Playing with sustainability: Using video games to simulate futures of scarcity
by Shawna Kelly and Bonnie Nardi

Abstract
Many popular video games sustain compelling storylines that narrativize scarce resources, promote competitive and collaborative social interaction, and foreground survival goals — all necessary skills for making sense of a changed and changing global environment. In this article, we analyze representative commercial video games in four categories: civilization simulations, post–apocalypse first–person shooters, multiplayer survivor horror games, and historical recreations. We examine the ways their game mechanics and game scenarios represent social, economic and environmental interdependencies. We contrast these representations with future scenarios of gradually increasing scarcity of resources, climate change, and other human–environment interactions which can be influenced by transitioning to sustainable practices. Because good game mechanics can cultivate imaginative visions of situational potentials and solutions to problems, a key objective of the paper is to suggest game mechanics and scenarios that simulate and model sustainable practices. This agenda includes shifting away from growth as a game goal; strategizing with depletable resources; emphasizing scavenging versus combat for resource acquisition; and, developing more complex avenues for social interaction and collaboration among players. Incorporating more sustainability science concepts into commercial video games can offer a public outlet for exploring the complex interdependencies of a changing world.

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Introduction
"Are violent video games adequately preparing children for the apocalypse?" This question is the headline of a 2009 video newscast from the satirical news service, The Onion. In it, a group of professors and analysts debate the usefulness of video games as a simulation tool for developing necessary survival skills for a potentially changed world. The professor of media and politics argues that games "just need to teach the basic concepts — which they do." The historian emphasizes that kids are going to need practical skills not yet available in today’s games such as "how to find drinking water by collecting the morning dew in human skulls." The Onion News Network analyst fires back: "The games make it seem deceptively simple. A kid’s not going to be able to kill a six–foot-long irradiated beetle just by pressing a few buttons" (The Onion, 2009).

While the video is presented as tongue–in–cheek comedy, its question provokes an intriguing topic for inquiry. What role can commercial online video games play in helping players make sense of complex systems? Using examples from commercial simulation games, post–apocalypse first–person shooters, multiplayer survivor horror games, and historical recreation games, we identify narratives,
themes, and game mechanics that would be useful for exploring sustainable practices in possible
global futures of scarcity. We argue that because games encourage players to be both creative and
strategic in coming up with solutions to problems, they are useful tools for proactively thinking about
the future and making sense of complex system models.

**Connecting sustainability and game studies**

Like *The Onion* debaters, we are interested in gaming and its relation to possible futures in which
resources may be scarce. From the game studies perspective, the motivation for integrating games
and sustainability comes from research detailing commercial video games as imaginative and
exploratory spaces full of social interaction and group problem solving. From a sustainability point
of view, the motivation comes from the potential for games to create a cohesive context for
understanding complex systems. Combined, games offer an avenue for engaging the gaming
community in the larger public debate surrounding sustainability and our global future.

Within research on sustainability, global futures is a topic that, like game studies, has developed
from several different perspectives. It includes investigating global problems of climate change,
resource depletion, pollution, and other issues of impending global change. In popular culture such
as Hollywood movies (e.g., *Carriers*, *28 Days Later*, *The Terminator*) and survivalist fiction (e.g.,
Rawles, 2006), change is often depicted as a rapid collapse occurring on the scale of days or weeks
—a apocalypse. While powerful events such as a nuclear attack may cause events to unfold in a
way that merits the term “apocalypse,” and while various “tipping point” phenomena (Diamond,
2004; Lovelock, 2009) may instigate rapid non-linear changes (as is common in ecosystems),
Tainter (1990), Diamond (2004), and others observe that collapse in human societies frequently
occurs more gradually, and is the much more likely scenario for our civilization.

A global futures scenario is not one of total apocalypse, but of a gradually increasing scarcity of
resources escalating to the point at which significant adaptations are required. The change is
sometimes called the Long Emergency or the Long Descent (see Greer, 2008; Raghavan and Ma,
2011). Global futures researchers include archaeologists who study the rise and fall of civilizations
and have identified warning trends in modern day civilizations (e.g., Tainter, 1990; Tainter and
Crumley, 2007), and world system modelers who look holistically at current and historical
interactions between humans and the environment, and create models of likely and/or potential
futures (Meadows, et al., 1972; 1982; Turner, 2008). Others contributing to global futures research
include climate scientists concerned with potential environmental, and social impacts of changing
weather patterns (e.g., U.S. National Climate Data Center, 2012a, 2012b), resource specialists
analyzing dependence on non-renewable resources (e.g., Diamond, 2004; Willis and Church, 2012),
human–computer interaction researchers exploring technological options for futures of scarcity
(Tomlinson, et al., 2013; 2012) and investigative journalists (e.g., Wald and Schwartz, 2012) who
argue that present rates of resource consumption are unsustainable.

