkin & B. S. Noveck (Eds.), *The state of play: Law, games, and virtual worlds* (pp. 137-144). New York: NYU Press.

Dibbell, J. (2006b). *Play money, or, How I quit my day job and made millions trading virtual loot*. New York, NY: Basic Books.

Dixon, N. M. (2000). *Common knowledge: How companies thrive by sharing what they know*. Boston, MA: Harvard Business School; McGraw-Hill.

DMDN206. (2007). Design and the Internet [Web log]. Retrieved from http://www.mediazone.co.nz/blogs/DMDN206/?page_id=69

DOE/Lawrence Berkeley National Laboratory. (2009). Spontaneous assembly: A new look at how proteins assemble and organize themselves into complex patterns. *ScienceDaily*. Retrieved from http://www.sciencedaily.com/releases/2009/07/090708132820.htm

Drexler, K. E. (1986). *Engines of creation*. New York: Doubleday.

Dumitrica, D., & Gaden, G. (2009). Knee-high boots and six-pack abs: Autoethnographic reflections on gender and technology in Second Life. *Journal of Virtual World Research*. Retrieved from http://journals.tdl.org/jvwr/article/viewArticle/323

EFF. (2008). *Unintended consequences: Ten years under the DMCA*. Retrieved from http://www.eff.org/wp/unintended-consequences-ten-years-under-dmca

EFF. (2010). *Chilling effects of DMCA*. Retrieved from http://www.chillingeffects.org/copyright/

Emotiv. (2010). *Emotiv EPOC*. Retrieved from http://www.emotiv.com/epoc/

Engelbart, D. (2001). Augmenting human intellect: A conceptual framework (1962). In R. Packer & K. Jordan (Eds.), *Multimedia: from Wagner to virtual reality* (1st ed.) (pp. 64-90). New York: Norton.

Facebook Statistics. (2010). Retrieved May 25, 2010 from http://www.facebook.com/press/info.php?statistics

Farshchian, B. A. (2003). Presence technologies for informal collaboration. In G. Riva, F. Davide & W. A. Ijsselsteijn (Eds.), *Being there: Concepts, effects and measurements of user presence in synthetic environments* (pp. 209-222). Amsterdam: IOS Press/Ohmsha.

Firestone, J. M. (2008). On doing knowledge management. *Knowledge Management Research & Practice, 6*(1), 13-22.

Firestone, J. M., & McElroy, M. W. (2003). *Key issues in the new knowledge management*. Boston, MA: Butterworth-Heinemann.

Flick, U. (2006). *An introduction to qualitative research* (3rd ed.). London: Sage.

Florida, R. L. (2002). *The rise of the creative class and how it's transforming work, leisure, community and everyday life*. New York: Basic Books.

Florida, R. L. (2005). *The flight of the creative class: The new global competition for talent*. New York: HarperBusiness.

Foerster, H. v. (1995a). Constructions of the Mind: interview with Heinz von Foerster. *Stanford Humanities Review, 4*(2). Retrieved from http://www.stanford.edu/group/SHR/4-2/text/interviewvonf.html

Foerster, H. v. (1995b). Ethics and second-order cybernetics. *Construcitons of the Mind, 4*(2). Retrieved from http://www.stanford.edu/group/SHR/4-2/text/foerster.html

Fominykh, M., Prasolova-Fu00F8rland, E., Morozov, M., & Gerasimov, A. (2008). *Virtual campus as a framework for educational and social activities*. Paper presented at the IASTED International Conference on Computers and Advanced Technology in Education. Retrieved from http://bit.ly/n5qIq2

Fornas, J. (2002). *Digital borderlands: Cultural studies of identity and interactivity on the Internet*. New York: Peter Lang.

Free Software Foundation. (2011). *The Free Software Definition*. Retrieved from http://www.gnu.org/philosophy/free-sw.html

Friedman, T. L. (2006). *The world is flat: A brief history of the twenty-first century* (updated and expanded ed.). New York: Farrar, Straus and Giroux.

Garreau, J. (2005). *Radical evolution: the promise and peril of enhancing our minds, our bodies--and what it means to be human* (1st ed.). New York: Doubleday.

Gartner. (2007). *Gartner says 80 percent of active internet users will have a "second life" in the virtual world by the end of 2011*. Retrieved from http://www.gartner.com/it/page.jsp?id=503861

Gartner. (2009). *Gartner says enterprises must get control of their avatars*. Retrieved from http://www.gartner.com/newsroom/id/1201413

Gee, J. P. (2008). Learning and games. In K. Salen (Ed.), *The ecology of games: Connecting youth, games, and learning* (pp. 21-40.). Cambridge, MA: MIT Press.

Gell-Mann, M. (1994). *The quark and the jaguar: Adventures in the simple and the complex*. London: Little, Brown and Co.

George, M. L., Works, J., & Watson-Hemphill, K. (2005). *Fast innovation: Achieving superior differentiation, speed to market, and increased profitability*. New York: McGraw-Hill.

Ghosh, R. A. (2005a). Cooking-pot markets and balanced value flows. In R. A. Ghosh (Ed.), *CODE: Collaborative ownership and the digital economy* (pp. 153-168). Cambridge, MA: MIT Press.

Ghosh, R. A. (Ed.). (2005b). *CODE: Collaborative ownership and the digital economy*. Cambridge, MA: MIT Press.

Gibbons, T. (2009). Google submission hammers section 92A. *New Zealand PC World Magazine*. Retrieved from http://pcworld.co.nz/pcworld/pcw.nsf/feature/93FEDCEF6636CF90CC25757A0072B4B7

Gibson, W. (1984). *Neuromancer*. New York: Ace Books.

Gibson, W. (2003). *Pattern recognition.* G.P. Putnam's Sons.

Gilson, C. H. J., Pratt, M., Roberts, K., & Weymes, E. (2000). *Peak performance: Business lessons from the world's top sports organizations*. London: HarperCollinsBusiness.

Gladwell, M. (2008). *Outliers: The story of success*. New York, NY: Little, Brown and Co.

Gleick, J. (1999). *Faster: The acceleration of just about everything*. New York: Pantheon Books.

Goertzel, B. (2007). *AI meets the metaverse: Teachable AI agents living in virtual worlds*. Retrieved from http://www.kurzweilai.net/meme/frame.html?main=/articles/art0710.html

Gold, R. L. (1958). Roles of sociological field observations. *Social Forces, 36*, 217-223.

Goldman, R., & Gabriel, R. P. (2005). *Innovation happens elsewhere: Open source as business strategy*. Amsterdam: Morgan Kaufmann.

Goman, C. K. (2002). Five reasons people don't tell what they know. *Knowledge Management.* Retrieved from www.providersedge.com/docs/km_articles/

Grau, O. (2003). *Virtual art: From illusion to immersion* (rev. and expanded ed.). Cambridge, MA: MIT Press.

Guest, T. (2007). *Second lives: A journey through virtual worlds*. New York: Random House.

Guimaraes, M. J. L. J. (2005). Doing anthropology in cyberspace: Fieldwork boundaries and social environments. In C. Hine (Ed.), *Virtual methods: Issues in social research on the Internet* (pp. 141-156). Oxford: Berg.

Hadjiloucas, T., & Winter, R. (2005). *Reporting the value of acquired intangible assets*. Retrieved from http://www.buildingipvalue.com/05_SF/364_368.htm

Halal, W. E. (2008). *Technology's promise: Expert knowledge on the transformation of business and society*. Basingstoke, England: Palgrave MacMillan.
Hall, J. S. (2005). *Nanofuture. NY*: Prometheus Books.
Hamel, G. (2007). *The future of management*. Boston, MA: Harvard Business School Press.
Handzic, M., Lagumdzija, A., & Celjo, A. (2008). Auditing knowledge management practices: Model and application. *Knowledge Management Research & Practice, 6*, 90-99.
Haraway, D. (1992). The promises of monsters. In L. Grossberg, C. Nelson & P. A. Treichler (Eds.), *Cultural studies* (pp. 295-337). New York: Routledge.
Haraway, D. (1993). A cyborg manifesto. In S. During (Ed.), *The cultural studies reader* (pp. 271-291). London: Routledge.
Haraway, D. J. (1991). *Simians, cyborgs, and women: The reinvention of nature*. New York: Routledge.
Hayek, F. A. (1945). The use of knowledge in society. *American Economic Review, 35*(4), 519.
Heider, D. (2009a). Identity and reality: What does it mean to live virtually? In Heider, *Living virtually: Researching new worlds* (pp. 131-143). New York: Peter Lang.
Heider, D. (2009b). *Living virtually: Researching new worlds*. New York: Peter Lang.
Heim, M. (1993). *The metaphysics of virtual reality*. New York: Oxford University Press.
Heylighen, F. (2008). Accelerating socio-technological evolution: From ephemeralization and stigmergy to the global brain. In G. Modelski, T. C. Devezas, W. R. Thompson & Fundação Calouste Gulbenkian. (Eds.), *Globalization as evolutionary process: Modeling global change* (pp. 284-309.). London: Routledge.
Highsmith, J. A. (2004). *Agile project management: Creating innovative products*. Boston, MA: Addison-Wesley.
Hine, C. (2000). *Virtual ethnography*. London: Sage.
Hine, C. (2005). *Virtual methods:Iissues in social research on the Internet*. Oxford: Berg.
Hippel, E. v. (2005). *Democratizing innovation*. Cambridge, MA: MIT Press.
Howe, J. (2008). *Crowdsourcing: Why the power of the crowd is driving the future of business*. New York: Crown Business.
Hunter, D., & Lastowka, F. G. (2003). The laws of the virtual worlds. *Public Law and Legal Theory Research Paper Series* 26. Retrieved from http://papers.ssrn.com/abstract=402860
Hunter, I. (2008). *Imagine: What Wedgwood, Da Vinci, Mozart, Eiffel, Disney (and many others) can teach us about innovation*. North Shore NZ: Penguin Books.
Hussi, T. (2003). *Reconfiguring knowledge management: Combining intellectual capital, intangible assets and knowledge creation*. Retrieved from http://140.118.1.131/teaching/2006%20KM/2006%20paper/Reconfiguring%20KM.pdf
IBM. *IBM Virtual World Guidelines*. Retrieved from http://domino.research.ibm.com/comm/research_projects.nsf/pages/virtualworlds.IBMVirtualWorldGuidelines.html
Ijsselsteijn, W. A. (2003). Presence in the past: What can we learn from media history? In G. Riva, F. Davide & W. A. Ijsselsteijn (Eds.), *Being there: Concepts, effects and measurements of user presence in synthetic environments* (pp. pp 18-40). Amsterdam: IOS Press/Ohmsha.
IP Value: Building and enforcing intellectual property value. (2008). Retrieved http://www.buildingipvalue.com/
Jankowski, N. W., & Selm, M. v. (2005). Epilogue: Methodological concerns and innovations in internet research. In C. Hine (Ed.), *Virtual methods: Issues in social research on the Internet* (pp. 199-207). Oxford: Berg.
Johansson, F. (2004). *The Medici effect: Breakthrough insights at the intersection of ideas, concepts, and cultures*. Boston, MA: Harvard Business School Press.