Interested researchers are looking for successful ways to intermix the different contributions to
global futures research to make sense of disparate datasets and theories. Tomlinson, et al. (2013;
2012) approach global futures research as a means for adaptive strategizing for a global transition to
sustainability. Computational methods, including gaming simulations, offer a format for testing
scenarios. The IHOPE (Integrated History and Future of People on Earth) group, an international
contsortium of distinguished archaeologists, biologists, chemists, economists, geographers, and
systems theorists, notes that modeling is necessary for thinking about futures of scarcity,
specifically, “using different ... approaches ranging from systems dynamics models to simulation
games to scenario analysis” [1]. We concur with their identification of simulation games as a source
of interesting models, e.g., *Sid Meier’s Civilization* (MicroProse, et al., 1991), and believe that such
games can be used more widely to explore systems dynamics.

Games sustain compelling storylines which are made even more interesting by being interactive
(Atkins, 2003). Good game mechanics cultivate imaginative responses and encourage players to
think outside the box when they encounter problems, and to carefully examine situational potentials
(Brown and Thomas, 2008). Commercial video games narrativize scarce resources, promote
competitive and collaborative social interaction, and foreground survival goals. They have the
capacity to convey the complexity of futures research to wider publics who can attain new insights
and devise solutions, as well as generate new ways of thinking about the future. As global population
and consumption habits continue to strain existing social and economic infrastructures, a community
that has explored conditions of scarcity and adaptations will be of growing relevance and importance
(see Diamond, 2004; Costanza, et al., 2007; Wald and Schwartz, 2012).

In making an argument about global futures research and online video gaming, we take our cue not
from the many virtual zombies already roaming cyberspace, but from the intellectual vitality and
creativity of the gaming community. Gamers expend tremendous energy and generativity outside of
games as well as within. They participate in modding, theorycrafting, machinima, and peer
production of sophisticated online guides and videos that analyze complex gaming challenges (see Consalvo, 2007; Nardi, 2010; Paul, 2012). World of Warcraft fans have “written a quarter of a million wiki articles on WoWWiki — creating the largest wiki after Wikipedia.” [2] Gamers engage in complicated, ongoing, voluntary conversations with each other. Lively (often witty and literate) discussions populate gaming forums on just about anything from player etiquette to the design of the shoulders of a priest’s armor (see Kow and Nardi, 2012; Paul, 2012). Expertise is developed and shared spontaneously. Players freely contribute countless hours to discussions of efficiency, best practices, workarounds, and number crunching for their favorite games. We envision “global futures games” as a means of drawing on the energy and smarts of gamers to generate novel understandings of global problems. We were inspired by Foldit (Cooper, et al., 2010), a free molecular design game that is fun in its own right, but also challenges the public to create potential solutions to some of biology’s most difficult problems. Modeling world systems is more complex than protein folding, but we believe that playing games can be a way to think holistically about the complexities of global futures.

Philosopher John Dewey (2005) identified artifacts and activities as socially desirable if they engender the continual remaking of experience and community. A vibrant fandom is part of what makes the gaming community a dynamic space of intellectual engagement and enthusiasm. It is striking that video gamers are able to carry forward their gaming experiences through mods, theorycrafting, authoring, and conversation. This carrying forward is, to us, the heart of the video gaming experience. The thoughts provoked, analyses conducted, words written, YouTube videos produced, mods programmed, conversations enjoyed, friendships developed, and emotions touched—all arise from gaming, changing both the person and the community. Video games themselves evolve as a result of player engagement by eventually incorporating some of these extensions of gaming activity. Developers pick up on forum discussions, study the kinds of mods players seem to like, pay attention to the conversations gamers have with community managers, and observe how players instruct one another—drawing on these resources to alter games and create new ones. Video games exhibit the agency to stimulate the remaking of experience and community by sustaining gamers’ interests and imaginations. They thus seem to us a natural source of ideas for confronting some of humanity’s most vexing problems. Game developers and modders can take up the challenge of pushing games in new directions to help us think through futures, leveraging clever game mechanics and new themes to entice the naturally spirited and inventive gaming community.

Although the problems we seek to confront through gaming are serious, this doesn’t mean that games should lose their entertainment value—quite the contrary. A government committee on science education found that games and simulations offer new ways of teaching traditional scientific concepts (U.S. National Research Council, 2011); however, the emphasis on information transfer and banal rewards within the serious games movement often results in a playing experience that is too instrumental and didactic (see e.g., Jenkins, et al., 2003; Shaffer, et al., 2005). As Gee (2003) and Thomas and Brown (2009) point out, game mechanics themselves are inherently thought provoking. A good game privileges interesting and challenging mechanics over information transfer, or it fails as a game. The extended energy and creativity that make gaming special, and which we identify as critical to advancing the agenda of adaptive strategizing, will be lost without games that people actually want to play. The alternate reality game World Without Oil offered a great opportunity for players to experience a potential future oil crisis (McGonigal, 2011). But this serious game lacks the mainstream audience and popular culture appeal of commercial games. Rather than a new line of “serious” global futures games, we look to commercial games that reflect global future themes, and analyze which game mechanics and scenarios might be most useful for exploring global futures research.

Commercial online video games, even in their current forms, have the potential to offer brainstorming possibilities for adaptive strategizing in futures of scarcity.

The challenge: Moving beyond mere survival

In order to explore the potential for commercial games to offer insights for global futures research, we examine civilization simulation games, post–apocalyptic first–person–shooter games, multiplayer survival horror games, and games that involve historical recreations. By incorporating sustainability themes, developers might evolve mechanisms of social interaction in games for play experiences that cultivate strong social problem solving and create an interface for understanding complex systems.

End goal of the game: Balance instead of growth
Future scenarios of potential collapse and decline tend to focus on the physical needs of food, clothing, shelter, and simple basics. But in envisioning futures of scarcity occurring in a long descent rather than all-out apocalypse or a sudden vast emergency, a more nuanced approach is needed. It is important to consider the more complex aspects of civilization. Theorists generally consider games to be a good space for simulating possible outcomes (Costanza, et al., 2007; Castranova and Falk, 2009), which makes them ideal for exploring the interactions and interdependencies between human beings and their environment. Civilization (MicroProse, 1991) was released on the heels of prior exploration and colonization games such as M.U.L.E. (Ozark Softscape, 1983), and captured the imagination of the gaming community (Edwards, 2007). It pioneered a genre of games that lets players explore resource management, cultural evolution, and colonial expansion.

For years, educators and game enthusiasts alike have lauded the educational opportunities offered by open-ended simulation games like Civilization for helping players explore different outcomes within the same scenario (e.g., Pagnotti and Russell, 2012; Squire, 2008; Squire and Barab, 2004). At the same time, educators began raising questions about what exactly players were learning by playing simulation games and how this kind of learning helped educators meet their goals (Squire, 2002; Gee, 2003).

Civilization V ( Firaxis Games, 2010), the most recent addition to the franchise, is graphically beautiful and follows the same collection of city settlement, unit movements, building decisions, and scripted political interactions as previous games in the series. Simulation games give players the opportunity to compare the outcomes of different choices — an essential activity for generating informed discussion about adapting strategically to futures of scarcity. For example, immediately upon starting a new game, Civilization V players must choose where on the map they will locate their first city. Depending on the resources available on and around the location they select, players will have a different experience. If a city is located near food, it will increase the number of citizens quickly, whereas a city located near strategic resources like horses will develop mounted troops and build up a powerful army earlier in the game. Resources also determine player interactions within the game, encouraging players to trade with each other or with the computer when a particular resource is needed. This kind of strategic resource management offers a framework for players to think about and understand similar kinds of discussions about our natural resources and international trade policies.

As a space for exploring how social, economic and environmental changes affect a system, the potential of games like Civilization V is readily apparent. The appeal of the game comes from watching decisions made at the beginning play out throughout the game as the player sees the civilization grow, and tests the variations and optional strategies that can be used in subsequent games. The collective purpose of the game is to grow a thriving civilization as quickly and efficiently as possible.