Johnson, D. R. (2006). The new virtual literacy: How the screen affects the law. In J. M. Balkin & B. S. Noveck (Eds.), *The state of play: Law, games, and virtual worlds* (pp. 245-256). New York: NYU Press.

Johnson, S. (2001). *Emergence: The connected lives of ants, brains, cities, and software*. New York: Scribner.

Kapor, M. (2006). Architecture is politics (and politics is architecture) [Web log post]. Retrieved from http://blog.kapor.com/index9cd7.html?p=29

Kapor, M. (2007). *Mitch Kapor at Davos: Second Life.* Retrieved from http://thinkd2c.wordpress.com/2007/01/30/mitch-kapor-at-davos-second-life/

Kelly, K. (1994). *Out of control: The rise of neo-biological civilization*. Reading, MA: Addison-Wesley.

Kelly, K. (2008). *Beyond free.* Retrieved from http://www.changethis.com/53.01.BeyondFree

Kincheloe, J. L. (2001). Describing the bricolage: Conceptualizing a new rigor in qualitative research. *Qualitative Inquiry, 7*(6), 679-692.

Klein, J. H. (2008). Some directions for research in knowledge sharing. *Knowledge Management Research & Practice, 6*, 41-46.

Koch, R., & Leitner, K.-H. (2008). The dynamics and functions of self-organization in the fuzzy front end: Empirical evidence from the Austrian semiconductor industry. *Creativity and Innovation Management, 17*(3), 216-226.

Koster, R. (2006). Declaring the rights of players. In J. M. Balkin & B. S. Noveck (Eds.), *The state of play: Law, games, and virtual worlds*. New York: NYU Press.

Kozinets, R. V. (2002). The field behind the screen: Using netnography for marketing research in online communities. *Journal of Marketing Research, 39*(1), 61-72.

Krotoski, A. K., Lyons, E., & Barnett, J. (2009). The social life of Second Life: An analysis of the social networks of a virtual world. In D. Heider (Ed.), *Living virtually: Researching new worlds* (pp. 47-65). New York: Peter Lang.

Kuhn, T. S. (1970). *The structure of scientific revolutions* (2nd ed.). Chicago, IL: University of Chicago Press.

Kurzweil, R. (1999). *The age of spiritual machines: When computers exceed human intelligence*. New York: Viking.

Kurzweil, R. (2005). *The singularity is near: When humans transcend biology*. New York: Viking.

Kurzweil, R., & Grossman, T. (2004). *Fantastic voyage: Live long enough to live forever*. Emmaus, PA: Rodale.

Kurzweil, R., Kurzweil Foundation, & M.I.T. Press. (1987). *The age of intelligent machines* [videorecording]. Waltham, MA: Kurzweil Foundation/MIT Press.

Kurzweil, R., Richards, J. W., & Gilder, G. F. (2002). *Are we spiritual machines? Ray Kurzweil vs. the critics of strong AI*. Seattle, WA: Discovery Institute Press.

Kzero (2009). Active VW user forecast: 2009–2013 [Web log post]. Retrieved from http://www.kzero.co.uk/blog/?p=3836

Kzero (2012) Quick Stat: Top 15 Virtual Worlds. Retrieved from http://www.kzero.co.uk/blog/category/second-life-strategy/

Kzero (2013) Virtual Worlds/MMOs: key data, metrics and insights. Retrieved from http://www.slideshare.net/fullscreen/nicmitham/kzero-digital-kids-conference/11

Laszlo, E. (1963). *Individualism, collectivism, and political power: A relational analysis of ideological conflict*. The Hague: Nijhoff.

Laszlo, E. (1974). *A strategy for the future: The systems approach to world order*. New York: G. Braziller.