This emphasis on growth offers both an opportunity and a stumbling block for exploring futures of scarcity. Civilization’s focus on growth as the measure of success (the size of armies, number of citizens, and the amount of resources the player controls) has a profound impact on goals, strategies, and the final outcome of the game. The game mirrors common thinking about success in today’s world — that the viability of a civilization should be measured through economic growth, population growth, production growth, growth in education and literacy, growth in the standard of living. Many of the simulation and business simulation game genres, e.g., SimCity (Maxis, 1989), Railroad Tycoon (MicroProse, 1990), Rollercoaster Tycoon (Sawyer, 1999), and Zoo Tycoon (Blue Fang, 2001), also emphasize economic, social, and resource growth as indicators of success within the game. A key challenge offered by thinking about future scaring is to develop new game metrics and mechanics that are not predicated on simple linear growth but speak to the need for adapting to very slow growth or even attempting to reach stasis. In a finite world (such as the one we live in), the concept of a linear pattern of ever-increasing growth is an unsustainable long-term goal (Meadows, et al., 1972; 1982). Finitude means that growth-based ideals will eventually collapse. A more realistic alternative is to think in terms of long growth, stasis, or cyclical patterns of abundance: growth and scarcity interspersed in a sustainable way. We might envision games that model these cyclical patterns and ask players to figure out how to manage them. Such cycles could be situated within real-world contexts of designing sustainable houses (U.S. Department of Housing and Urban Development, 2012), managing “shrinking cities” (Shrinking Cities International Research Network (SCIRN), n.d.), building “transition towns” (Transition Network, 2013), the development of aquaponics (Rakocy, et al., 2006), designing technologies that use less power and other resources, and other contemporary, real-world activities geared toward futures of scarcity. For example, agriculture influences both natural and social environments, so focusing on low-impact agricultural practices such as crop rotation and natural pest control, or privileging regional food transportation, might offer deeper insights into issues of sustainability and local/global resource allocation. What adjustments and strategies are necessary when growth is not the dynamic? These concerns could provide game mechanics as interesting and challenging as those centered on growth. These elements (sustainable houses and so on) could provide material for the thematic and aesthetic design elements of new games. Global futures games can make visible the possibility of low/no growth as a challenging and achievable goal.
Resource acquisition: Scavenging instead of combat

Academic research in the survival-horror genre often focuses on what makes a game experience “scary” (Carr, 2003; Perron, 2004; Kirkland, 2010). At the same time, this genre expresses deeper cultural narratives about success in stressful situations. For example, Browning (2011) included the Resident Evil franchise (Capcom, 1996) in a study about a popular-culture narrative shift from individual to multiple-person “survival spaces.” As survival spaces, survival-horror games offer interesting insights into motivations and behaviors for futures of scarcity.

The common survival horror game scenario plunges players into a strange world with danger around every corner. In the Resident Evil games, for example, a deadly virus has mutated humans and animals into grotesque zombie-like horrors. To heighten the challenge and thrill of survival games, the world is designed around scarcity, requiring the player to conserve ammo and limiting the items he or she can carry. The games reinforce a popular game mechanic: if it’s scary-looking, shoot it and search it for loot; however, the mechanics of limitation add a reflective function to the goal of shoot-and-loot, forcing the player to engage scarcity as an ongoing problem. As such, they have the potential to scale up to societal levels, not remaining as simply personal problems solved by individual players.

With the current popularity of zombie-related books, movies, and television shows, video games companies are exploring interesting twists on the traditional survival-horror game. Fortnite (Epic Games, anticipated 2014) is an example of thinking beyond shoot-and-loot mechanics. According to Cliff Bleszinski (2012), Epic Games’ studio head, “A lot of games say they are about survival, but they’re more about going out and killing creatures. This game is truly about enduring.” The gameplay of Fortnite involves scavenging materials from a deserted city, bringing those materials back to a basecamp, and then working with other players to create a defensible structure from the materials before zombies attack at night. Currently released demo videos show players using explosives to demolish a building, then collecting the useful parts that have broken free during the explosion. The scavenging and collaborative building elements of Fortnite suggest that its gameplay will encourage creativity and imagination in how the players interact with the environment and each other.

Fortnite aspires to get players to think strategically about resource collection, including how to carry the building materials back to the home base, and how each piece will contribute to the overall defensiveness of the tower. This kind of creative interaction with the environment lends itself well to futures of scarcity, where having customized resources individually delivered to your home (e.g., shopping online stores) could be a luxury of the past. More generally, Fortnite players are must learn to recognize potentially novel uses of familiar objects and consider reappropriating them for their immediate needs.

Of course the details of carrying materials and so on are not central to global futures games; it is the idea of thinking strategically in new ways about the environment under conditions of stress, as would characterize futures of scarcity. The premise of Fortnite is that survival in a video game should be more than just living through the zombie apocalypse and shooting as many zombies as possible. It should entail finding ways to thrive afterward — to locate strategic means of adapting to altered futures.

Complex social modeling: Dynamic interactions instead of fixed roles

For exploring global futures, games have the potential to offer insights into the social dynamics of people interacting in futures of scarcity. When Hollywood puts forth representations of futuristic societies like those in Mad Max or Waterworld, the societies are presented wholly formed on the screen, with the social dynamics determined by the film’s narrative. Digital games, on the other hand, offer the opportunity to experiment with multiple models of social interaction, and to consider the friction between individually and socially motivated goals in futures of scarcity.

The majority of games in the post-apocalyptic and survival horror genres have been single-player games. Players may interact with other computer-controlled characters within the game, but the multiplayer possibilities are usually either absent or created after game releases through fan-developed mods. One notable exception is the Left 4 Dead (Turtle Rock Studios/Valve, 2008) franchise — a first-person-shooter game where four players cooperate to defeat computer-controlled zombies or four other players controlling zombies. Left 4 Dead is a fast-paced game that focuses on quick reaction times, coordinating with other players, and learning the defensive and offensive possibilities of the environment (Haselton, 2011). The single-player version of the game is fun and challenging, but it has been the multiplayer aspect of Left 4 Dead that made this game
franchise a success — *Left 4 Dead 2* (Turtle Rock Studios/Valve, 2009) sold 20 million copies in the first two weeks after its release.

Multiplayer games are a strong draw. Players often play select new games or continue to play games that are no longer interesting to them because of social connections with other players. They want to play with (and against) their friends. The popularity of *Left 4 Dead 2* suggests that it has the right idea for making a survival/post-apocalyptic multiplayer game. However, in terms of gameplay, the social interactions within the game are constrained by the game design. Players are assigned a role — either human or "infected" zombie — and must collaborate with people with the same role, and compete with the opposite role. In sports terms, two opposing teams of players is a standard structure for determining how to play a game; however, assigned teams are a highly regulated form of social interaction. The challenge for games that strive to model complex systems is to develop innovative forms of social interaction that make players engage intellectually in determining what roles they, and the other players, will take on during the game. This is a challenge that players are more than willing to accept, as seen in the leadership roles that many players take on in multiplayer games (Lisk, *et al.*, 2012).

An excellent example of interesting player interaction appears in *DayZ* (Bohemia Interactive Studios, 2013). *DayZ* is a persistent–world combat simulation that strives to be hyperrealistic: movement on foot, health, noise when moving, and scavenging for resources in abandoned buildings are all designed to imitate a life–like experience. It takes time and effort to do even simple tasks in *DayZ*. There is no automatic map; you have to scavenge one. You can kill local wildlife for food, but you must find matches and collect firewood to build a fire to cook the meat. If you are injured, you need to locate a medical blood bag and have another player give you a blood transfusion.

This level of detailed realism may sound excruciatingly dull, but it serves to highlight the fascinating multiplayer aspect of the game: Each player is motivated to work cooperatively with another player, or to attack her and steal her resources. Players are not assigned to a team by the game, so each player must determine whether other players are friend or foe. As game reviewer Quintin Smith says: "This is *DayZ*, one part glacially paced horror game, one part riveting social experiment. And simply put, it's a stunning zombie game because, like every half–decent zombie flick, it's not about zombies. It's about panic, who you are, and what you're willing to become" [3]. *DayZ* players, facing the prisoner’s dilemma with each and every encounter with another player, must make ethical decisions about their own and others’ behaviors. The *DayZ* gaming community has engaged in thoughtful out–of–game discussions about the benefits and perils of trust, collaboration, and competition (e.g., Reddit.com, 2012, 2014). Because healing in *DayZ* requires interaction with other players, some players have deliberately labeled themselves medics and will advertise their willingness to heal other players on game forums and wikis, although they (and the people who contact them) run the risk of betrayal within the game. The thrill of playing *DayZ* comes in large part from the necessity and uncertainty of interacting with other players, which, in turn, encourages self–reflection and public discussion. The ability for *DayZ* to provoke thoughtful discourse between players both inside and outside of the game makes it a good example of one way that digital games support innovative social interaction that could be useful for thinking about futures of scarcity.