Laszlo, E. (1987). *Evolution: The grand synthesis*. Boston: New Science Library.

Laszlo, E. (1991). *The new evolutionary paradigm*. New York: Gordon and Breach Science Publishers.
Laszlo, E. (2004). *Science and the Akashic field: An integral theory of everything*. Rochester, VT: Inner Traditions.
Laszlo, E. (2006). *Science and the reenchantment of the cosmos: The rise of the integral vision of reality*. Rochester, VT: Inner Traditions.
Laszlo, E. (2007). *Science and the Akashic field: An integral theory of everything* (2nd ed.). Rochester, VT: Inner Traditions.
Leadbeater, C. (2000). *Living on thin air: The new economy*. London: Penguin Books.
Leadbeater, C. (2008). *We-think*. London: Profile.
LEGC. (2008). *Digital Content & Health Technologies Innovation Concepts*
Innovation concepts report Digital content sector. Auckland, NZ: LEGC.
Leibnitz, K., Wakamiya, N., & Murata, M. (2007). Biologically inspired networking. In Q. H. Mahmoud (Ed.), *Cognitive networks: Towards self-aware networks* (pp. 1-19.). Chichester, England: John Wiley & Sons Ltd.
Lencioni, P. (2002). *The five dysfunctions of a team: A leadership fable.* San Francisco, CA: Jossey-Bass.
Leonard, D., & Swap, W. (2004). Deep smarts. *Havard Business Review, 13*. Retrieved from http://hbr.org/2004/09/deep-smarts/ar/1
Lessig, L. (1999). *Code and other laws of cyberspace*. New York: Basic Books.
Lessig, L. (2001). *The future of ideas: The fate of the commons in a connected world*. New York: Random House.
Lessig, L. (2004). *Free culture: How big media uses technology and the law to lock down culture and control creativity*. New York: Penguin Books.
Lessig, L. (2006). *Code: Version 2.0* (2nd ed.). New York: Basic Books.
Lessig, L. (2008). *Remix: Making art and commerce thrive in the hybrid economy*. New York: Penguin Books.
Levy, S. (1994). *Hackers: Heroes of the computer revolution*. New York: Dell.
Liebowitz, J., & Megbolugbeb, I. (2003). A set of frameworks to aid the project manager in conceptualizing and implementing knowledge management initiatives. *International Journal of Project Management, 21*(3), 189-198.
Lin, N. (2001). *Social capital: A theory of social structure and action*. Cambridge: Cambridge University Press.
Linden Lab (2008). Protecting your copyrighted content. Retrieved from https://blogs.secondlife.com/community/features/blog/tags/copybot
Linden Lab, (2009) *Terms of Service.* Retrieved from www.secondlife.com
Linden Lab, (2010) Retrieved from www.secondlife.com
Linden Lab (2010a). *DMCA: Digital Millenium Copyright Act*. Retrieved from http://secondlife.com/corporate/dmca.php
Linden Lab (2010b). *Economic statistics (raw data files) Second Life*. Retrieved from http://secondlife.com/statistics/economy-data.php
Liyanage, S., Jones, A. J., & Singapore Institute of Management. (2002). *Investing in knowledge capital: Management imperatives*. Singapore: Singapore Institute of Management.
Loke, J. (2009). Identity and gender in Second Life. *Living virtually: Researching new worlds* (pp. 145-161). New York: Peter Lang.
Lombard, M., & Ditton, T. (1997). At the heart of it all: The concept of presence. *Journal of Computer Mediated-Communication 3*(2). Retrieved from http://jcmc.indiana.edu/vol3/issue2/lombard.html

Lovelock, J. (1979). *Gaia: A new look at life on earth*. Oxford: Oxford University Press.
Mahmoud, Q. H. (2007). *Cognitive networks: Towards self-aware networks*. Chichester, England: John Wiley & Sons Ltd.
Malaby, T. M. (2009). *Making virtual worlds: Linden Lab and Second Life*. Ithaca: Cornell University Press.
Mantovani, F., Agliati, A., Mortillaro, M., Vescovo, A., & Zurloni, V. (2006). Communication–presence roundtrip: Travelling along theoretical, methodological and applicative connections. In G. Riva, M. T. Anguera, B. K. Wiederhold & F. Mantovani (Eds.), *Communication to presence: Cognition, emotions and culture towards the ultimate communicative experience*, vol. 9 (pp. 3-22). Amsterdam: IOS Press/Ohmsha.
Margulis, L. (1970). *Origin of eukaryotic cells: Evidence and research implications for a theory of the origin and evolution of microbial, plant, and animal cells on the Precambrian earth*. New Haven, CT: Yale University Press.
Margulis, L. (1996). *Gaia to microcosm*. Dubuque, IA: Kendall/Hunt Pub.
Margulis, L. (1999). *The symbiotic planet: A new look at evolution*. London: Phoenix.
Margulis, L., & Sagan, D. (1991). *Mystery dance: On the evolution of human sexuality*. New York: Summit Books.
Margulis, L., & Sagan, D. (1997). *Slanted truths: Essays on Gaia, symbiosis, and evolution*. New York: Copernicus.
Marinova, D., & Phillimore, J. (2003). Models of innovation. In L. V. Shavinina (Ed.), *The international handbook on innovation* (pp. 44-53). Amsterdam: Elsevier.
Maturana, H. R., & Varela, F. J. (1980). *Autopoiesis and cognition: The realization of the living.* New York: Springer.
Maturana, H. R., & Varela, F. J. (1992). *The tree of knowledge: The biological roots of human understanding* (rev. ed.). Boston, MA: Shambhala.
Mau, B., Leonard, J., & Institute without Boundaries. (2004). *Massive change*. London: Phaidon.
Markley, R. (1996). *Virtual realities and their discontents*. Baltimore, MD: Johns Hopkins University Press.
May, M. E. (2007). *The elegant solution: Toyota's formula for mastering innovation*. New York: Free Press.
Meadows, M. S. (2008). *I, avatar: The culture and consequences of having a second life*. Indianapolis, IN: New Riders.
Montague, R. (2007). *Your brain is (almost) perfect: How we make decisions*. New York: Plume.
Moon, P. (2008). BT futurist: AI entities will win Nobel prizes by 2020. *Computerworld*. Retrieved from http://www.computerworld.com.au/index.php/id;1028029695
Morgado, L. (2009). Interconnecting virtual worlds. *Journal of Virtual World Research.* Retrieved from http://journals.tdl.org/jvwr/article/viewArticle/469
Morley, D., & Robins, K. (1995). *Spaces of identity: Global media, electronic landscapes and cultural boundaries*. London: Routledge.
Mullins, J. (2009). Memristor minds: The future of artificial intelligence. *New Scientist*. Retrieved from http://www.newscientist.com/article/mg20327151.600-memristor-minds-the-future-of-artificial-intelligence.html
Neva, P. (2006). *Consider yourself served*. Retrieved from http://secondthoughts.typepad.com/second_thoughts/2006/07/consider_yourse.html
Nickles, T. (2003). Evolutionary models of innovation and the meno problem. In L. V. Shavinina (Ed.), *The international handbook on innovation* (pp. 54-78). Amsterdam: Elsevier.
Nielsen. (2008). *Video gamers in Europe 2008*. London: Nielsen Games.

Nonaka, I. o., & Takeuchi, H. (1995). *The knowledge-creating company*. New York: Oxford University Press.

O'Mahony, M. (2002). *Cyborg: The man-machine*. New York: Thames & Hudson.

OECD. (2005). *Oslo manual: Guidelines for collecting and interpreting innovation data* (3rd ed.): OECD Publishing Eurostat.

OECD. (2008). Science & IT: Part 3: Innovation: Can something new be measured? (Vol. 2007, 13,

Okely, J., & Callaway, H. (1992). *Anthropology and autobiography*. London: Routledge.

Olsen, G. M., & Olsen, J. S. (2002). Distance matters. In J. M. Carroll (Ed.), *Human-computer interaction in the new millennium* (pp. 139-178). New York: ACM Press/Addison-Wesley.

Ondrejka, C. (2008). Education unleashed: Participatory culture, education, and innovation in Second Life. In K. Salen (Ed.), *The ecology of games: Connecting youth, games, and learning* (pp. 229-251). Cambridge, MA: MIT Press.

Ondrejka, C. R. (2006). Escaping the gilded cage: User created content and building the metaverse. In J. M. Balkin & B. S. Noveck (Eds.), *The state of play: Law, games, and virtual worlds* (pp 158-179). New York: NYU Press.

Open Architecture Network. (2010). *Ownership and copyright*. Retrieved from http://openarchitecturenetwork.org/node/6417/guidelines#ownership

Orwell, G. (1949). *Nineteen eighty-four: A novel*. London: Secker & Warburg

Osborn, A. F. (1963). *Applied imagination: Principles and procedures of creative problem-solving* (3rd rev. ed.). New York: Scribner.

Packer, R., & Jordan, K. (Eds.). (2001). *Multimedia: From Wagner to virtual reality*. New York: Norton.

Page, S. E. (2007). *The difference: How the power of diversity creates better groups, firms, schools, and societies*. Princeton: Princeton University Press.

Perez, S. (2008). *Enterprise 2.0 to become a $4.6 billion industry by 2013*. Retrieved from http://www.readwriteweb.com/archives/enterprise_20_to_become_a_46_billion_industry.php

Perkowitz, S. (2004). *Digital people: From bionic humans to androids*. Washington, DC: Joseph Henry Press.

Peters, T. J. (1997). *The circle of innovation: You can't shrink your way to greatness.* New York: Knopf.

Physorg.com. (2008). *Real and virtual pendulums swing as one in mixed reality state*. Retrieved from http://www.physorg.com/news124372701.html

Polanyi, M. (1967). *The tacit dimension*. London: Routledge & Kegan Paul.

Porat, M. U., Rubin, M. R. (1977). *The information economy*. Washington: US Dept. of Commerce, Office of Telecommunications.