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**Strategizing with resources: Considering long–term consequences and interdependencies**

Games based on wars (e.g., the U.S. Civil War, World War II) develop historically accurate reconstructions of actual battles, weapons, terrain, and so on. The graphics of games like *Total War: Shogun 2* (The Creative Assembly, 2011) and *L.A. Noire* (Team Bondi and Rockstar Leeds, 2011) are painstakingly rendered with authentic period details. The gaming community is already thinking historically and using history to engage problem solving and creativity. The *Sid Meier’s Civilization* franchise draws deeply on multiple historical epochs, and the accuracy of these simulations create worlds that invite players to "... spend their time reimagining how science and technology could work in the game" [4]. Games that explore futures of scarcity are often inspired by the complex historical conditions that produce scarcity. Historical reconstructions can be especially suited to analyzing alternative solutions and gaining a bird’s–eye view of the larger historical conditions that shape outcomes — precisely what is needed to confront adaptation to changed conditions. On a small scale, geographically based social simulations like *Civilization* can be used to explore the complexities of international politics (Weir and Baranowski, 2011). Large–scale simulations — like IHOP–themed games — engage relationships between climate, agriculture, technology, disease, language, culture, war and other variables to explain historical patterns of human settlement, population, energy use and Earth system cycles such as global biogeochemistry (see Constanza, *et al.*, 2007). Historical recreations can give players a deeper sense of connection between historical eras, an understanding many young people do not acquire from conventional education, and provide stimulating gaming challenges (see Squire and Barab, 2004; U.S. National Research Council, 2011). Games that model social conflict offer opportunities for understanding the historical events that direct current policy decisions (Landwehr, *et al.*, 2013).
Games allow players to do more than recreate historical moments. Many games simulate fantasy and science fiction scenarios based on historical motivations. The science fiction genre reimagines exploration and colonization in space, replacing sailing ships with spaceships and hostile natives with aliens. The real–time–strategy game genre frequently uses exploration and colonization as a narrative reason to develop resources into complex societies and armies. For example, the series of popular Warcraft real–time strategy games (Blizzard Entertainment, 1994/1995/2003) allows players to explore the conflicts between human natives and an invading horde arriving from another planet. Much like the Civilization series, in order to win the game, the player must direct units (troops) to collect resources, build infrastructure, train new troops and engage in combat. Real–time–strategy games emphasize quick–thinking strategy, creating the opportunity for efficient players to develop resources and armies more quickly than their slower counterparts.

For games to adequately explore futures of scarcity, a more complex model of resources needs to be developed. Many games require finesse in collecting and using resources. In the Warcraft series, certain resources (wood and gold) are limited and must be collected and used strategically — once the forests and mines run out, that is it. However, an individual game is of short duration and players only focus on the short–term uses of resources. The Civilization series takes a longer perspective, but once resources are discovered and developed, they produce the same amount each turn, never running out or being affected by production problems. It is hard to imagine a gold mine or corn field outside of a video game that produces the same amount each and every time that it is harvested.

Instead, for thinking about resource use that emphasizes sustainable practices, we turn to the old Atari game M.U.L.E. (Ozark Softscape, 1983) a simple space colonization game. Although simplistic in its graphics, the gameplay of M.U.L.E. created a loyal fanbase who continued to hold game tournaments into the 2000s and have created multiple tribute versions of the game online and mobile (Cox, 2012). M.U.L.E. has several notable game mechanics for resources that encourage players to think more strategically about resource management.

The premise of the game is that the player(s) are dropped off on a planet and told to make the colony a success. During each turn, players purchase a plot of land from the company store and develop it to produce one of three resources. At the end of the turn, players then have the option to sell their produced good to the central store and buy the remaining resources required to continue working their plots of land. What makes M.U.L.E. interesting is that it combines both randomization and strategizing into resource management.

**Variable production and spoilage.** In M.U.L.E., each plot of land produces resources each turn, but the production is not for a given amount. Sometimes the plot will produce more, sometimes less. Certain plots of land are better for certain resources, e.g., those located near a river produce better for food than mining, but overall the randomization of production reflects the variables of weather, efficiency and other complex factors. In addition, stockpiling food or energy from previous rounds is a limited option. Storage of food or energy can lead to spoilage of part of the stored resource. Therefore, players who decide to save eight units of energy for the next turn and consume four during production activities may only have two left over to sell if two spoil. These design features encourage the player to develop more flexible strategies that can accommodate a range of production.

**Periodic random events.** After the players have made all of their decisions about which resources they will collect from their plots of land that turn, there is a chance that sunspots, meteorites and other events will change the standard production of resources throughout parts of the colony by growing extra food or making it harder to collect energy. In addition, an individual player’s machinery might break, or pests may attack her farm, making her lose her crop from that plot of land. Therefore, the player must strategize for a longer game, rather than focusing only on the most immediate financial reward.

**Responsive vendor prices.** One of the best–known features of M.U.L.E. involves its supply and demand economics. If all four players produce food and sell food to the store in turn one, then the store has extra food in turn two and will pay much less to buy the same food crop that sold well in turn one. Additionally, when the store has sold all of its stored units, the players must negotiate directly with each other or suffer a production penalty for not having enough food or energy to fulfill their needs for the next turn. This creates the potential for players to monopolize and demand large payments for scarce resources, or to alter the colony’s market for a turn and make a profit selling to the store. Responsive vendor pricing shifts the player’s attention from a narrow worldview where items have a fixed value, to a more nuanced perspective where resources have value in relation to supply and demand across a group of people.

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**Paratextual discussions of alternative futures**

The vitality of video gaming lies not just in playing games but in the recursive creativity evident in
"paratexts" (Consalvo, 2007) such as blogs, machinima, and forum texts. These venues provide a space in which to discuss specific games and game mechanics, which can also become a discussion about alternative futures and exploring these futures. For example, a key problem in examining futures of scarcity is to make decisions about what we could do without, since we can't have it all. Thinking through what society values is an exercise made more real by imagining what we would decide to forgo if lifestyles need to change. To adapt, society will be forced to make tough decisions about what is most important. It will be necessary to expend limited resources carefully to maximize social good. We will have to decide how to relinquish valued commodities and activities we enjoy in present conditions of abundance.

How can such choices be made? Video games, and the related discussions that occur in paratexts, are a potential way to encourage discussions of the ramifications of societal resource allocation under conditions of scarcity. If we cut back on education, what are the outcomes? If we move toward the use of more public transportation can we keep the interstate highway system going? Would it be worth it? What about air conditioning? It’s a luxury that takes up a surprising amount of fossil fuel and moves people into hot climates with little water, potentially creating new problems with water shortages (Cox, 2010). Can we build houses differently, and if so, how much fuel and building material could we save? What would the initial eco–friendly building costs be, and how long would it take to amortize them?

We believe that a way to engage the problematic of “making tough choices” is to develop frameworks that spell out social values. The following framework suggests that in addition to the basics of food, clothing and shelter, every person is entitled to:

- Engage in restorative activities such as play and creating or appreciating art.
- Take advantage of formal or informal education.
- Have the freedom to express himself or herself.
- Work (paid work, raising children, gardening, etc.).
- Experience wild nature.

If society were organized around providing these opportunities how would it operate? Who would pay for which opportunities? How could the common good be established and maintained? How should this framework be modified to be better? When these kinds of questions are built into the designs of games, they encourage discussions to take place in paratexts and flow back into gameplay.

Because adaptation to futures of scarcity involves everyone, it is important that many voices be heard in discussions. At present there is something of a divide between “casual” and “hardcore” gamers perpetuated by the media, by game genre segmentation, and by the gaming community itself. Casual gamers believe hardcore gamers “do not have a life” and the hardcore believe that casual gamers are not even real gamers (see Nardi, 2010; Kelly, 2012). Games like Farmville (Zynga, 2009), Angry Birds (Rovio Entertainment, 2009), and Bejeweled (PopCap Games, 2001) are labeled “casual games,” implying that they require little skill or strategy. Games like those discussed above, such as the survival horror and simulation genres, are sold to the hardcore audience that is expected to know game conventions and to engage in more intense play. (We are not committing theoretically to the “casual” and “hardcore” terms but using them as shorthand in the way they are used in the gaming community.)

The possibility of games exploring futures of scarcity offers an interesting opportunity to bring together casual and hardcore gamers. A wide spectrum of collaborating gamers would be a novel mix, and create a potentially exciting use of video gaming technology. Rather than creating one game in order to problem–solve environmental and social perils of impending global change, multiple but related games with similar themes could weave together. Larger questions which seem daunting could be broken into segments and portrayed in different games, requiring different time commitments, but still being challenging and fun for all. For example, a problem such as safe and reliable access to clean drinking water (a request posed by the fictitious Onion panel member), involves questions of locating, purifying, and transporting the water, as well as considering practices that would make these solutions sustainable both socially and environmentally. This kind of analysis is a lot to take on, and could be broken out into pieces within multiple games. Similar efforts such as citizen science, Wikipedia, and the game Foldit, have shown that large, diverse groups can successfully contribute to collective knowledge production projects when the work is segmented properly. Even casual gamers engage in ongoing online discussions through Facebook, Twitter, and other social media, such that collaborative knowledge generation is no longer only the domain of more dedicated gamers. The gaming community continues to attract new, more diverse members, and the discussions that gameplay evokes can be both a creative and dynamic space for solving interesting problems.