Purbrick, D. J., & Ondrejka, C. (2006). *User creation and scripting in Second Life*. Retrieved from http://www.langnetsymposium.com/speakers.asp

Raymond, E. S. (1999). *The cathedral and the bazaar: Musings on Linux and open source by an accidental revolutionary*. Beijing: O'Reilly.

Raymond, E. S. (2001). *The cathedral and the bazaar: Musings on Linux and Open Source by an accidental revolutionary* (rev. ed.). Beijing: O'Reilly.

Reeves, B., & Read, J. L. (2009). *Total engagement: Using games and virtual worlds to change the way people work and businesses compete*. Boston, MA: Harvard Business Press.

Rheingold, H. (1991). *Virtual reality*. New York: Summit Books.

Rheingold, H. (1993). *The virtual community: Homesteading on the electronic frontier*. Reading, MA: Addison-Wesley.

Rickards, T. (2003). The future of innovation. In L. V. Shavinina (Ed.), *The international handbook on innovation* (pp. 1094-1112). Amsterdam: Elsevier.

Rifkin, J. (1991). *Biosphere politics: A new consciousness for a new century*. New York: Crown.

Ritke-Jones, W. F. (2008). Using cyberspace to promote transformative learning experiences and consequently democracy in the workplace. In P. Zemliansky & K. St. Amant (Eds.), *Handbook of research on virtual workplaces and the new nature of business practices* (pp. 207-222). Hershey, PA: Information Science Reference.

Riva, G., Davide, F., & Ijsselsteijn, W. A. (2003). *Being there: Concepts, effects and measurements of user presence in synthetic environments*. Amsterdam: IOS Press/Ohmsha.

Riva, G., & Ijsselsteijn, W. A. (2003). Being there: The experience of presence in mediated environments. In G. Riva, M. T. Anguera, B. K. Wiederhold & F. Mantovani (Eds.), *Being there: Concepts, effects and measurements of user presence in synthetic environments* (pp. 4-16). Amsterdam: IOS Press/Ohmsha.

Riva, G., Mantovani, F., Capideville, C. S., Preziosa, A., Morganti, F., Villani, D., et al. (2007). Affective interactions using virtual reality: The link between presence and emotions. *CyberPsychology & Behavior, 10*(1), 45-56.

Riva, G., & Waterworth, J. A. (2003). Presence and the self: A cognitive neuroscience approach. *Presence-Connect*. Retrieved from http://presence.cs.ucl.ac.uk/presenceconnect/articles/Apr2003/jwworthApr72003114532/jwworthApr72003114532.html

Rive, P. B. (2008). Knowledge transfer and marketing in Second Life. In P. Zemliansky & K. St. Amant (Eds.), *Handbook of research on virtual workplaces and the new nature of business practices* (pp. 424-438). Hershey, PA: Information Science Reference.

Rive, P. B., Thomassen, A. (2012). International collaboration and design innovation in virtual worlds: lessons from Second Life. In K. St.Amant, S. Kelsey (Eds.), *Computer-mediated communication across cultures: International interactions in online environments*. Hershey, PA: Information Science Reference.

Rive, P. B. (2009). *Creating Shiva: Design 2029 wiki*. Retrieved from http://www.launchsite.co.nz/secondlife/design2029/2029wiki/index.php?title=Creating_Shiva

Rive, P. B., Thomassen, A., Lyons, M., & Billinghurst, M. (2008). *Face to face with the White Rabbit: Sharing ideas in SL*. Paper presented at the IEEE International Professional Communications Conference.

Roberts, K. (2004). *Lovemarks: The future beyond brands*. Auckland, NZ: Reed.

Rogers, E. M. (1962). *Diffusion of innovations*. New York: Free Press of Glencoe.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Root-Bernstein, R. (2003a). The Art of Innovation: Polymaths and Universality of the Creative Process. In L. V. Shavinina (Ed.), *The International Handbook on Innovation* (pp. 267-278). Amsterdam: Elsevier.

Root-Bernstein, R. (2003b). Problem generation and innovation. In L. V. Shavinina (Ed.), *The international handbook on innovation* (pp. 170-179). Amsterdam: Elsevier.

Root-Bernstein, R., & Root-Bernstein, M. (2003). Intuitive tools for innovative thinking. In L. V. Shavinina (Ed.), *The international handbook on innovation* (pp. 377-387). Amsterdam: Elsevier.

Rosenberg, N. (1982). *Inside the black box: Technology and economics*. Cambridge: Cambridge University Press.

Ryan, M. (2009). The sociotechnical infrastructure of virtual worlds. In D. Heider (Ed.), *Living virtually: Researching new worlds* (pp. 23-44). New York: Peter Lang.