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**Conclusion**
The collaboration, joyful competition, and intellectual curiosity found in the gaming community are rich resources for designing and playing games that explore complex questions about sustainability and resource scarcity. Playfulness itself can be an asset for approaching the serious, daunting problems that modern civilization faces. Games have already opened up frightening futures as thematic terrain. Although current images tend to be exaggerated (zombies and so on), stark futures are nothing new to gamers. The willingness to entertain strong notions of societal decline along with the energizing nature of gaming and its can-do attitude are promising means for designing and thinking through scenarios of possible futures.

If The Onion video title actually outlines an opportunity for game developers and the gaming community, then we suggest that games are currently headed in the right direction. Games can model making tough choices and cycles of scarcity, and games are pushing beyond current mechanics to incorporate more intellectually challenging options. Players are learning new ways of interacting with virtual environments, such as how to improvise objects into defensible buildings in Fortnite, how to negotiate with other players in DayZ, and how to think about long-term and short-term strategies and explore possible outcomes in M.U.L.E. and the Civilization franchise. Games like Foldit have been designed so that the game’s parameters are closely aligned to match the parameters of a real-world problem. At the same time, games could incorporate game more nuanced goals and mechanics to model sustainable practices and offer players opportunities to explore potential futures of scarcity.

To contribute to sustainability research, and engage players in the larger public discussion around futures of scarcity, games should:

- Move beyond growth as the end goal of a game — uncontrollable growth is an unsustainable scenario and asks little of the player’s imagination.
- Emphasize scavenging over combat for resource collection — encourage players to interact with their environment in creative ways instead of simply looking for targets.
- Offer complex avenues for social interaction — there are many different kinds of social connections that can be supported by modern media beyond “us versus them.”
- Encourage strategizing with resources — scenarios that incorporate long-term consequences and interdependencies of resource use have a lasting appeal.

Futures of scarcity require people to think strategically about adaptation and redesigning life — what is important to us, how we make choices, and the tradeoffs with which we will have to contend. Researchers interested in global futures should explore digital games both as avenues for simulating futures of scarcity and for a better understanding of public ideas about futures of scarcity. Developers, gamers, and game studies scholars should challenge the gaming community to bring problem solving in a game closer to problem solving outside the game. Video games can be generative platforms to develop adaptive strategies, make the strategies visible and critiquable, and give members of the gaming community an entry point from which to begin and develop discussions about the future. Not only can better science lead to more interesting challenges within games, but the creativity of games could lead to better science for understanding a complex global model of potential futures.

About the authors

Shawna Kelly, New Media Communications, Oregon State University. Dr. Kelly’s research focuses on critical inquiry into the social and cultural aspects of online communication, more specifically the role that communication technologies play in people’s everyday experiences. She has critically examined online gaming and virtual world communities, including practices of enculturation, citizenship, interpersonal relationships, and “addiction.” Her specialty is casual game users or first-time/inexperienced users exploring video games. Working with corporations, She has explored sociality and technology adoption through the lens of gaming on mobile technologies, as well as exploring the social motivations for payday advance loan use and repayment in personal finances. Recently, Dr. Kelly has been working with the University of California, Irvine, Department of Informatics, to explore the intersection between interactive entertainment representations of future calamities and public discussions of transitioning toward environmental sustainability. She teaches classes on media theory, game studies, and UX research. Direct comments to: shawna [dot] kelly [at] oregonstate [dot] edu

Bonnie Nardi, Department of Informatics, University of California, Irvine. Dr. Nardi’s research interests include theory in human–computer interaction and computer–supported collaborative work; computer–mediated communication technologies; and, studies of social life on the Internet. She has studied how World of Warcraft players collaborate as well as the relationship of off–line, online, and in–game activity. She is author of numerous scientific articles and books, including My Life as a Night Elf Priest: An Anthropological Account of World of Warcraft (Ann Arbor: University of Michigan Press, 2010), and Ethnography and Virtual Worlds: A Handbook of Method (Princeton University Press, 2012) with Tom Boellstorff, Celia Pearce and T.L. Taylor. Her most
recent research concerns future directions for technology, collapse computing, and the role of technology in supporting adaptation to sustainable practices. Dr. Nardi is a faculty member in the Department of Informatics in the Donald Bren School of Information and Computer Sciences at the University of California, Irvine.

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