Rybas, N., & Gajjala, R. (2007). Developing cyberethnographic research methods for understanding digitally mediated identities. *Forum Qualitative Social Research, 8*(3). Retrieved from http://www.qualitative-research.net/index.php/fqs/article/viewArticle/282/619

Rymaszewski, M., Au, W. J., & Wallace, M. (2007). *Second Life: The Official Guide*. Hoboken, NJ: John Wiley & Sons, Inc.
Saffer. D. (2009) *Designing for interaction: Creating innovative applications and devices*. Indianapolis, IN: New Riders.
Sagan, C. (1977). *The dragons of Eden: Speculations on the evolution of human intelligence*. New York: Random House.
Salen, K. (2008). *The ecology of games: Connecting youth, games, and learning*. Cambridge, MA: MIT Press.
Sanoff, H. (1990). *Participatory design: Theory and techniques*. Raleigh, NC: Henry Sanoff.
Sayre, S. (2001). *Qualitative methods for marketplace research*. Thousand Oaks, CA: Sage.
Schroeder, R. (Ed.). (2002). *The social life of Avatars: Presence and interaction in shared virtual environments*. London: Springer.
Schultz, M. F. (2006). Fear and norms and rock & roll: What jambands can teach us about persuading people to obey copyright law. *Berkeley Technology Law Journal, 21*, 651-728.
Schultz, R. (2007) *Open source architecture: A manifesto*. Retrieved from http://studiowikitecture.wordpress.com/2007/06/28/open-source-architecture-a-manifest/
Sebell, M. H. (2008). *Stage gates: Good or bad for innovation?* Retrieved from http://www.creativerealities.com/knowledgeArticles.html
Shavinina, L. V. (2003). *The international handbook on innovation*. Amsterdam: Elsevier.
Shaw, T. (2007). *Wikitecture 2.0: Designing the architecture of architectrual design collaboration*. Retrieved from http://studiowikitecture.wikispaces.com/Wikitecture+2.0+-+Program+and+Protocol
Shields, R. (2003). *The virtual*. London: Routledge.
Shirky, C. (2008). *Here comes everybody: The power of organizing without organizations*. New York: Penguin Press.
Skoyles, J. R., & Sagan, D. (2002). *Up from dragons: The evolution of human intelligence*. New York: McGraw-Hill.
Sloodle (2011) Retrieved from http://www.sloodle.org/blog
Smedlund, A. (2008). The knowledge system of a firm: Social capital for explicit, tacit and potential knowledge. *Journal of Knowledge Management, 12*(1), 63-77. Retrieved from http://www.emeraldinsight.com.helicon.vuw.ac.nz/Insight/ViewContentServlet?Filename=Published/EmeraldFullTextArticle/Articles/2300120105.html
Smith, M. A., & Kollock, P. (1999). *Communities in cyberspace*. New York: Routledge.
Snowdon, D. N. (2002). Complex acts of knowing: Paradox and descriptive self-awareness. *Journal of Knowledge Management, 6*(2), 100-111.
Stake, R. (2005). Qualitative case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research*. Thousand Oaks, CA: Sage.
Stephenson, N. (1992). *Snow crash*. New York: Bantam Books.
Sterling, B. (2005). *Shaping things*. Cambridge, MA: MIT Press.
Sternberg, R. J., Pretz, J. E., & Kaufman, J. C. (2003). Types of innovation. In L. V. Shavinina (Ed.), *The international handbook on innovation* (pp. 158-169). Amsterdam: Elsevier.
Stewart, T. A. (2001). *The wealth of knowledge: Intellectual capital and the twenty-first century organization*. New York: Currency.
Studio_Wikitecture (2011). *Studio Wikitecture*. Retrieved from http://maps.secondlife.com/secondlife/Architecture%20Island/89/96/23
Studio Wikitecture (n.d.). *Studio Wikitecture: How to use the in-world 'Wiki-Tree' interface*. Retrieved from http://studiowikitecture.wikidot.com/how-to

Suler, J. (2006). *The psychology of avatars and graphical space*. Retrieved from http://www.enotalone.com/article/2460.html
Sundén, J. (2003). *Material virtualities: Approaching online textual embodiment*. New York: P. Lang.
Sunstein, C. R. (2006). *Infotopia: How many minds produce knowledge?* Oxford: Oxford University Press.
Suri, J. F., & IDEO. (2005). *Thoughtless acts? Observations on intuitive design*. San Francisco, CA: Chronicle Books.
Surowiecki, J. (2004). *The wisdom of crowds: Why the many are smarter than the few and how collective wisdom shapes business, economies, societies, and nations.* New York: Doubleday.
Tapscott, D., & Williams, A. D. (2006). *Wikinomics: How mass collaboration changes everything*. New York: Portfolio.
Taylor, M. C. (1997). *Hiding*. Chicago, IL: University of Chicago Press.
Taylor, T.L. (2006). *Play between worlds: Online multiplayer games and contemporary play*. Cambridge, MA: MIT Press.
Teece, D. J. (2000). *Managing intellectual capital: Organizational, strategic, and policy dimensions*. Oxford: Oxford University Press.
Teilhard de Chardin, P. (1959). *The phenomenon of man*. New York: Harper.
Terdiman, D. (2008). *Mitch Kapor: 3D cameras will make virtual worlds easier to use*. Retrieved from http://news.cnet.com/8301-13772_3-9873205-52.html
Thomassen, A. (2003). *In control: Engendering a continuum of flow of a cyclic process within the context of potentially disruptive GUI interactions for web based applications*. Utrecht, The Netherlands: Hogeschool Voor De Kunsten Utrecht.
Thomassen, A., & Bijk, E. (2003). Knowledge management in design education. In A. Thomassen (Ed.), *In control: Engendering a continuum of flow of a cyclic process within the context of potentially disruptive GUI interactions for web based applications* (pp 243-250). Utrecht, The Netherlands: Hogeschool Voor De Kunsten Utrecht.
Thomassen, A., & Rive, P. (2010). How to enable knowledge exchange in SL in design education? *Learning, Media and Technology, 35*(2), 155-169.
Tiffany, L. (2007). *Starting a Second Life business*. Retrieved from http://www.entrepreneur.com/startingabusiness/businessideas/article172768.html
Tiffin, J., & Rajasingham, L. (2003). *The global virtual university*. London: RoutledgeFalmer.
Tiffin, J., & Terashima, N. (2001). *HyperReality: Paradigm for the third millenium*. London: Routledge.
Toffler, A. (1980). *The third wave*. New York: Morrow.
Turkle, S., Breazeal, C., Dasté, O., & Scassellati, B. (2006). Encounters with Kismet and Cog: Children respond to relational artifacts. In P. Messaris & L. Humphreys (Eds.), *Digital media: Transformations in human communication*. New York: Peter Lang.
Turner, F. (2006). *From counterculture to cyberculture: Stewart Brand, the Whole Earth Network, and the rise of digital utopianism*. Chicago, IL: University of Chicago Press.
(2008). *Virtual Policy'08*. BERR Conference Centre, London, 22-23 July, 2008).
Virtual worlds news: Report: Virtual worlds growth to skyrocket. (2009). Retrieved from http://www.virtualworldsnews.com/2009/06/report-virtual-worlds-growth-to-skyrocket-.html
Von Krogh, G., Nonaka, I., & Ichijo, K. (2000). *Enabling knowledge creation: How to unlock the mystery of tacit knowledge and release the power of innovation*. Oxford: Oxford University Press.

Wark, M. (1988). *On technological time: Cruising Virilio's over-exposed city*. Retrieved from http://www.evolutionzone.com/kulturezone/futurec/mwark/mwark.virilio

Waterworth, E. L., & Waterworth, J. A. (2003). The illusion of being creative. In G. Riva, F. Davide & W. A. Ijsselsteijn (Eds.), *Being there: Concepts, effects and measurements of user presence in synthetic environments* (pp. 224-236). Amsterdam: IOS Press/Ohmsha.

Watson, P. (2005). *Ideas: A history of thought and invention, from fire to Freud.* New York: HarperCollins.

Weick, K. (1991). The non-traditional quality of organizational learning. *Organizaton Science, 2*(1), 116-124.

Wertheim, M. (1999). *The pearly gates of cyberspace: A history of space from Dante to the Internet*. New York: W.W. Norton.

White, J. (2009). Ethnography versus case study: Positioning research and researchers. *Qualitative Research Journal, 9*(1), 18-27.

Wiener, N. (1954). *The human use of human beings: Cybernetics and society* (2nd ed.). New York: Doubleday.

Wiener, N. (1961). *Cybernetics: Or control and communication in the animal and the machine* (2nd ed.). Cambridge, MA: MIT Press.

Studio Wikitecture (n.d.). *Studio Wikitecture: How to use the in-world "Wiki-Tree" Interface*. Retrieved from http://studiowikitecture.wikidot.com/how-to

Willis, J. W. (2007). *Foundations of qualitative research: Interpretive and critical approaches* Thousand Oaks, CA: Sage.

Wilson, C. (1963). *The outsider*. London: Pan.

Wilson, S. M., & Peterson, L. C. (2002). The anthropology of online communities. *Annual Review of Anthropology, 31*(1), 449-467.

Wolfe, T. (1993). *From Bauhaus to our house*. London: Picador/Jonathan Cape.

Wolfram, S. (2002). *A new kind of science*. Champaign, IL: Wolfram Media.

Yankelovich, N. (2007). *MPK20: Sun's virtual workplace*. Retrieved from http://research.sun.com/projects/mc/mpk20.html

Yee, N., Bailenson, J. N., Urbanek, M., Chang, F., & Merget, D. (2007). The unbearable likeness of being digital: The persistence of nonverbal social norms in online virtual environments. *CyberPsychology & Behavior, 10*(1), 115-121.

Yin, R. K. (2009). *Case study research: Design and methods* (4th ed.). Thousand Oaks, CA: Sage.

Zarsky, T. (2006). Privacy and data collection in virtual worlds. In J. M. Balkin & B. S. Noveck (Eds.), *State of play: Law, games and virtual worlds*. New York: NYU Press.

Zukav, G. (1991). *The dancing Wu Li masters: An overview of the new physics*. London: Rider.